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# BOOK OF PROCEEDINGS
# AND ABSTRACTS

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# Contents

# Prospective Serbian Varieties of Wild Flax *(Camelina Sativa (L.) Crantz)* in The Prilep Region

## Daniela Pelivanoska - Dameska[1*] Ljupco Mihajlov [2] Natalija Markova - Ruzdik [3]

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## Abstract

*Camelina sativa (L.) Crantz* is an important oilseed crop belonging to the *Brassicaceae* family. This crop, which has become very popular in recent years, is distinguished by a number of positive agronomic and agrotechnical properties, including low water and fertilizer intake, strong adaptation and resistance. Wild flax is a culture that is characterized by high economic value because it is used as a raw material for several purposes, namely: production of biofuels, biolubricants, active substances for pesticides, food for domestic animals, food for fish, in the cosmetic and pharmaceutical industry, in the industry for the production of edible oil, etc. In our country, this culture is still unknown, it is not grown and there are no literary data about it. With this in mind, we set ourselves the goal of performing investigations on some important morphological characteristics of the first Serbian varieties of *Camelina sativa L. Cruntz* in the Prilep area. The experiment was carried out on a soil type with a low content of humus and nitrogen, a medium supply of phosphorus and potassium and a moderately acidic reaction. Two cultivars "NS Zlatka" and "NS Slatka" from the Republic of Serbia, Institute of Horticultural Crops and Fields in Novi Sad, were placed in a randomized block system in three replications. The most important morphological and production characteristics were investigated, namely: plant height without root, number of branches per plant, number of pods per plant, average number of plants per m2 and average seed yield per unit area. Based on the obtained results, it can be concluded that both varieties are characterized by good morphological and production properties and an average seed yield per unit area of 1348 kg/ha for "NS Zlatka" and 1204 kg/ha for "NS Slatka".

**Keywords:** Wild flax, varieties, morphological characteristics, yield

## Introduction

Wild or also known as false flax *Camelina sativa (L.) Crantz*, is an annual, self-fertile, oil-bearing plant belonging to the *Brassicaceae* family (Berti et. al. 2016). The word camelina comes from the Greek word chamai, meaning short, dwarf, and the word linion, meaning flax. Cvejić et. al. (2016). Flax originated in southeastern Europe and southwestern Asia (Kagale et. al. 2014), and was domesticated in southeastern Europe in the Bronze Age, i.e. 2000 (Zubr 1997). The products obtained from this plant have been used since ancient times in the food, cosmetic industry, alternative and veterinary medicine, as well as for the production of biofuels and biolubricants (Zubr 1997). Wild flax or *Camelina sativa (L.) Crantz* stands out as an alternative oilseed crop characterized by modest growing

requirements, short vegetation (85 to 100 days from emergence to harvest) and versatile uses (Gehringer et. al. 2006; Marjanović Jeromela et. al., 2021; Kuzmanović et. al. 2021). This culture quickly absorbs water and nutrients from the soil, has little need for mineral and organic fertilizers and good tolerance to pests and diseases. Wild flax is well suited for production in temperate climates (Cvejić et. al. 2016). *Camelina sativa (L.) Crantz* is an annual plant species with a spindle-shaped root, which is deep and does not impoverish the soil in terms of moisture. The stem is branched, mostly herbaceous, although it may become woody at maturity. The leaves are arrow shaped. They are sharp, stationary, 5-10 cm long with smooth edges. The flowers are small with a pale yellow or greenish-yellow color and have 4 petals. Flax belongs to self-fertilizing plant species. The fruit is a pear-shaped shell containing the seed. The seeds are small, mostly yellow, oblong and characterized by an uneven surface. The mass of 1000 flax seeds is about 2-3 g (Marjanović-Jeromela et.al. 2016). In our country, this culture is not yet grown and there are no literary data from official research about it.

Keeping this in mind, we set ourselves the goal of performing investigations on some important morphological properties of two introduced varieties of *Camelina sativa (L.) Crantz* in the Prilep region.

The results of this research helped us to determine the most important morphological characteristics and the average seed yield of the two Novi Sad camelina varieties and the tendency for its spread and cultivation in the territory of the Republic of North Macedonia.

**Materials and Methods**

The research experiment on the wild flax *Camelina sativa (L.) Crantz* was placed on a colluvial-deluvial soil type with a low content of humus and nitrogen and medium availability of phosphorus and potassium. In the experiments, two genotypes of Serbian selection NS Zlatka and NS Slatka, which were created in the Republic of Serbia - Institute of Horticultural Crops and Fields in Novi Sad (Marjanović-Jeromela et. al. 2016), were tested. The experiment was set up in a randomized block system in three repetitions on the surfaces of the JNU Tobacco Institute - Prilep with coordinates N $41^0$ 22, 135', E $021^0$30, 707' and an altitude of 677m. The dimension of the basic plot was 10 m2, with 8 rows in the plot and an inter-row distance of 0.25 m. All necessary agrotechnical measures and adequate amount of fertilizer were fully applied to manifest the highest genetic potential of the varieties. Autumn basic tillage was carried out at a depth of 0.25 m, and during the vegetation the crop was fed with KAN (+/-

27%) at 42 g per row. Sowing was done on April 8, while harvesting on July 8. Harvesting was done at full maturity, manually, by pulling out whole plants with the root, with separate bunches formed on the plot itself for each replicate. The following important parameters were analyzed in this paper: plant height, root length, number of branches per plant, number of pods per plant, average number of plants per m2 and average seed yield per unit area.

**Results and Discussion**

Sowing date and climatic conditions affect the physiological processes of plants, i.e. their critical stages in terms of seed formation, quality and yield (Popović et. al. 2016; Righini et.al. 2019; Lily et. al. 2021). The vegetative period of the spring form of *Camelina sativa (L.) Crantz* is short and lasts from 85-100 days from germination to harvest (Cvejić et. al. 2016). The vegetative period of the spring form of *Camelina sativa (L.) Crantz* is short and lasts from 85-100 days from germination to harvest (Cvejić et. al. 2016). In 2023, during the 90-day vegetation period, total precipitation of 80 mm and an average daily temperature of about 19°C were recorded in the Prilep region.

One of the first morphological characteristics examined was the height of the above-ground part of the plant, which represents the distance from the base of the stem at ground level to its top. The optimal height ensures greater resistance of the plants to lodging, and therefore a higher and more stable yield. In the NS Zlatka variety, the maximum height of the stem was 110 cm, in the three repetitions, while the minimum height was 80 cm. The Novi Sad variety NS Slatka, on the other hand, was distinguished by a maximum height of 101 cm, and a minimum height of 81.5 cm. According to the obtained results, it can be noted that the average height of the variety NS Zlatka is distinguished by a higher height, which on average is 94.45 cm, while the Novi Sad variety NS Slatka is distinguished by a lower stem by 0.86 cm, 93.58 cm.

The stems of the camellia can be more or less branched depending on the variety and the density of sowing. A second morphological characteristic examined is the number of primary lateral branches originating from the main plant stem. The average number of lateral branches in the Novi Sad variety NS Zlatka from the three repetitions was 7. The Novi Sad variety NS Slatka was also characterized by a maximum average number of 7 branches. According to this morphological characteristic, it can be noted that there are no differences in the number of lateral branches between the two studied varieties.

One of the more important indicators that reflect the productivity of Camelina sativa is the number of pods per plant. Depending on the physiology of the plants and the conditions for growth and development, the number of pods in the examined Novi Sad cultivars NS Zlatka and NS Slatka varies from 100 to 300. In the research where the number of pods per plant was manually counted, a maximum number of 289 pods was recorded in both varieties. The average number of pods counted in the variety NS Zlatka was 184, which is 20 pods richer than the variety NS Slatka, which has an average of 164 pods per plant.

The average number of plants per unit area is one of the most significant elements of yield. This property is directly dependent on climatic factors and available moisture during vegetation. Figure 2 graphically shows the number of plants per one hectare sown with seeds that have laboratory determined 80% germination. From the obtained results, it can be noted that the Novi Sad variety NS Slatka is distinguished by an average number of 7,014,000 plants per ha, while the Novi Sad variety NS Zlatka has 787,000 less plants, that is, the average number of plants per ha for this variety was 6,277,200.

The yield is the most relevant indicator of the success of growing *Camelina sativa (L.) Crantz* in our conditions. The obtained yield depends primarily on the genetic characteristics of the variety, on its adaptation to soil and climatic conditions and on the applied agrotechnical measures. According to research done in the Prilep region, there is no significant difference in seed yield between the two studied varieties. From figure 2, it can be concluded from the calculations that the Novi Sad variety NS Zlatka, as the highest variety, gives the highest seed yield, which is about 1348 kg/ha, while the second Novi Sad variety NS Slatka, is distinguished by a significant seed yield, which is 1204 kg/ha.
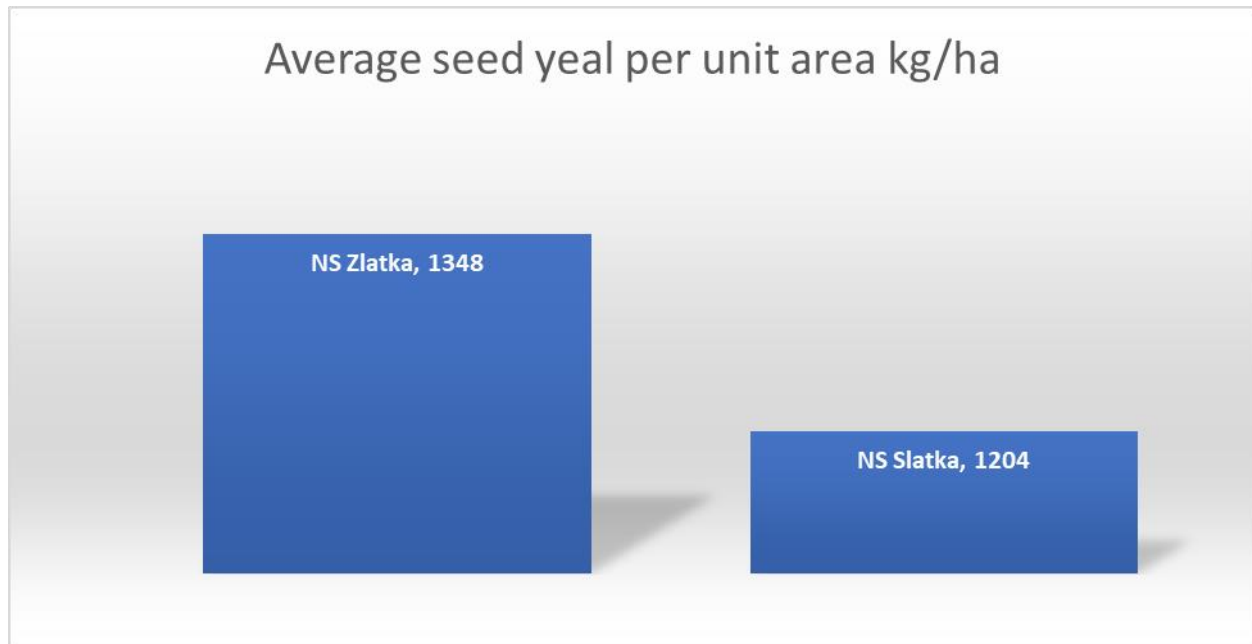
Figure 2. Average seed yield per unit area kg/ha of two varieties of *Camelina sativa (L.) Crantz,* 2023 in the Prilep region (NS Zlatka and NS Slatka).

**Conclusion**

*Camelina sativa* (L.) Crantz is an oil-bearing plant with a short vegetation period of 85 – 100 days. Wild flax is a culture that has high environmental adaptability, quickly absorbs water and nutrients from the soil, has little need for mineral and organic fertilizers and is characterized by good tolerance to pests and diseases. Plant height is a significant morphological characteristic that plays a key role in the production of a plant with high lodging and breakage resistance and a high harvest index. In view of the presented morphological characteristics of the investigated Novi Sad varieties of *Camelina sativa* (L.) Crantz, it can be concluded that these varieties are quite adaptable to our climatic conditions and there are no major deviations in terms of the average seed yield. The obtained results of this research can greatly help for the introduction, testing and development of other more profitable and profitable varieties of this oil-bearing crop in different regions of R. North Macedonia.

**References**

Cvejić, S., Marjanović Jeromela, A., Vollmann, J., Jocić, S., Bogdanović, S., Miladinović, D., & Imerovski, I. (2016). Značaj gajenja lanik (Camelina sativa L.) – novog izvora biljnih ulja 57. Savetovanje Proizvodnja i prerada uljarica sa medjunarodnim učešćem, Zbornik Radova, 19-24, 51-68.

Kagale, S., Koh, C., Nixon, J., Bollina, V., Clarke, W., Tuteja, R., Spillane, C., Robinson, S., Links, M.,Clarke, C., Higgins, E., Huebert, T., Sharpe, A., & Parkin, A.P. (2014). The emerging biofuel crop Camelina

sativa retains a highly undifferentiated hexaploid genome structure. Nature, https://doi.org/10.1038/ncomms.4706.

Zubr, J. (1997). Oil-seed crop: Camelina sativa. Ind. Crops Prod. 6, 113–119.

Gehringer, A.., Friedt, W., Lühs, & W., Snowdon, R.J. (2006). Genetic mapping of agronomic traits in false flax (*Camelina sativa subsp. sativa*). Genome, 49(12), 1555-1563.

Kuzmanović, B., Petrović, S., Nagl, N., Mladenov, V., Grahovac, N., Zanneti, F., Eynck, C., Vollmann, J., & Marjanović Jeromela, A. (2021). Yield-related traits of 20 Spring Camelina genotype grown in multi-environment study in Serbia. Agronomy, 11, 858.

Marjanović Jeromela, A., Terzić, S., Cvejić, S., Jocković, M., Zeremski, T., Miladinović, D., Jocić, S., & Vollmann, J. (2016). Production quality of false flax (*Camelina sativa (L.) Crantz*) 'Stepski' seed, a new promising oilseed crop for different uses. Proceedings of the III International Congress "Food Technology, Quality and Safety", Novi Sad, 296-299.

Popović, V., Vidić, M., Vučković, S., Dolijanović, Z., Đukić, V., Čobanović, L., & Veselić J. (2016): Potencijal rodnosti NS sorti soje Glycine max u proizvodnom rejonu Srbije. Zbornik naučnih radova Instituta PKB Agroekonomik, Beograd, 22: 1-2.

# The Effects of ecoAgra on Acclimatization of Tissue Cultured Banana Seedlings

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## Abstract

Türkiye's banana production area has increased significantly in recent years. The increase of production areas has also increased the need for banana seedlings. It is well known that the quality of seedling directly affects yield and quality of banana productivity. In this study, the effects of ecoAgra (biostimulant) on the development of seedlings of banana plants produced by tissue culture were investigated. 'Grand Nain' banana cultivar was used as a plant material. Two different treatments were applied except for the Control. In the first treatment (T1), seedlings propagated by tissue culture were transplanted to the viols containing peat:perlite (3:1) mixture and after that ecoAgra was applied (1 L ecoAgra/300 L water). In the second treatment (T2), ecoAgra treatment (1 L ecoAgra/300 L water) was applied 2 times (first, seedlings were transplanted into viols with peat:perlite (3:1) mixture and second, seedlings transferred to 0.5 L pots). Cultural treatments were applied as standard in all treatments. Pseodostem height and diameter, the number of primary roots, average root length, average root diameter, fresh and dry weights of shoot and root were examined. Compared to Control treatment, all the examined features were determined the highest values in T2 treatment and followed by T1. Pseodostem height and diameter were 17.6 cm and 15.31 mm in Control treatment respectively. On the other hand, pseodostem height and diameter were 18.2 cm and 18.37 mm in T1 treatment, and 21.5 cm and 20.28 mm in T2 treatment, respectively. Primary root length was 13.6 cm in the Control tratment, 16 cm in T1 treatment and 19.7 cm in T2 treatment. The highest fresh and dry weights of shoot and root were determined in T2 treatment. As a result of the study, T2 treatment was recommended in terms of all examined features.

**Keywords:** Biostimulant, seedling, tissue culture, root quality, fresh weight

## Introduction

Bananas are one of the most produced and traded fruits in the world. In the last decade, the area of banana cultivation worldwide has increased by 10%, and production has increased by 25% (FAO, 2022). The production situation of banana is much the same in Türkiye too. Turkey's cultivated area increased from 4.670 ha in 2013 to 13.611 ha in 2023. Banana production in Türkiye was 215.472 tons in 2013 and 930.240 tons in 2023 (TUİK, 2023). Protected cultivation has played an important role in increasing banana production in Türkiye. The main reason for the increase in protected cultivation of

banana is low labour cost, high financial income and consumer demand have contributed to the increase in banana production in Turkey. Bananas have been grown under open field conditions in the tropics. However, bananas have been grown both open fields and protected cultivation. Open field cultivation has been grown some microclimatic (Alanaya and Gazipaşa districts of Antalya). On the other hand, protected production is common Manavgat, Serik and Aksu districst of /Antalya, Anamau, Bozyazı and Erdemli disticts of Mersin and Adana and Hatay province. Therefore, there is a need for banana seedlings due to the increase in banana production areas and the renewal of existing orchards. The propagation of banana seedlings is mainly done by tissue culture in Türkiye for protected cultivation. The propagation of banana by tissue culture is the most widely used to produce virus-free, homogeneous and abundant plants (Al-Amin et. al., 2009). Bananas propagated by tissue culture are planted in vials and kept in plant growth chambers and then transferred to greenhouse for acclimatization. Tissue-cultured seedlings do not have strong roots at the rooting stage. However, these roots are strengthened with various applications in the aclimitaziton stage.

The use of healthy seedlings in the establishment of banana plantations is important for the improvement of plant growth and development and also yield. Because, health seedlings have strong roots. Akpınar et. al. (2020) inoculated different species of arbuscular mycorrhiza (AM) on tissue-cultured banana plants and studied their effects on plant growth and nutrient uptake. It was reported that the mycorrhiza-treated plants had better root and shoot dry matter accumulation, phosphorus and zinc uptake than the control treatment. They also found that the growth of the plants was positively affected as the dose of mycorrhizae increased (Wei et. al. 2022), six different media were prepared with cocopite, traditional substrate and biochar: CK (100% coccopite by volume), T1 (2% biochar+98% coccopite), T2 (5% biochar+95% coccopite), T3 (10% biochar+90% coccopite), T4 (20% biochar+80% coccopite) and T5 (50% biochar+50% coccopite). In the biochar treatments, observations up to 10% showed positive results, but in the 20% and 50% biochar treatments, plant height, root length and root and shoot dry weights decreased with increasing dose. The highest pseudostem height and root length were determined in the T3 treatment. The highest root dry mass and shoot dry mass were also determined in the T3 treatment. Li et al. (2019) investigated the effect of the symbiotic fungus, *Piriformospora indica*, on the growth of tissue-cultured banana seedlings to explore its potential applications in the banana

tissue culture industry. It was found that four weeks after inoculation, seedlings in the symbiotic fungus treatments had increased plant height, more and longer roots, increased shoot fresh weight, leaf width and length, and stem circumference compared to control treatment.

The use of organic fertilisers is also known to be highly effective in plant growth. Fernandez et. al. (2016) investigated the effect of vermicompost humic acids in some physiological indicators in the micropropagation and acclimatization phase of banana seedlings. Vermicompost humic acid was applied various doses (10, 20, 30, 40, 50 mg/L) except for control. Plant height and stem diameter values was measured on the $0^{th}$, $25^{th}$ and $50^{th}$ days after transferring the plants to the pots. The highest root number, average root length and root dry weight for the 40 mg/l vermicompost humic acid application were recorded on day 50.

In addition to mycorrhizal fungi, biofertilisers and organic fertilisers, biostimulants also strengthen the root structure of seedlings. EcoAgra is one of the biostimulant. There is no study on the effect of ecoAgra on root development in banana seedlings. However, Uddin et. al. (2020) investigated the effects of ecoAgra practices in cherry tomato cultivation. The researchers applied 2 doses of ecoAgra (2 ml/L and 4 ml/L), except for the control. As a result of the research, plant height, number of flowers, stem diameter and fruit characteristics (such as fruit width, fruit length, fruit weight, etc.) increased with increasing dose.

As mentioned above, there is a growing demand for seedlings, particularly in fruit species with increasing production, such as bananas. Indeed, high quality fruit production can be achieved with high quality seedlings. A high quality seedling must have a strong root system. In this study, the effects of ecoAgra applications at different stages on the development of tissue-cultured banana seedlings were investigated.

**Materials and Methods**

The study was conducted between 2022-2023. The field study was carried out at Devtaş Aymuz company in Manavgat district of Antalya. The laboratory study was carried out at the Physiology Laboratory of Akdeniz University, Faculty of Agriculture, Department of Horticulture. 'Grand Nain' banana cultivar propagated by tissue culture method was used as plant material in the study. EcoAgra,

which is not commercially available in Türkiye. It was provided by the USA for research purposes. The

properties and nutrient content of ecoAgra are given in Table 1 (Uddin et. al., 2020).

Table 1. Properties and nutrient content of ecoAgra

| Ingredients | Trace ingredients | | Specification | |
|---|---|---|---|---|
| Alkanolamines | Total solids | 0.37% | pH | 9.7 |
| Amino acids | Total nitrogen (N) | 0.033% | Flash point | None |
| Corn oil | Ammoniacal (N) | 0.014% | Odor | Vegetable smell |
| Soy | Phosphorus (P) | <0.1% | Boiling Point | 214.4°F |
| Coconut oil | Iron (Fe) | <2.5 mg/kg | Freezing point | 28.0°F |
| Nonionic surfactants | Magnesium (Mg) | <2.5 mg/kg | Specific gravity | 1.001 |
| Plant based substance | Potassium (K) | <2.5 mg/kg | Solubility in $H_2O$ | 100% |
| No synthetics | Sodium (Na) | 1.3 mg/L | Appearance | Clear gold |

In the study, 2 different treatments were used except for control. Peat and perlite were used (3:1) as the

growing medium. The treatments are given below.

*Control:* Tissue culture propagated seedlings were transplanted to the acclimatization greenhouse by

planting in vials. Plants were transplanted into 0.5 L pots 3 weeks after transfer. The plants were watered

routinely during this period.

*Treatment 1 (T1):* ecoAgra treatment (1 L ecoAgra/300 L water) was applied when the tissue-cultured

seedlings were transplanted into viols. Plants were transplanted into 0.5 L pots 3 weeks after

transplanting. The plants were watered routinely during this period.

*Treatment 2 (T2):* The ecoAgra treatment (1 L ecoAgra/300 L water) was applied both when the tissue

culture propagated seedlings were transferred to the vials and 3 weeks later when they were transplanted

into 0.5 L pots. The plants were watered routinely during this period.

*The following criteria were examined in the experiment.*

*Stem height (cm):* It was determined by measuring the height from the ground level to the starting point

of the last petiole with a ruler.

*Stem diameter (cm):* It was determined by measuring 5 cm above the soil level with a digital caliper.

*Number of primary roots (number):* Primary roots were counted from the roots removed from the

growing medium.

*Mean root length (cm):* The lengths of all primary roots were measured with a ruler and averaged.

*Average root diameter (mm):* The diameter of all primary roots was measured with a caliper and

averaged.

*Shoot fresh weight (g):* Plants were cut at ground level and the wet weights of pseodostem and leaves were measured on a precision balance.

*Shoot dry weight (g):* Pseodostem and leaves were dried in an oven at 65 °C to constant weight.

*Root wet weight (g):* Plants were cut at soil level, roots removed from the growing medium and root weights measured on a precision balance.

*Root dry weight (g):* Roots for which wet weight was determined were dried in an oven at 65 °C to constant weight.

The study was designed as a randomized block design with 3 replications and 10 plants in each replicate (3 treatments X 3 replications X 10 plants in each replicate = 90 plants). The analysis of variance of all the data obtained from the study was carried out using the XLSTAT program, and the LSD test was used for the comparison of means.

**Results and Discussion**

The effects of different treatments on pseodostem height and diameter of banana seedling are given in Table 2. As seen the Table 2, the lowest pseodostem height and s diameter values were determined in the Control treatment. On the contrary, the highest pseodostem height and diameter values were determined in Treatment 2 (two times ecoAgra treatments at the viol and pot transfer stage of seedlings).

Table 2. Effects of different treatments on pseodostem height and diameter in banana seedling

| Treatments | Pseodo Stem Height (cm) | Pseodostem Diameter (mm) |
|---|---|---|
| Control | 17.6 b | 15.31 b |
| Treatment 1 | 18.2 b | 18.37 a |
| Treatment 2 | 21.5 a | 20.28 a |
| LSD$_{\%5}$ | 1,350 | 2,220 |

[a,b,c] Values within a row with different superscripts differ significantly at P<0.05

The effects of different treatments on the number of primary roots, average root length and average root diameter of banana seedling are given in Table 2. As seen Table 2, The lowest number of primary roots was determined in the Control treatment and followed by Treatment 1. However, the highest number of primary roots was obtained from Treatment 2 (Figure 1). The average root length varied between 13.6 cm and 19.7 cm. The highest average root length was obtained from Treatment 2 with 19.7 cm. The

lowest average root diameter was obtained in the Control treatment (2.37 mm) as the other criteria and

the highest in Treatment 2 (3.20 mm).

Table 3. The effects of different treatments on the number of primary roots, average root length and root diameter of banana seedlings

| Treatments | Number of Primary Roots | Average Root Length (cm) | Average Root Diameter (mm) |
|---|---|---|---|
| Control | 9.8 b | 13.6 c | 2.37 b |
| Treatment 1 | 10.2 b | 16 b | 3.13 a |
| Treatment 2 | 11.4 a | 19.7 a | 3.20 a |
| LSD$_{\%5}$ | 0,665 | 1,936 | 0,200 |

[a,b,c] Values within a row with different superscripts differ significantly at $P<0.05$
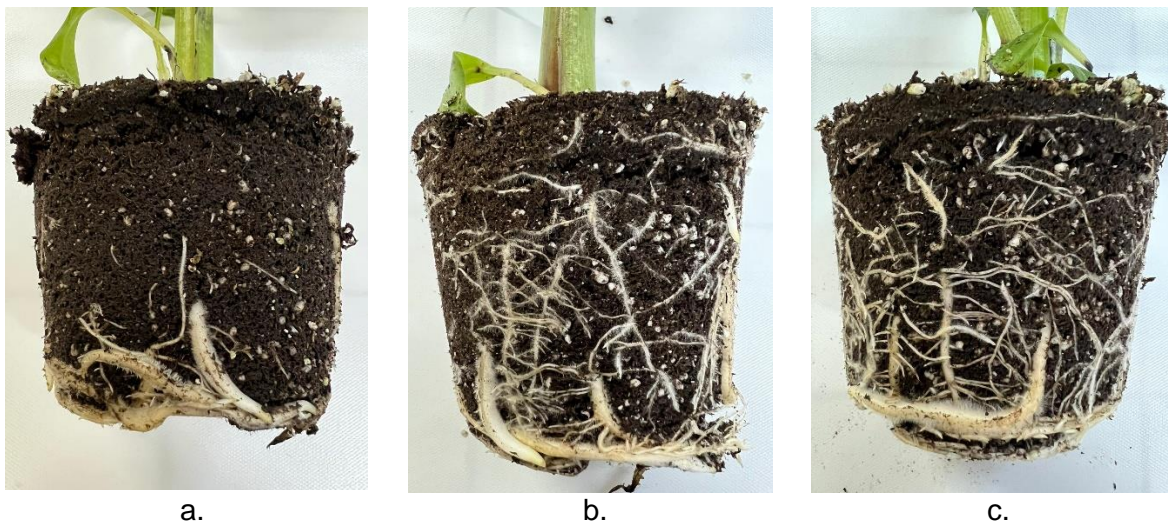


Figure 1. General views of the root structures of plants belonging to Control (a), T1 (b) and T2 (c).

The values of fresh and dry shoot and root weights, which are among the indicators of dry matter

accumulation. The shoot and root fresh and dry weight values are given in Table 4. Shoot fresh weight

values varied between 44.16 g and 64.9 g. The lowest shoot fresh weight was determined in the Control

treatment with 44.16 g and followed by Treatment 1 (ecoAgra was applied only viol stage) The highest

shoot fresh weight (64.9 g) was determined in Treatment 2 (two times ecoAgra treatments at the viol

and pot transfer stage of seedlings). The lowest shoot dry weight values were found in the Control

treatment (2.71 g) as in shoot fresh weight and the highest shoot dry weight values were found in

Treatment 2 (4.14 g). The lowest root wet weights (19.53 g) and dry weights (1.22 g) were recorded in

the Control treatment, while the highest root wet weights (24.46 g) and dry weights (1.64 g) were

determined in Treatment 2.

Table 4. The Effects of different treatments on shoot fresh and dry weight and root fresh and dry weight in banana seedlings

| Treatments | Shoot Fresh Weight (g) | Shoot Dry Weight (g) | Root Fresh Weight (g) | Root Dry Weight (g) |
|---|---|---|---|---|
| Control | 44.16 b | 2,71 c | 19.53 c | 1.22 c |
| Treatment 1 | 46.32 b | 3.17 b | 22.56 b | 1.42 b |
| Treatment 2 | 64.9 a | 4.14 a | 24.46 a | 1.64 a |
| LSD$_{\%5}$ | 4,263 | 0,277 | 1,330 | 0,099 |

[a,b,c] Values within a row with different superscripts differ significantly at P<0.05

In this study, the effects of biostimulants with the commercial name ecoAgra on the growth and development of tissue culture propagated banana seedlings were investigated. Except for control, 2 EcoAgra treatments were used. In Treatment 1, ecoAgra was applied only at the stage of transferring to the viols, while in Treatment 2, ecoAgra was applied at the two different stages (viols and the pots). The lowest pseodostem length, diameter, the number of primary roots, average root length and diameter, fresh and dry weight of shoots and fresh and dry root weights were determined in the Control treatment. However, the highest values were determined in Treatment 2 in terms of all the criteria examined. Studies on banana seedling growth showed that the lowest values of seedling growth were found in the Control group (Fernandez et. al., 2016; Li et. al., 2019; Akpınar et. Al, 2020; Wei et. al., 2022). We obtained similar results in the above studies. Our results also showed that two times the treatments gave better results than the others.

There are no previous studies the effect of ecoAgra on tissue banana seedlings acclimitazion. However, Uddin et. al. (2020) investigated the effects of ecoAgra on tomatoes. They found that the dose of application ecoAgra increased, it positively affected plant growth and fruit quality. We also obtained similar results with Uddin et al. (2020).

**Conclusion**

The results showed that both treatments of ecoAgra had a positive effect on the growth of the banana seedlings compared to the control. However, the treatment of ecoAgra two times (the transfer of the plants to the viols and transfer of the plants from the viols to 0.5 L pots after three weeks) gave the best results in all investigation criteria. In conclusion, the use of ecoAgra is recommended 2 times during the seedling growing stage in 'Grand Nain' banana seedling.

**Acknowledgements**

## References

Akpınar, Ç., Ortaş, İ. (2020). Mikoriza Aşılamasının Doku Kültürü Ortamında Yetiştirilen Muz Bitkisinin Büyümesi ve Besin Elementi Alımına Olan Etkisi. Alatarım 19(1),16-24.

Al-Amin, M. D., Karim, M. R., Amin, M. R., Rahman, S., Mamun, A. N. M., 2009. In Vitro Micropropagation of Banana (Musa Spp.). Bangladesh Journal of Agricultural Research. 34(4):645-659. https://doi.org/10.3329/bjar.v34i4.5840

FAO, 2022. https://www.fao.org/faostat/en/#data/QCL

Fernández, M. B. M., Chávez, E. S., Montero, D. C., García, A. C., López, D. M., Ardisana, E. F. H., & Álvarez, S. P. (2016). Influence of vermicompost humic acid on chlorophyll content and acclimatization in banana clone, Enano Guantanamero. African Journal of Biotechnology, 15(47): 2659-2670. https://doi.org/10.5897/AJB2016.15681

Li, D., Mensah, R. A., Liu, F., Tian, N., Qi, Q., Yeh, K., Xuhan, X., Chen, C., & Lai, Z. (2019). Effects of Piriformospora indica on rooting and growth of tissue-cultured banana (*Musa acuminata* cv. Tianbaojiao) seedlings. Scientia Horticulturae, 257:108649. https://doi.org/10.1016/j.scienta.2019.108649

TUİK, 2023. https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr

Uddin, A. F. M. J., Imam, M. H., Tusi, R. R., Bari, B. H. J., & Rakibuzzaman, M. (2020). Application of EcoAgra as Stimulator for Organic Cherry Tomato Production. International Journal of Business, Social and Scientific Research, 8(3), 34-37.

Wei, L., Huang, L., Li, X., Wang, Z., Chen, W., Huang, Q., Huang, Y., & Liu, Z. (2022). Biochar medium could significantly improve banana seedling growth. Ecology and Environment, 31(4), 732-739. https://doi.org/10.16258/j.cnki.1674-5906.2022.04.011

# Social Farming: Social Farming Projects in Türkiye and Their Outcomes

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## Abstract

Social farming is the combine agriculture with social and therapeutic benefits. It is very popular in Europe and Baltic countries  These farms focus on multifunctionality, not only producing food but also offering social services that benefit various vulnerable groups such as emotional disabilities, socially disadvantaged people, young offenders, elderly people, children with learning disabilities, addicts, the long-term unemployed, active seniors, schools, and kindergartens. Its main principles include offering care, promoting social inclusion, providing rehabilitation training, and ultimately improving the quality of life for these individuals. Social farming is also an important social service to meet policy demands for creating job opportunities in rural areas. Hence, this practice represents a synergy between agriculture and social welfare, helping to support both rural economies and the well-being of marginalized groups. This paper presents the scope of social farming and the results of social farming projects in which Turkey was involved as a partner.

Compared to Europe, social farming activities are not so common in Turkey. However, it is widely used in prisons and has the potential advantage to provide jobs for prisoners.  Türkiye was involved in three different international projects in the frame of social farming. One of them is Creen Care in Agriculture (COST-866), the other is Inclufar - Inclusive farming (Lifelong Learning program) and EcoFarms4Prisons (Erasmus KA200-Vet). The first two projects had already been completed, and the last one has been still going on. The main objective of Green Care was to increase scientific knowledge on best practices for implementing green care in agriculture to improve health and well-being.  On the other hand, Inclufar – inclusive farming was the combination of organic and biodynamic farming.  This approach brought positive benefits to people, nature and the landscape. The objective of ongoing project EcoFarms4Prisons is the using farming and agricultural resources to provide rehabilitation, education and vocational training for prisoners. The results of the social farming project show that Türkiye has significant potential in social farming and that social farming can be applied to many disadvantaged groups, from providing employment to reintegrating people into society.

**Keywords:** Green care, horticulture therapy, rural areas, disadvantaged people.

## Introduction

The main duty of the agricultural sector is to provide society's individuals with sufficient and quality food and basic necessities (Topal, 2010). Additionally, it contributes to solving employment issues, enhancing export opportunities, and supporting economic and social development. Social farming practices are also carried out within the agricultural farms. However, the purpose of social farming differs functionally from that of agricultural farms. Because social farming is based on a multi-functional view of agriculture (Braastad et al., 2007; Di Lavao et al., 2014; van Elsen et al., 2014). The main purpose of social farming and green care is the use of agricultural farms to improve mental and physical health (Braastad et al., 2007). According to Braastad et al., (2007), health and social services

need alternatives to traditional medical treatment, therapy, rehabilitation and vocational training education. van Elsen and Finuola (2013) stated that a better element such as provision, inclusion, rehabilitation, training and a better quality of life are included in social farming (van Elsen and Finuola 2013).

Social farming includes all activities related to animals, plants, forests and landscape (Braastad et al., 2007; Di Lavao et al., 2014; van Elsen et al., 2014). Across Europe, a wide range of people use social farming services, including People with mental health problems and people with disabilities (intellectual, physical and sensory), the elderly, children, people using drug/alcohol rehabilitation services, the long-term unemployed and active senior citizens and schools, kindergarten farms and prisoners. rehabilitation services, among others (Anonymous 2014; van Elsen et al., 2014).

Social farming is an advantage not only for farms, but also increases rural areas income and also can help improve the social and environmental awareness of clients. Some of the main benefits include containing health care costs or providing more efficient services; contributing to the viability of businesses, creating jobs and benefiting rural areas; providing new alternatives in health care and treatment; providing job training and skills development for individuals (Braastad et al., 2007; van Elsen and Finuola 201; Anonymous 2014). Increased social skills and confidence through working with others in a supportive environment. As a result, social farming activities improved physical and mental health and also social inclusion

Social farming has been gaining popularity day by day in Europe. Many different projects have been carried out related to social farming up to now. Firstly, starting with the European Community of Practice (CoP) Farming for Health (Hassink & van Dijk 2006), research activities were set up: the COST Action 866 Green Care in Agriculture (Braastad et al. 2007) and SoFar project in the frame of EU SoFar (Di Iacovo & O'Connor 2009) and Inclufar in body of Life Learning Program (van Elsen et al., 2014). The objective of the paper to evaluate the scope of social farming and the results of social farming projects in which Turkey is included as a partner.

**Materials and Methods**

In this paper, it is given basic information social farming and also results of social farming projects in which Turkey was involved, and their results were mentioned. Furthermore, it was given brief information about social farming status in Türkiye.

**Results**

Türkiye was involved in three different international projects in the frame of social farming in Europe. The first one is Creen Care in Agriculture (COST-866), the other is Inclufar - Inclusive farming (Lifelong Learning program) and the last one is EcoFarms4Prisons (Erasmus KA200-Vet). Green Care and Inclufar - Inclusive Farming (Lifelong Learning program) had been already completed. The last project has been still ongoing.

1. **Creen Care in Agriculture (COST-866)**

The Cost action was carried out between 2006 and 2010. There were 16 countries such as Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Greece, Iceland, Ireland, Italy, Malta, Netherlands, Norway, Poland, Slovenia, Sweden, Switzerland, Turkey and United Kingdom were involved in the action. Nearly 150 scientists from a number of disciplines and professions, such as psychiatry, psychology, ethology, sociology, social economics, nursing, ergo therapy, as well as from the agricultural and animal science, horticulture, forestry, landscape architecture, landscape ecology, and agricultural economic worked together (Braastad et al., 2007).

The main objective of the action was to increase scientific knowledge on the best practices for the implementation of practices in agriculture and improve of human mental and physical health and also quality of physical health and quality of life (Braastad et al., 2007). In order to achieve its objectives, the Action organized workshops, conferences and working group meetings during the action. Presentations at the meetings are published on the Action website: www.umb.no/greencare.

The action had three working groups namely Working Group 1 (Health effects), Working Group 2 (Economics) and Working Group 3 (Policy) (Braastad et al., 2007). Research on green care in the biological, medical and health sciences, including conceptual, theoretical and practical aspects were coordinated by Working Group 1 (Health Effects). On the other hand, research on the economics of green care services at the micro, mezzo and macro levels was coordinated by Working Group 2

(Economics). Working Group 3 (Policy), like the other Working Groups, coordinated research and developed new research on the management of green care services, as well as developing policy and discussing how green care can fit into current and future national health and social care systems, as well as positively influencing rural development.

Two workshops (Brussels 2006, Thessaloniki 2008) and one conference (Vienna 2007) were held during the action. One proceedings book with full papers from the first conference was published in 2007 (https://www.cost.eu/actions/866)

## 2. Inclufar - Inclusive farming (Lifelong Learning program)

Before the Inclufar project, two "Leonardo-Projects" supported by the European Lifelong Learning programme. The first one was DIANA. The training tools for practitioners are developed by DIANA. The second was MAIE. It was developed a curriculum to train farmers in the basics of starting social services on their farms (van Elsen et al., 2014). The third one was INCLUFAR. The INCLUFAR project focused on the transfer of experience from two existing training programs (van Elsen et al., 2014). The objective of the project was to transfer these experiences and to customize them to other European countries where there was a lack of such training experiences in the social farming sector. The Project was carried out between 2013 and 2015 (www.inclufar.eu). Austria, Bulgaria, Estonia, Finland, the Netherlands and Türkiye as well as the Northern Camphill Association covering Norway, Sweden, Finland, Estonia, Latvia and Russia (different initial conditions) were involved in the project (van Elsen et al., 2014).

After completing the project, The INCLUFAR handbook and curriculum were prepared, Curriculum was prepared in all partner languages. On the other hand, during the project, coaching team visited all partner countries through to Austria, Bulgaria, Estonia, Finland, Norway, the Netherlands and Türkiye. Furthermore, social and environmental inclusion were improved in partner countries.

## 3. EcoFarms4Prisons (Erasmus KA200-Vet).

The Erasmus+ project "EcoFarms4Prisons" – Cooperation for the improvement of sustainable and organic social farming practices in prison- was accepted in 2023 and it will last 36 months. Germany, Italy, Portugal and Turkiye are involved in the project. The objective of the project is the using farming and agricultural resources to provide rehabilitation, education and vocational training for prisoners. As

a result of the project, prisoners will have a better understanding of environmentally friendly farming practices.

### 4. Social farming status in Türkiye

Türkiye was involved in 3 different international projects about social farming. However, there are still no social farming farms like in Europe. However, Türkiye has a big advantage in the agriculture sector. Therefore, we can say that Türkiye can turn many agricultural farms into social farms. Compared to the target groups, the best implementation of social farming activities is managed by prisoners. Agricultural activities are carried out in open prisons in approximately 81 provinces. Prisoners work like in a factory in open prisons.

### Conclusion

Social farming is an important step for health community, clean and green environment, high quality food and better well-being life. Türkiye has significant potential in terms of agriculture sector. Because Social farming can be applied to many disadvantaged groups, from providing employment to reintegrating people into societySocial farming is also important to improve rural areas.

### Refererences

Anonymous, 2014. Costs and Benefits of Social Farming. Report of the Social Farming Across Borders (SoFAB) Project, 27 p.

Braastad, B. O., Gallis, C., Sempik, J., Senni, S., & van Elsen, T. (2007). COST Action 866 "Green Care in Agriculture" - a multi-disciplinary scientific network. Green care in agriculture: Health effects, economics and policies, 13-24.

Di Iacovo, F., Moruzzo, R., Rossignoli, C., & Scarpellini, P. 2014. Transition management and social innovation in rural areas: Lessons from social farming. The Journal of Agricultural Education and Extension, 20(3), 327-347.

Hassink, J., & Van Dijk, M. (2006). Farming for Health across Europe: comparison between countries, and recommendations for a research and policy agenda. In Farming for health (pp. 345-357). Dordrecht: Springer Netherlands.

Topal, Ş.M. (2010). Tarım sektörünün topluma karşı sorumlulukları. Trakya Üniversitesi Sosyal Bilimler Dergisi, 12:1, 1-31.

van Elsen, T., & Finuola, R. 2013, Policies and strategies of Green Care in Europe. – In: Gallis, C. (Ed.): Green Care for Human Therapy, Social innovation, Rural Economy and Education. Nova Science Publishers: 189-213, New York

van Elsen, T., Herz, G., Ehlers, H., Schäfer, W., & Merckens, K. (2014). Inclufar–Inclusıve Farming–A New Educational Approach in Social Farming. *Building Organic Bridges*, 2, 517-522.

# Assessing the Influence of Tirana's Agro-Ecological Conditions on the Nutritional Profile of Black Cumin (Nigella sativa)

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## Abstract

Black cumin (*Nigella sativa*), a widely cultivated aromatic plant, is renowned for its diverse medicinal properties and culinary applications. Its nutritional composition, however, can be influenced by environmental factors, including soil type, climate, and cultivation practices. This study investigates the impact of Tirana's distinct agro-ecological conditions on the nutritional profile of eight black cumin varieties sourced from different countries. The study investigated the nutritional composition of Nigella sativa seeds, specifically examining key parameters including total oil,ash,protein,carbohydrate, and nitrogen content, as well as moisture. These parameters provide valuable insights into quality and potential helth benefits of black cumin seeds. Results revealed significant variations in nutritional content among the studied varieties, highlighting the influence of genotype and environmental interaction. Notably, variety 3 exhibited the highest ash content, reaching 5.96%, suggesting potential differences in mineral uptake and accumulation. Variety 4 demonstrated the highest oil content at 31.36%, a crucial factor for its culinary and medicinal applications. Furthermore, variety 7 yielded the highest protein content, at 26.39%, and nitrogen content, at 4.98%, indicating its potential as a valuable source of these essential nutrients. This study provides valuable insights into the nutritional diversity of black cumin cultivated in Tirana's agro-ecological conditions. The findings contribute to a deeper understanding of how environmental factors can influence the quality and nutritional value of this important crop. Further research exploring the bioactive compounds and potential health benefits of these black cumin varieties is warranted.

**Keywords**: Nigella sativa, nutritional profile, variety, environment interaction

### Introduction

Nigella sativa, commonly known as black cumin, has been used in traditional medicine for centuries and is valued for its wide range of health benefits. (Srinivasan, 2018) The seeds are rich in nutrients, including proteins, carbohydrates, vitamins, and minerals, which have been widely studied for their potential benefits. (Hannan, 2021) Understanding the nutritional composition of *N. sativa* is important for several reasons. It helps us understand the health benefits of consuming seeds, compare different varieties or cultivation methods to select the best ones for specific purposes, and learn how the plant adapts to different growing conditions (Ramadan, 2021). One of the most notable features of *N. sativa* seeds is their high protein content, which includes essential amino acids that are crucial for important processes like protein building, enzyme function, and brain activity (Wu, 2016). These amino

acids support healthy brain function, including communication between nerve cells and overall cognitive health (Ramadan, 2007). The seeds also provide carbohydrates, which serve as a key energy source for both physical activity and basic body functions. (Holesh, 2023) Additionally, the high ash content of the seeds indicates they are rich in essential minerals, which are vital for maintaining balance in the body, supporting muscle function, nerve signaling, and bone strength. (Afoakwah, 2023) These combined nutritional benefits make *N. sativa* seeds valuable for use in food, nutrition, and medicine, with further research needed to explore their full potential. (Balyan, 2022)

Studying the nutritional components of *Nigella sativa* in Tirana, Albania, is essential to understand how local agro-ecological conditions influence its quality. This research supports the development of region-specific cultivation practices, enhances the plant's nutritional and medicinal value, and promotes its use in health, nutrition, and local agriculture. (J.Biturku, 2024)

**Materials and Methods**

**Material**

The seeds of eight *N. sativa.L* varieties were collected in 2023 from the  Didactic Experimental Field of Agricultural University of Tirana 41.3998180, 19.7285460, during August 2023. These varieties were initially sourced from the following sources: 1-Nabial MORSI.CO sample NO:136; 2- Jeddah Kindom of Saudi Arabia Sifa international Mfg.; 3- Medical plant Tirana; 4- Egypt; 5- Syria Almnarco.com; 6-Turkey; 7- Syria code 353 Natural dry nuts& herbs; 8- Turkey product No 012 Sakli Doga.

**Methods**

Nutritional composition of the Nigella seed oil cake was determined using the recommended methods of the association of official analytical chemists (AOAC 2002).

*Oil Extraction*

15 grams of *N. sativa.L* seeds were ground into a fine powder and placed in a Soxhlet extractor with 150–200 mL of petroleum ether (boiling range 40–60°C). The solvent was cycled for 6–8 hours

until clear, indicating complete extraction. The solvent-oil mixture was evaporated to recover the solvent, leaving crude oil as residue. The oil was collected and stored for further analysis. (Le, 2004)

*Moisture determination (%):*

Collected samples were washed and passed through pure water, then dried and ground. Approximately 1.5 g of the ground samples were weighed and placed in metal containers and left in the oven at 105 °C for 6-7 hours. After the samples were brought to room temperature, they were weighed again and the percentage of moisture was determined. (Kaya, 1998)

*Protein determination (%)*

It was determined by the Kjeldahl method (Bremner, 1965). Protein was calculated using a nitrogen conversion factor of 6.25. (Mariotti, 2008)

*Determination of ash (%):*

1.5 g of the ground seeds sample was placed in a tared porcelain crucible and weighed together with the porcelain crucible. Then, the porcelain crucibles were burned in a muffle furnace at 550-600 °C until the color of the samples in the crucible turned silver. After the temperature of the samples coming out of the furnace reached room temperature, they were weighed again and the amount of ash was determined. (Thiex, 2012)

*Determination of carbohydrates*

The total carbohydrate amount was determined with the following difference formula (Sahin and Sumnu, 2006): Total carbohydrate amount (%) = dry sample % - fat % - protein % - ash % - fiber % Dry sample means the sample dried in a 105˚C oven until it reaches a constant weight, and its moisture is removed. (Koksal, 2001)

**Results and Discussion**

The nutritional analysis of eight *Nigella sativa* varieties grown in the Tirana region revealed variations in key traits, including moisture, ash, crude oil, protein, and carbohydrate content. Moisture content ranged from 6.90% in T-4 to 7.30% in T-5, showing consistent levels suitable for storage and

processing. Ash content, which reflects the mineral composition, varied between 4.52% in T-4 and 5.96% in T-3, indicating differences in mineral richness among the varieties. Crude oil content showed notable variation, with T-4 having the highest value (31.36%) and T-5 the lowest (23.14%). Protein content ranged from 20.94% in T-4 to 24.91% in T-2, highlighting differences in the availability of essential amino acids. Carbohydrate content was highest in T-5 (40.76%) and lowest in T-1 (35.52%), contributing significantly to the seeds' energy value. These findings are summarized in Table 1.

Table 1: Nutritional Composition of *Nigella sativa* Varieties Cultivated in Tirana, Albania

| Variety | Moisture (%) | Ash (%) | Crude Oil (%) | (N%) | Protein (%) | Carbohydrate (%) |
|---------|-------------|---------|---------------|------|-------------|------------------|
| T-1 | 7.1 | 5.54 | 29.9 | 4.14 | 21.942 | 35.518 |
| T-2 | 7.23 | 5.88 | 23.7 | 4.7 | 24.91 | 38.28 |
| T-3 | 7.14 | 5.96 | 25.42 | 3.99 | 21.147 | 40.333 |
| T-4 | 6.9 | 4.52 | 31.36 | 3.95 | 20.935 | 36.285 |
| T-5 | 7.3 | 5.43 | 23.14 | 4.41 | 23.373 | 40.757 |
| T-6 | 6.11 | 5.62 | 23.25 | 4.66 | 24.698 | 40.322 |
| T-7 | 6.42 | 5.75 | 24.75 | 4.98 | 26.394 | 36.686 |
| T-8 | 6.46 | 5.56 | 27.18 | 4.03 | 21.359 | 39.441 |

Table 1. presents the moisture, ash, crude oil, protein, and carbohydrate content of eight Nigella sativa varieties grown in Tirana, Albania, highlighting variability influenced by genetic and environmental factors.

To provide a clearer comparison, Chart 1 presents a grouped bar chart illustrating the nutritional traits across the eight varieties. This visualization highlights standout characteristics, such as the high crude oil content in T-4 and the notable protein level in T-2.

Chart.1 Comparison of Nutritional Traits across Varieties of *N. sativa L.*
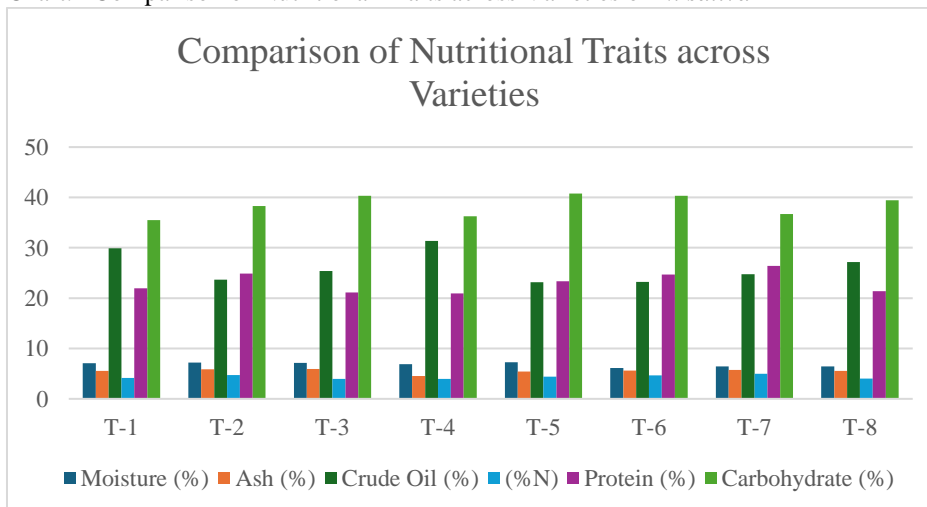
Chart.1 The chart compares key nutritional traits—Moisture, Ash, Crude Oil, Protein, and Carbohydrates—across eight *Nigella sativa* varieties (T-1 to T-8) grown in Tirana. It highlights the variability in nutritional content, such as high crude oil in T-4 and notable protein in T-2, aiding in identifying varieties with optimal profiles for specific applications.

Further analysis of trait relationships is shown in Figure 1, a correlation matrix that illustrates the interdependence between key nutritional components.

Figure1. Correlation matrix among nutritional traits

| | Variety. | Moisture. | Ash. | Crude.Oil | N | Protein. | Carbohydrate. |
|---|---|---|---|---|---|---|---|
| Variety. | 1 | | | | | | |
| Moisture. | -0.73738 | 1 | | | | | |
| Ash. | -0.0405 | -0.00566 | 1 | | | | |
| Crude.Oil | -0.26644 | 0.107102 | -0.67992 | 1 | | | |
| N | 0.23288 | -0.3246 | 0.428984 | -0.67838 | 1 | | |
| Protein. | 0.23288 | -0.3246 | 0.428984 | -0.67838 | 1 | 1 | |
| Carbohydrate. | 0.338325 | -0.05221 | 0.385855 | -0.71259 | 0.006151 | 0.006151 | 1 |

The correlation matrix reveals key relationships among traits of *Nigella sativa*. Protein and Nitrogen show a perfect positive correlation (1.00), while Ash and Nitrogen have a moderate positive correlation (0.43). Negative correlations include Carbohydrates and Crude Oil (-0.71) as well as Ash and Crude Oil (-0.68), indicating trade-offs between these traits. Moisture and Ash exhibit almost no correlation (-0.01), suggesting independence. These insights underscore the combined influence of genetic factors and growing local conditions on the nutritional composition of *N. sativa L.* Our findings align with those reported by (Hossain, 2024), who analyzed the nutritional composition of Nigella sativa seeds and observed similar ranges in moisture, ash, crude oil, protein, and carbohydrate contents. This consistency underscores the reliability of our data and highlights the potential of *N. Sativa L.* as a valuable crop in Albania.

**Discussion**

This study marks the first comprehensive evaluation of the nutritional profile of *Nigella sativa* varieties cultivated in the Tirana region of Albania. By analyzing key traits such as moisture, ash, crude oil, protein, and carbohydrates, it provides valuable baseline data for the local adaptation and quality of this medicinal plant. The findings emphasize the significance of *N. sativa* as a versatile crop with

applications in food, nutrition, and medicine, highlighting its potential for contributing to Albania's agricultural diversity.

The research also sheds light on how genetic variability and local agro-ecological conditions influence seed quality, offering critical insights for developing region-specific cultivation strategies. This study provides a foundation for promoting *N. sativa* as a high-value crop in Albania, with opportunities to enhance its use in functional foods, dietary supplements, and pharmaceuticals. Furthermore, these results can guide future research into optimizing its cultivation under different environmental conditions and exploring its bioactive properties. By bridging the gap in knowledge about *N. sativa*'s performance in Albania, this work supports sustainable agricultural practices and adds value to the country's agricultural output.

### Acknowledgements

### References

Afoakwah, N. A. (2023). Nutritional, biochemical, and functional characteristics of black cumin seeds. In *Biochemistry, nutrition, and therapeutics of black cumin seed* (pp. 27--41). Elsevier.

AOAC 2002, F. P. (n.d.). *AOAC International methods committee guidelines for validation of qualitative and quantitative food microbiological official methods of analysis.* Oxford University Press.

Balyan, P. a. (2022). Traditional and modern usage of Nigella sativa L.(Black cumin. *Annals of Phytomedicine*, 255--265.

Bremner, J. (1965). Total nitrogen. *Methods of soil analysis. Part*.

Hannan, M. A. (2021). Black cumin (Nigella sativa L.): A comprehensive review on phytochemistry, health benefits, molecular pharmacology, and safety. *Nutrients*, 1784.

Holesh, J. E. (2023). *Physiology, carbohydrates.* StatPearls Publishing.

Hossain, M. a. (2024). Nutritional composition, fatty acids, bioactive compounds, and antioxidant activity of Nigella sativa seed grown in Bangladesh. *Discover Food*, 52.

J.Biturku, E. D. (2024). Toward Sustainable Food System: Enhancing Agricultural Diversity by Growing Nigella sativa L. Under Agroecological Condition of Albania. *International Food Innovation and Sustainability Congress*, (p. 90). Istambul, Turkey.

Kaya, N. (1998). Biyokimya uygulama k{\i}lavuzu. *kaya1998biyokimya*, 57.

Koksal, .. (2001). Dougu Karadeniz Bolgesi Findiklarinda Bitki Bunyesindeki Karbonhidrat Duzeyinin Enzimatik Yontemle Belirlenmesi. *Journal of Agricultural Sciences, 7*.

Le, P. M.-A. (2004). The petroleum ether extract of Nigella sativa exerts lipid-lowering and insulin-sensitizing actions in the rat. *Journal of ethnopharmacology*, 251--259.

Mariotti, F. a. (2008). Converting nitrogen into protein—beyond 6.25 and Jones' factors. *Critical reviews in food science and nutrition*, 177--184.

Ramadan, M. F. (2007). Nutritional value, functional properties and nutraceutical applications of black cumin (Nigella sativa L.): an overview. *International journal of food science \& technology*, 1208--1218.

Ramadan, M. F. (2007). Nutritional value, functional properties and nutraceutical applications of black cumin (Nigella sativa L.): an overview. *International journal of food science \& technology*, 1208--1218.

Ramadan, M. F. (2021). *Introduction to black cumin (Nigella sativa): Chemistry, technology, functionality and applications.* Springer.

Srinivasan, K. (2018). Cumin (Cuminum cyminum) and black cumin (Nigella sativa) seeds: traditional uses, chemical constituents, and nutraceutical effects. *Food quality and safety*, 1--16.

Thiex, N. a. (2012). Determination of ash in animal feed: AOAC official method 942.05 revisited. *Journal of AOAC International*, 1392--1397.

Wu, G. (2016). Dietary protein intake and human health. *Food \& function*(Food \& function), 1251--1265.

# Dörtlü Bakteri Formülasyonlarının Yenice Kırmızı Biberi Gelişme, Verim ve Kalitesi Üzerine Etkisi

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## Özet

Çevre dostu tarımsal uygulamalara olan artan gereksinim, bitki gelişmesini teşvik edici yararlı bakteri easlı gübrelerin kullanılmasını teşvik etmektedir. Bu araştırma mineral gübreleme (NPK, 20 kg N/da + 8 kg $P_2O_5$ /da + 8 kg $K_2O$/da) ve azot fikseri, fosfat çözücü, indol asetik asit üretici ve ACC deaminaze aktivitesine sahip bakteri easlı üç dörtlü bakteri formülasyonunun (BF1:*Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111 + *Bacillus megaterium* RC491+ *Bacillus thuringiensis* RC591; BF2: *Pseudomonas fluorescens* RC512+ *Pseudomonas stutzeri* RC281+ *Bacillus subtilis* RC111+*Bacillus licheniformis* RC601 ve BF3: *Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111+ *Bacillus megaterium* RC491+ *Pantoea agglomerans* RC58) Yenice Kırmızı Biberi (*Capsicum annuum* L. var. c*onoides* cv. *kapija*) gelişme, verim ve kalitesi üzerine etkisi test edilmiştir. Tarlaya dikim öncesinde fidanların kök akzamı 60 dakika süreyle bakteri süspansiyonu (yoğunluk $10^9$ cfu $ml^{-1}$ ) içine daldırılmış, bakteri uygulanmayan fidanlar ise sadece su içinde bekletilmiştir. İki deneme seti ortalamasına göre BF1, BF2 ve BF3 bakteri formülasyaonları aşılamasıyla sırası ile kontrole kıyasla, biber bitki boyu %15,7, 14,1 ve11,2; gövde çapı % 16,2, 15,7 ve 11,0; meyve boyu %24,9, 20,9 ve 16,8; meyve eni %22,4, 18,1 ve 17,7; meyve et kalınlığı %25,0, 21,6 ve 15,9; meyve ağırlığı %25,7, 20,5 ve 17,9; biber meyve verimi %28,2, 24,5 ve 22,8; klorofil oranı ise sırası ile %25,1, 21,8 ve 19,2, suda çözünen kuru madde miktarı %16,8, 10,6 ve 11,8; kapya biber L* değeri %18,4, 15,2 ve 14,1 ve a* değeri ise sırası ile %25,6, 21,3 ve 23,7 oranlarında artmıştır. Optimum mineral gübre uygulamasında ise bitki boyu %14,7, gövde çapı %16.7, meyve boyu %26,6, meyve eni %24,7, meyve et kalınlığı %21,8, meyve ağırlığı %25,6, biber verimi %27,5, klorofil oranı %24,8, SÇKM oranı %8,5, kapya biber L* değeri %10,6 ve a* değeri ise %19,4 oranında artmıştır. Test edilen bakteri formülasyonları biber gelişme, verim ve kalite parametreleri bakımından optimum mineral gübrelemeye eşit veya daha yüksek oranda etkin bulunmuştur. Bu çalışmada test edilen formülasyonların sürdürülebilir ve organik kapya biber üretiminde biyolojik gübre olarak kullanılma potansiyeli bulunmaktadır.

**Anahtar Kelimeler:** Yenice kırmızı biberi, bitki gelişmesini teşvik edici bakteri, biyolojik gübre, biyoformülasyon, verim ve kalite

### Giriş

Tarımsal üretimi artırmak için kimyasal gübreler gelişigüzel kullanılmaktadır, ancak insan ve çevre sağlığı bakımından olumsuz etkileri nedeniyle sürdürülebilir olmayan bir yaklaşım olarak kabul edilmektedir. Çevre dostu tarımsal uygulamalara olan artan gereksinim, bitki gelişmesini teşvik edici yararlı bakteri easlı gübrelerin kullanılmasını teşvik etmektedir. Yenice Ziraat Odası tarafından 10.03.2021 tarihinde 692-Menşe Adı Coğrafi İşaret tescili ile Biber/İşlenmiş ve İşlenmemiş meyve ve sebzeler ile mantarla Ürün/Üriün Grubunda tescil edilmiş, daha çok taze, salçalık ve konservelik olarak kullanılan konik şekilli  "Yenice Kırmızı Biberi" (*Capsicum annuum* L. var. c*onoides* cv.kapija) [*Capsicum annuum* L. var. *conoides* (Mill.) Irish], coğrafi açıdan Çanakkale ilinde Yenice ilçesi başta olmak üzere; Bayramiç, Biga ve Çan ilçelerinde yetiştirilmektedir (Çiftçi vd., 2023). Kırmızı rengini

aldığında tüketilen, salçalık ve yağlık olarak ta adlandırılan, Yenice Kırmızı Biberi taze olarak tüketilebildiği gibi, dondurulmuş, kurutulmuş veya közlenmiş olarak ya da salça, sos, baharat ve konserve olarak da tüketilebilmektedir. Bu çeşit parlak, doygun homojen kırmızı renk, et kalınlığının fazla, SÇKM ve şeker içeriği yüksek, bitki boyu 50-100 cm arasında değişmektedir. Meyveleri konik şekilli, ucu hafifçe kıvrık, 3-4 loplu, meyve boyu 15-20 cm, meyve eni 6,5-8 mm, meyve et kalınlığı 3-4 mm ve meyve ağırlığı yaklaşık 100-170 gramdır. Genellikle taze olarak ve konserve halinde ihraç edilen Kapya biberi, Yenice ilçesinde fazla miktarda üretildiği ve bu bölgedeki sanayi tesislerinde değerlendirilmesi dolayısıyla da ulusal pazarlarda "Yenice Biberi" adıyla tanınmaktadır.

Bitki gelişmesini teşvik edici bakterilerin, gelişmeyi teşvik mekanizmaları tam olarak açıklanamamış olmakla birlikte, bu bakterilerin bir çok faydalı özellikleri bakımından tarımda kullanımı giderek yaygınlaşmaktadır. Bir çok durumda kimyasal uygulamaların neden olduğu ekolojik zararlar giderek kontrol edilemez ve çoğu zaman geri döndürülemez hale gelmektedir. Bu zorluklar nedeniyle sürdürülebilir gıda üretim sistemleri geliştirmek amacıyla, alternatif gübreleme mekanizmalarının araştırılması dünya çapında artmakta ve özellikle başta fosfor olmak üzere besin çözünürlüğü (Çakmakçı vd., 2010; Borgi vd., 2020; Verma vd., 2020), fosfor ve benzeri besin elementlerinin bitkiler tarafından kolayca alınabilen biyolojik olarak kullanılabilir forma dönüştürülmesi (Çakmakçı vd., 2006, 2007; Dey, 2021), bitki hastalıklarını baskılama (Bektas ve Kusek, 2021; Jayakumar vd., 2021), bitki bağışıklık tepkilerini ve topluluk ekolojisini değiştirme (Wang ve diğerleri, 2022), azot fiksetme (Çakmakçı vd., 2001; Şahin vd., 2004; Hara vd., 2020), indol asetik asit (IAA), gibberellinler (GA) ve sitokininler gibi kök mimarisini değiştiren fitohormonları salgılama (Aslantaş vd., 2007; Çakmakçı vd., 2009; 2020; Khan vd., 2020), stres etileni miktarını ve stresinin olumsuz etkilerini azaltma (Çakmakçı, 2009; Yıldırım vd., 2008; Karagöz vd., 2018) gibi özellikleri bakımından etkin mikroorganizmalar kullanılarak biyolojik gübre formülasyonları geliştirilmektedir. Bu araştırmada azot fikseri, fosfat çözücü, indol asetik asit üretici ve ACC deaminaze aktivitesine sahip bakteri esaslı üç dörtlü bakteri formülasyonunun Yenice Kırmızı Biberi (*Capsicum annuum* L. var. c*onoides* cv. *kapija*) gelişme, verim ve kalitesi üzerine etkisi test edilmiştir.

## Materyal ve Methot

Tarla denemeleri Çanakkale ilinin kapya biber üretiminin en fazla yapıldığı ilçelerden biri olan Yenice'de merkeze bağlı Cumhuriyet mahallesinde kapya biber üretim alanlarında 260/37 ada parsel numaralı arazinin yaklaşık 5 dekarlık kısmında gerçekleştirilmiştir. Denemelerde Yenice Kırmızı Biberi (*Capsicum annuum* L. var. *conoides* cv. kapija) çeşidi kullanılmıştır. Biber tohumları 14 Nisan 2023 tarihinde, hayvan gübresi ile organik maddece zenginleştirilmiş, işlenmiş tırmıkla düzeltilmiş, tınlı - kumlu su tutma kapasitesi yüksek fideliğe ekilmiştir. Tohum ekimi yapılan fideliğin üzeri geceleri düşük sıcaklık dolayısıyla plastik örtü ile kapatılmıştır. Fideler tüpsüz olarak yetiştirilmiştir. Fideliklerde ince süzgeçle düzenli sulama ve elle yabancı ot kontrolü yapılmıştır. Yaklaşık olarak 15 cm boya ulaşan fideler dikime hazır hale gelmiştir. Fidelerin tarlaya dikimi öncesinde fidelikten kolay sökümünün sağlanması için söküm öncesi sulaması yapılmış ve fidelerin köklerinin zedelenmeden çıkarılmasına özen gösterilmiştir. Fidelerin 8 Haziran 2023 tarihinde sökülen fideler, tarlaya dikim öncesinde bakteri süspansiyonuna kök daldırması yöntemiyle ile dikime hazırlanmıştır. Bakateri aşılama olarak, kök daldırmasında, fidelerin inokulasyonu köklenmiş çıplak biber fidelerinin kök bölgesinin dikim öncesinde 60 dakika bütünüyle bakteri süspansiyonu ($10^9$ cfu ml$^{-1}$) içine daldırılması şeklinde gerçekleştirilmiştir. (Çakmakçı vd., 2011, 2012). Fideler topraksız olarak kök bölgesi bakteri süspansiyonu ile inoküle edildikten sonra kök bölgesi seviyesine kadar toprağa dikilmiştir. Normal kök daldırma yöntemiyle biyolojik gübre aşılanıp tarlaya dikilen fideler, daha sonra ikinci bir bakteri aşılaması olarak mikrobiyal gübrenin fideler üzerine püskürtülmesi yöntemiyle de bakteri uygulanmıştır. Bitkilere sprey olarak (püskürtme yöntemi) mikrobiyal gübre uygulaması dikimden 20 gün sonra kaymak tabakası kırma ve hafif boğaz doldurma çapası sonrasında yapılmış ve akabinde biberlere su uygulanmıştır.

Bu araştırma mineral gübreleme (NPK, 20 kg N/da + 8 kg $P_2O_5$ /da + 8 kg $K_2O$/da) ve azot fikseri, fosfat çözücü, indol asetik asit üretici ve ACC deaminaze aktivitesine sahip bakteri esaslı üç dörtlü bakteri formülasyonunun (BF1:*Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111 + *Bacillus megaterium* RC491+ *Bacillus thuringiensis* RC591; BF2: *Pseudomonas fluorescens* RC512+ *Pseudomonas stutzeri* RC281+ *Bacillus subtilis* RC111+*Bacillus licheniformis* RC601 ve BF3: *Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111+ *Bacillus megaterium* RC491+ *Pantoea*

*agglomerans* RC58) Yenice Kırmızı Biberi (*Capsicum annuum* L. var. *conoides* cv. *kapija*) gelişme, verim ve kalitesi üzerine etkisi test edilmiştir .Tarla denemesi tesadüf bolkları deneme desenine göre dört tekerrürlü kurulmuş, blok ve parseller arasında 1'er m boşluk bırakılmıştır. Uygulamalar parsellere tesadüfi olarak dağıtılmıştır. Her bir parsel genişliği 3,2 m ve uzunluğu 20 m olmak üzere, 80 cm sıra aralıklı ve 30 cm sıra üstü aralıklı 4 sıra fide dikimi yapılmıştır. Tarla denemesi her bir parsel alanı 3,2 x 20=64 m$^2$ toplam deneme alanı 15,8 m x 104 m= 1643 m$^2$ x 2 tekrar = 3286 m$^2$ olacak şekilde kurulmuştur. Parsel ve bloklar arasında 1 m olacak şekilde biber dikimi yapılmıştır.

Dene alanı erken ilkbaharda 3 ton/da yanmış çiftlik gübresi verilerek derin sürülmüş, dikim zamanında diskaro öncesi 3 ton/da yanmış çiftlik gübresi verilerek toprağa karıştırılmış ve diskaro ile fide dikimine hazırlanmıştır. Gübreleme programı olarak mineral gübre uygulanan parsellere ve mikrobiyal gübre uygulamalarında dikim öncesi diskaro önüne olmak üzere fosforlu ve potasyumlu gübrenin tamamı ile azotlu gübrenin yarısı uygulanmıştır. Planlanan dozlarda mineral gübre Kompoze 15-15-15 ve CAN%26 gübreleri ile karşılanmıştır. Azotun %50'si dikim öncesi toprak işlemede, kalan kısmın %25'i ara çapada, geri kalan %25'i de çiçeklenmeden önce verilmiştir.

Damlama sulama boruları iki sıra arasına bitki gövdesi ile temas etmeyecek şekilde yerleştirilmiş ve biber fidesi dikildikten sonra fidelere can suyu verilmiştir. Dikimden sonra düzenli sulamalar 15 gün sonra yapılmaya başlamıştır. Meyve verdikten sonra birer hafta aralıklarla sulama yapılmıştır. Dikimden 20 gün sonra kaymak tabakası kırma ve hafif boğaz doldurma çapası yapılmıştır. Bundan 20 gün sonra üçüncü bir ot çapası yapılmıştır. Denemeler süresince bitkilere herhangi bir kimyasal ilaç uygulanması yapılmamıştır. Saksılarda yabancı ot çıkması durumunda elle kontrol edilmiştir.

Tarla denemelerinde biber hasadında parsel kenarlarından birer sıra ve parsel başlarından birer metre kenar tesiri olarak ayrılmış, kalan kısım (2 sıra, 18 m uzunluk=36 m$^2$) biber hasadı yapılmıştır. Denemede mikrobiyal gübre etkinliğinin belirlenmesi için aşağıdaki parametreler belirlenmiştir.

*Gövde çapı* (mm): Toprak yüzeyinden itibaren yaklaşık 3-5 cm yükseklikten bitkide dallanmanın başladığı noktanın altından dijital kumpas kullanılarak gövdenin çapı ölçülmüştür.

*Bitki boyu (cm):* Hasat döneminde her bitkinin toprak yüzeyinden bitkinin en uç noktasına kadar olan uzunluk ölçülmüştür.

*Meyve boyu (cm):* Meyve boyu, sap kısmından uca kadarki kısmın cetvel yardımıyla ölçülmesiyle belirlenmiştir.

*Meyve eni (mm):* Meyve eni, sapın altından meyve etinin en geniş kısmından dijital kumpas yardımıyla ölçülmüştür.

*Meyve et kalınlığı (mm):* Meyveler uzunlamasına kesilmiş, meyve eti kalınlığı sapa yakın olan yerden dijital kumpas ile ölçülerek belirlenmiştir.

*Meyve ağırlığı (gram):* Her bir hasat parselindeki 40 bitki işaretlenmiş ve meyve ağırlıkları belirlenmiştir.

*Meyve verimi (kg/da):* Kenar tesiri haricinde kalan parsel hasat alanı içindeki parsel verimleri dekara çevrilerek hesaplanmıştır

*Klorofil (SPAD değeri):* Biber yaprak klorofil miktarı taşınabilir klorofil metre (SPAD-502, Konica Minolta Sensing, Inc., Japan) ile ölçülmüştür. Klorofil metre, klorofil miktarı indeks değerini, yaprak tarafından emilen kırmızı ışıkla yapraktan geçen arasındaki ilişkiden yararlanarak dolaylı olarak ölçmektedir. Her bir bitkide, tam olgunlaşmış yaprağın orta damarının her iki kenarında, 4 farklı noktasında ölçüm yapılmıştır

*SÇKM; pH; TEA:* Hasat sırasında kenarlardan birer sıra kenar tesiri olarak bırakılmış, parsellerin orta 2 sırasından sırasında kalan diğer bitkiler arasından her bir tekerrürden 40 bitki işaretlenip, meyve özellikleri ile ilgili ölçümler bu 40 bitkinin meyvelerinden tesadüfi seçilen 20 meyvede yapılmıştır. Kapya biberde en önemli kalite unsurlarından olan suda çözünür kuru madde (SÇKM) tayini için, her parsele ait 20 adet meyvede Refraktometre' cihazı yardımı ile ölçülmüştür. Bunun için biberlerden elde edilen meyve suyu süzüldükten sonra, 2-3 damla örneği refraktometrenin (ATAGO, ATC-1) okuyucusuna damlatılarak SÇKM miktarları (%) belirlenmiştir. Örneklerin pH değeri, biber örneklerinin pürelerinden pH-metre kullanılarak belirlenmiştir. Elde edilen meyve sularının pH'sı pH metre ile ve titre edilebilir asitlik (TEA) değerleri ölçülmüştür.

*Meyve Kabuk Rengi:* L*, a* ve b* değerleri: Meyve kabuğundaki renk değişimleri 20'şer adet biberde hakim rengin olduğu bölgede kromametre yardımıyla L*, a* ve b* değerleri olarak tespit edilmiş ve Chroma, Hue açı (h°) değeri olarak değerlendirilmiştir

Saksı ve tarla denemelerinde belirlenen tüm veriler SPSS programı kullanılarak (özellikle

varyans ve çoklu karşılaştırma testleri yapılarak) istatistikî olarak analiz edildikten sonra, uygulamalar arasındaki farklılıklar ortaya konulmuştur.

**Sonuçlar ve Tartışma**

Tarla denemelerinde dörtlü mikrobiyal gübre aşılamaları ve mineral gübre Yenice Kırmızı Biberinde ölçülen bütün gelişme ve verim parametrelerini kontrole göre artırmış ve artış oranları istatistiki bakımından önemli bulunmuştur. En yüksek gelişme ve verim parametreleri NPK ve MF1 formülasyonunda belirlenmiş, bunu MF2 ve MF3 aşılamaları izlemiştir. Bitki boyu ve meyve eni bakımından mikrobiyal formüller ve mineral gübre benzer sonuç verirken; meyve verimi hariç diğer gelişme verim parametreleri bakımından mineral NPK ve MF1 ve MF2 ağılamalarıbenzer sonuç vermiş ve aynı gruba girmiştir (Tablo 1). Ölçülen bütün parametreler bakımından en yüksek değerler mineral gübre ve MF1 mikrobiyal gübre uygulamasından alınmıştır. En yüksek klorofil içeriği ve meyve verimi birinci grubu oluşturan MF1 Ve NPK uygulamalarında belirlenmiş, bunu ikinci grubu oluşturan MF3 ve üçüncü grubu oluşturan MF3 bakteri formülasyonu izlemiştir (Tablo 1, 2). Bu araştırmada bakteri aşılamalarıyla ulaşılan meyve boyu (18,36-19,90 cm), meyve eni (7,08-7,49 cm), meyve eti kalınlığı (6,46-6,98 mm) ve meyve ağırlığı (162,6-173,4 g) değerleri Çiftçi vd. tarafından yenice kırmızı biberinde belirlenen meyve boyu (18,49 cm), meyve eni (7,52 cm), meyve eti kalınlığı (5,78 mm) ve meyve ağırlığı (158,2 g) değerlerinden yüksek bulunmuştur. İlaveten *Bacillus subtilis* içerikli mikrobiyal gübre uygulamalarıyla biberde tuz stresine karşı bitki gelişmesini olumlu yönde etkilediği vurgulanmıştır (Öztürk ve Dursun, 2023). Kimyasal gübre yerine alternatif gübre olarak biber rizosferinden izole edilen fosfat çözücü bakterilerin kaya fosfat ve hayvansal kemik atıklarıyla birlikte kullanımının biberde gelişme ve verimi artırdığı belirlenmiştir (Jayakumar vd., 2019). Biber üzerine yürütülen araştırmalarda *Bacillus amyloliquefaciens* suşu ile kök aşılamasının  Ca ve Fe,  C vitamini ve antioksidan bileşiklerini artırdığı, doğal pigmentlerin ve fenolik bileşiklerin gelişimini teşvik ettiği, ve biberin organoleptik çekiciliğini artırdığı vurgulanmıştır (Cisternas-Jamet vd., 2020).

**Tablo 1.** Mineral gübre ve mikrobiyal gübre formülasyonları kombinasyonlarının kapya biber büyüme ve verim özellikleri üzerine etkisi

| Uygula-malar | Bitki boyu (cm) | Gövde çapı (mm) | Meyve boyu (cm) | Meyve eni (cm) | Meyve et Kalınlığı (mm) | Meyve ağırlığı (gr) | Meyve verimi kg/da |
|---|---|---|---|---|---|---|---|
| Kontrol | 61,85 c | 12,66 c | 15,72 c | 6,01 c | 5,58 c | 137,9 c | 3998 d |
| NPK | 70,92 a | 14,77 a | 19,90 a | 7,49 a | 6,98 ab | 173,2 a | 5099 a |
| **MF1** | 71,59 a | 14,64 a | 19,63 a | 7,36 a | 6,93 a | 173,4 a | 5125 a |
| MF2 | 70,56 a | 14,93 a | 19,01 ab | 7,10 ab | 6,79 ab | 166,2 ab | 4978 b |
| MF3 | 68,80 a | 14,05 b | 18,36 b | 7,08 ab | 6,46 b | 162,6 b | 4910 c |

*Kontrol: Bakteri ve gübre uygulanmamış; NPK (20 kg N/da + 8 kg $P_2O_5$ /da + 8 kg $K_2O$/da); **MF1** (*Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111 + *Bacillus megaterium* RC491+ *Bacillus thuringiensis* RC591); MF2 (*Pseudomonas fluorescens* RC512+ *Pseudomonas stutzeri* RC281+ *Bacillus subtilis* RC111+*Bacillus licheniformis* RC601); MF3 (*Pseudomonas fluorescens* RC512+ *Bacillus subtilis* RC111+ *Bacillus megaterium* RC491+ *Pantoea agglomerans* RC58);
**Aynı harfle gösterilen ortalamalar arasındaki farklar kendi grubunda önemli ($p \leq 0,01$) değildir

Tarla deneme ortalamasına göre BF1, BF2 ve BF3 bakteri formülasyaonları aşılamasıyla sırası ile kontrole kıyasla, biber bitki boyu %15,7, 14,1 ve11,2; gövde çapı % 16,2, 15,7 ve 11,0; meyve boyu %24,9, 20,9 ve 16,8; meyve eni %22,4, 18,1 ve 17,7; meyve et kalınlığı %25,0, 21,6 ve 15,9; meyve ağırlığı %25,7, 20,5 ve 17,9; biber meyve verimi %28,2, 24,5 ve 22,8; klorofil oranı ise sırası ile %25,1, 21,8 ve 19,2, suda çözünen kuru madde miktarı %16,8, 10,6 ve 11,8; kapya biber L* değeri %18,4, 15,2 ve 14,1 ve a* değeri ise sırası ile %25,6, 21,3 ve 23,7 oranlarında artmıştır. Optimum mineral gübre uygulamasında ise bitki boyu %14,7, gövde çapı %16.7, meyve boyu %26,6, meyve eni %24,7, meyve et kalınlığı %21,8, meyve ağırlığı %25,6, biber verimi %27,5, klorofil oranı %24,8, SÇKM oranı %8,5, kapya biber L* değeri %10,6 ve a* değeri ise %19,4 oranında artmıştır.

Bu araştırmada test edilen mineral çözücü ve azot bağlayıcı bakteri konsorsiyumlarının biber gelişme, verim ve kalite parametrelerini olmlu etkilediği belirlenmişltir. Azot bağlayıcı ve fosfor çözücü *Burkholderia cepacia* KD 2.10, *Serratia marcescens* KAHN 15.12 ve *Bacillus thuringiensis* SAHA 12.12 bakteri konsorsiyumu aşılamaları sonucunda, biber bitki boyunu, yaprak sayısını, çiçeklenme yaşını, bitkinin toprak üstü akzamı ve kökün kuru ağırlığını ve biber kök uzunluğunu önemli ölçüde etkilediği ve kimyasal gübre kullanımını azaltabildiği bildirilmiştir (Swandi vd., 2019). Potansiyel P-çözündürücü, K-çözündürücü ve N-sabitleyici *Erwinia persicina* EU-A3SK3, *Halomonas aquamarina* EU-B2RNL2 ve *Pseudomonas extremorientalis* EU-B1RTR1 bakteri suşlarının mikrobiyal konsorsiyumunun biber üzerine aşılanması, tekli aşılamalra ve aşılanmamış konrole kıyasla biber gelişmesi (sürgün/kök biyokütlesi ve uzunluğu; bitki başına yaprak, dal ve meyve sayısı) ve fizyolojik parametrelerde (klorofil

içeriği, toplam çözünür şeker, fenolikler ve flavonoidler) artışa yol açmış ve mineral çözücü ve azot bağlayıcı suşların engebeli bölgelerde sürdürülebilir yetiştiricilik için kullanılabileceği vurgulanmıştır (Devi vd., 2022). Tuzlu toprakta büyüyen biber bitkilerinin rizosferinden izole edilen PGPR suşlarının (Microbacterium oleivorans KNUC7074, Brevibacterium iodinum KNUC7183 ve Rhizobium massiliae KNUC7586) aşılanmış bitkilerde, aşılanmamış bitkilere göre önemli bitki boyu, taze ağırlık, kuru ağırlık, toplam klorofil içeriği, çözünür şeker ve prolin içeriği önemli ölçüde artmış; tuz stresi altındaki PGPR ile tedavi edilen bitkilerde bakteri aşılaması antioksidan enzimlerin aktivitesi (askorbat peroksidaz, guaiakol peroksidaz, ve katalaz) yükselmiş ve tuz stresi altında bitkilerin gelişmesinin iyileştirilebildiği vurgulanmıştır (Hahm vd., 2017). Biberden izole edilerek tanılanan laktik asit bakterilerinin (*Lactilactobacillus curvatus* ve *Lactiplantibacillus plantarum*) patojenlere karşı etki gösterdiği, etkili bir antimutajenik ve detoksifiye edici olduğu, sebze fermantasyon başlatıcıları olarak umut verici sonuçlar verdiği ve gıda güvenliğine katkı sağlayabileceği vurgulanmıştır (Nunez vd., 2024).

**Tablo 1.** Mineral gübre ve **m**ikrobiyal gübre formülasyonları kombinasyonlarının kapya biber büyüme ve verim özellikleri üzerine etkisi

| Uygula-malar | Klorofil (SPAD) | SÇKM (%) | pH | TEA | L* | a* | b* |
|---|---|---|---|---|---|---|---|
| Kontrol | 53,24 d | 5,80 c | 4,70 c | 2,61 b | 26,41 c | 22,93 c | 23,30 a |
| NPK | 66,44 a | 6,29 b | 4,75 bc | 2,56 b | 29,21 b | 27,38 ab | 19,46 bc |
| **MF1** | 66,61 a | 6,77 a | 4,84 a | 2,79 a | 31,27 a | 28,79 a | 17,545 c |
| MF2 | 64,85 b | 6,42 b | 4,87 a | 2,75 a | 30,41 ab | 27,80 ab | 19,14 bc |
| MF3 | 63,48 c | 6,49 b | 4,76 bc | 2,76 a | 30,14 ab | 28,37 a | 19,01 bc |

*SÇKM: Suda çözünür kuru madde miktarı; TEA: Titre edilebilir asitlik miktarı,**Aynı harfle gösterilen ortalamalar arasındaki farklar kendi grubunda önemli (p≤0,01) değildir

Kapya biber SÇKM oranı bütün uygulamalarla kontrole kıyasla artmış ve artış oranları istatistiki bakımdan önemli bulunmuş, en yüksek SÇKM içeriği birinci grubu oluşturan MF1 aşılanmış biberlerde belirlenmiş; diğer uygulamalar ikinci benzer sonuç vermiş ve ikinci grubu oluşturmuştur (Tablo 2). Biber pH miktarı MF1 ve MF2 uygulamalarıyla diğer konulara kıyasla yüksek bulunmuş, diğer uygulamalar aynı gruba girmiştir. Titre edilebilir asitlik miktarı bakımından mikrobiyal formüller, aynı gruba giren mineral gübre ve kontrole kontrole kıyasla artmış ve istatistiki bakımdan önemli bulunmuştur. İlaveten mikrobiyal gübre uygulamalarının, kontrol ve optimum kimyasal gübre uygulamasına kıyasla, kapya biber SÇKM ve L* değerlerini artırdığı ve artış oranlarının istatistiksel olarak önemli bulunduğu belirlenmiştir.

Bu sonuçlara göre bu denemede test edilen mikrobiyal gübre formülasyonlarının, organik biber yetiştiriciliğinde ve iyi tarım uygulamaları başta olmak üzere azaltılmış gübre uygulama ve biber yetiştirme programlarında kullanılabilecektir.

Mikrobiyal gübrenin aşılanması kontrole göre bütün parametrelerde önemli artışlar sağlarken optimum gübre ile benzer sonuç vermiştir. Birim meyve ağırlığına ilaveten özellikle kapya biberde önemli kalite kriterlerinden birisi olan meyve eti kalınlığının artmış olması, etli ve meyve eti kalın olmasının özellikle sebze işleme sanayinde tercih edilen bir özellik olması dolayısıyla önemli bir sonuçtur. Özellikle kapya biberde meyve iriliğinin tüketiciler için tercih sebebi olduğu, verimi olumlu etkilediği, meyve et kalınlığının önemli bir kalite kriteri olduğu bilinmektedir. Meyve eti kalınlığını Mikrobiyal MF1, MF2 ve MF3 aşılamalrı ile meyve et kalınlığının %25,0, 21,6 ve 15,9 oranında artırmış olması çok önemlidir ve test edilen mikrobiyal gübrenin Yenice kapya biberi yetiştiriciliğinde çok önemli potansiyele sahip olduğunu göstermektedir.

Meyvelerin kalın etli olması özellikle sebze işleme sanayinde tercih edilen bir özelliktir. Kapya tipi kırmızı biber yetiştiriciliğinde işleme sanayiye yönelik olarak meyve eti kalınlığı da önemli kalite kriterlerinden biridir. Meyve eti kalınlığı, salçanın verimini etkilemekte ve özellikle salçaya işlenecekler olmak üzere gıda üretiminde önemli kriterlerden biridir. Denemelerde kapya biber meyve eti kalınlığının mikrobiyal gübre gübre uygulamalarında artmış olması önemlidir.

Suda çözünür kuru madde (SÇKM) hem üretim hem de kalite kontrolünün önemli bir ölçütüdür (Şahiner, 2019). SÇKM miktarı meyvelerde olgunluk ve hasat zamanının belirlenmesinde, salça ve konserve işlemede üretimin denetim altında tutulması için önemli bir kriterdir. Yüksek SÇKM içeriği, özellikle salça üretiminde arzu edilmektedir. SÇKM içeriğinin yüksekliği, meyveden suyu buharlaştırmak için gereksinim duyulan enerji miktarını azalttığı ve işleme süresini kısalttığı için endüstriyel işleme sürecinde salça üretim etkinliğini artırmaktadır. SÇKM, biberde hem üretim hem de kalite kontrolünde önemli bir ölçüttür. Bu kriter hasat zamanının belirlenmesinde, salça veya konserve işleme aşamalarında sürekli olarak üretimin denetlenmesi için önemlidir. Bu araştırmada test edilen mikrobiyal gübre uygulamalarından özellikle MF1 formülasyonunun etkisi gerek kontrol ve gerekse mineral gübreye kıyasla daha yüksek bulunmuştur. Mikrobiyal gübrenin mineral gübreye kıyasla daha yüksek SÇKM içeriğine sahip biber üretimi sağlaması önemlidir.

TEA, kırmızı biberde işleme sanayi sırasında tat değerini oluşturma, salça gibi ürünlerin işlenmesinde ise tekstür ve yapısı açısından önemlidir. Renk meyve kalite kriterleri arasında en önemli ve karmaşık olanlardan biridir. Renk tüketicinin gıda kalitesini değerlendirdiği en önemli kriterlerden biridir ayrıca kırmızı biberin kalitesinden sorumlu olan meyve karotenoid bileşiminin göstergesidir (Minguez-Mosquera, 2008). Biberde rengin parlaklığını belirten L değeri ve rengin yoğunluğunu belirten a değeri önemlidir. Rengin yoğunluğunu ifade eden a değerinin pozitif olması kırmızıyı, negatif olması ise yeşili temsil etmektedir. Hem sanayilik hem de taze tüketimi yapılan kapya tipi yağlık biberin üretiminde en önemli kalite özelliği renklenmedir. Mikrobiyal gübre formülasyonu uygulanan biberlerde L* değeri ve a* değerinin yüksek olması biberlerin kalite bakımından istenilen parlaklık ve kırmızı renge sahip olduğunu göstermektedir.

Test edilen mikrobiyal gübre adayı bakteri formülasyonları gelişme, verim ve kalite parametreleri bakımından kimyasal gübreye yakın sonuç vermiştir. Hatta mikrobiyal uygulamalar kalite bakımından mineral gübrelemeden daha iyi sonuçlar vermiştir. Bu araştırma alanında ilk ve özgün olarak yerel koşullardan izole edilen azot fiksasyon, fosfat çözme, potasyum çözme, indol asetik asit üretme ve ACC deaminaze aktivitesine sahip bakterilerden geliştirilen mikrobiyal formüller tarla denemelerinde bitki boyu, gövde çapı, meyve boyu, meyve eni, meyve et kalınlığı ve meyve ağırlığı, meyve verimi, klorofil içeriği bakımından optimum kimyasal uygulaması ile benzer sonuç vermiştir.

**Sonuçlar**

Test edilen mikrobiyal gübre adayı bakteri formülasyonları gelişme, verim ve kalite parametreleri bakımından kimyasal gübreye yakın sonuç vermiştir. Hatta mikrobiyal uygulamalar kalite bakımından mineral gübrelemeden daha iyi sonuçlar vermiştir. Tarımsal sürdürülebilirliğe engel olan uygulamalar olan kimyasal gübrelemeler hem ekonomik açıdan üreticiye yük olmakta hem de topraklarımızı kirleterek tarımsal üretimin devamlılığını zora sokmaktadır. Bu sebeple kimyasal gübreleme uygulamalarının yerini gelecekte çevre dostu ve daha ekonomik mikrobiyal gübre uygulamaları alarak sorunların çözüme kavuşacağını öngörüyoruz.

**Teşekkür**

**Kaynaklar**

Aslantaş, R., Çakmakçı, R., Sahin, F. (2007). Effect of plant growth promoting rhizobacteria on young apple tree growth and fruit yield under orchard conditions. Scientia Horticulturae, 111; 371-377.

Bektas, I., Kusek, M. (2021). Biological control of onion basal rot disease using phosphate solubilising rhizobacteria. Biocontrol Science Technology, 31, 190–205.

Borgi, M.A., Saidi, I., Moula, A., Rhimi, S., Rhimi, M. (2020). The attractive *Serratia plymuthica* BMA1 strain with high rock phosphate-solubilizing activity and its effect on the growth and phosphorus uptake by *Vicia faba* L. plants. Geomicrobiology Journal, 37, 437–445.

Cisternas-Jamet, J., Salvatierra-Martinez, R., Vega-Galvez, A., Stoll, A., Uribe, E., Goni, M.G. (2020). Biochemical composition as a function of fruit maturity stage of bell pepper (*Capsicum annum*) inoculated with *Bacillus amyloliquefaciens*. Scientia Horticulturae, 263, 109107.

Çakmakçı, R., 2009. Stres koşullarında ACC deaminaze üretici bakteriler tarafından bitki gelişiminin teşvik edilmesi. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 40(1), 109-125.

Çakmakçı, R., Kantar, F., Şahin, F. (2001). Effect of $N_2$- fixing bacterial inoculations on yield of sugar beet and barley. Journal of Plant Nutrition and Soil Science, 164 (5), 527-531.

Çakmakçı, R., Dönmez, M.F., Aydin, A., Şahin, F. (2006). Growth promotion of plants by plant growth-promoting rhizobacteria under greenhouse and two different field soil conditions. Soil Biology & Biochemistry, 38 (6), 1482-1487.

Çakmakçı, R., Erat, M., Erdoğan, Ü., Dönmez F. (2007). The influence of plant growth-promoting rhizobacteria on growth and enzyme activities in wheat and spinach plants. Journal of Plant Nutrition and Soil Science, 170 (2), 288-295.

Çakmakçı, R., Erat, M., Oral, B., Erdoğan, Ü., Şahin, F. (2009). Enzyme activities and growth promotion of spinach by indole-3-acetic acid-producing rhizobacteria. Journal of Horticultural Science & Biotechnology, 84 (4), 375-380.

Çakmakçı, R., Dönmez, M.F., Ertürk, Y., Erat, M., Haznedar A., Sekban, R. (2010). Diversity and metabolic potential of culturable bacteria from the rhizosphere of Turkish tea grown in acidic soils. Plant and Soil. 332:299-318.

Çakmakçı R., Ertürk Y., Atasever A., Ercişli S., Şentürk M., Erat M., Haznedar A., Sekban R. (2011). The use of plant growth promoting rhizobacteria for organic tea production in Turkey. Proceedings of Tea-Organic-Low Carbon International Symposium. Guangyuan/China, 6-9 June. pp: 89-97.

Çakmakçı R., Ertürk Y., Dönmez F., Erat M., Haznedar A., Sekban R. (2012). Tea growth and yield in relation to mixed cultures of $N_2$-fixing and phosphate solubilizing bacteria. 23rd International Scientific-Experts Congress on Agriculture and Food Industry, 27-29 September. "Ege Üniv. Ziraat Fak. Derg. Special Issue Vol 1, pp: 17-21.

Çakmakçı, R., Mosber, G., Milton, A.H., Alatürk, F., Ali, B. (2020). The effect of auxin and auxin-producing bacteria on the growth, essential oil yield, and composition in medicinal and aromatic plants. Current Microbiology, 77 (4), 564–577.

Çiftci, H.N., Gündoğdu, M.A., Kaynaş, K. (2023). Department quality changes of yenice capia pepper grown at different altitudes. International Journal of Innovative Approaches in Science Research, 7 (2), 47-61.

Devi, R., Kaur, T., Kour, D., Yadav, A.N., Suman, A. (2022). Potential applications of mineral solubilizing rhizospheric and nitrogen fixing endophytic bacteria as microbial consortium for the growth promotion of chilli (*Capsicum annum* L.). Biologia, 77 (10), 2933-2943.

Dey, A. (2021). Liquid biofertilizers and their applications: An overview. B.B. Mishra, S.K. Nayak, S. Mohapatra ve D. Samantaray (eds.) Environmental and Agricultural Microbiology: Applications for Sustainability (275–292), Scrivener Publishing LLC, Beverly, USA.

Hahm, M.S., Son, J.S., Hwang, Y.J., Kwon, D.K., Ghim, S.Y. (2017). Alleviation of Salt Stress in Pepper (*Capsicum annum* L.) Plants by Plant Growth-Promoting Rhizobacteria. Journal of Microbiology and Biotechnolog, 27 (10), 1790-1797

Hara, S., Morikawa, T., M., Wasai, S., Kasahara, Y., Koshiba, T., Yamazaki, K., … ve Minamisawa, K. (2020). Identification of nitrogen-fixing *Bradyrhizobium* associated with roots of field-grown sorghum by metagenome and proteome. Frontiers in Microbiology, 10, 407.

Jayakumar, N., Paulraj, P., Sajeesh, P., Sajna, K., Zinneera, A. (2019). Application of native phosphate solubilizing bacteria for the use of cheap organic and inorganic phosphate source in agricultural practise of *Capsicum annum* (Chili) - A pilot scale field study. Materials Today-Proceedings, 16, 1630-1639.

Jayakumar, V., Sundar, A. R., Viswanathan, R. (2021). Biocontrol of *Colletotrichum falcatum* with volatile metabolites produced by endophytic bacteria and profiling VOCs by headspace SPME coupled with GC–MS. Sugar Tech 23, 94–107.

Karagöz, H., Çakmakçı, R., Hosseınpour, A., Kodaz, S. (2018). Alleviation of water stress and promotion of the growth of sugar beet (*Beta vulgaris* L.) plants by multi-traits rhizobacteria. Applied Ecology and Environmental Research 16(5), 6801-6813.

Khan, N., Bano, A., Ali, S. ve Babar, Md. A. (2020). Crosstalk amongst phytohormones from planta and PGPR under biotic and abiotic stresses. Plant Growth Regulation, 90, 189–203.

Minguez-Mosquera, M.I., Pérez-Galvez, A., Hornero-Méndez, D. (2008). Color quality in red pepper *(Capsicum annuum,* L.) and derived products. ACS Symposium Series, 983. 311-327, In. Color Quality of Fresh and Processed Foods, June 2008.

Nunez, I.M., Verni, M.C., Martinez, F.E.A., Babot, J.D., Teran, V., Danilovich, M.E., Cartagena, E., Alberto, M.R., Arena, M.E., (2024). Novel Lactic Acid Bacteria Strains from Regional Peppers with Health-Promoting Potential. Fermentation-Basel, 10 (4), 209.

Öztürk, H.İ., Dursun, A. (2023). Effect of microbial fertilizer on the development of pepper (Capsicum annuum L.) seedlings exposed to salt stress. Manas Journal of Agriculture Veterinary and Life, 13 (1), 17-23.

Swandi, M.K., Mubarik, N.R., Tjahjoleksono, A. (2019). Rhizobacterial inoculants: The formulation as biofertilizer and its application on chili plants (*Capsicum annum* L.). Malaysian Journal of Microbiology, 15, 44-51.

Şahin, F., Çakmakçı, R. ve Kantar, F. (2004). Sugar beet and barley yields in relation to inoculation with $N_2$-fixing and phosphate solubilizing bacteria. Plant and Soil, 265, 123-129.

Şahiner, A. (2019). Bursa ve çevresinde kapya tipi biber (*Capsicum annuum* L. var. *conoides* (Mill.) Irish) yetiştiriciliğinde farklı çeşitlerin verim ve kalite özelliklerinin değerlendirilmesi. Uludağ Üniversitesi Fen Bilimleri Enstitüsü, Bahçe Bitkileri ABD yüksek lisans tezi, Bursa.

Verma, M., Singh, A., Dwivedi, D.H. ve Arora, N.K. (2020). Zinc and phosphate solubilizing *Rhizobium radiobacter* (LB2) for enhancing quality and yield of loose leaf lettuce in saline soil. Environmental Sustainability, 3, 209–218.

Wang, Y., Liu, H., Shen, Z., Miao, Y., Wang, J., Jiang, X., Shen, Q. ve Li, R. (2022). Richness and antagonistic effects co-affect plant growth promotion by synthetic microbial consortia. *Applied Soil Ecology,* 170, 104300.

Yıldırım, E., Turan, M., Dönmez, M.F. 2008. Mitigation of salt stress in radish (*Raphanus sativus* L.) by plant growth promoting rhizobacteria. Romanian Biotechnological letters, 13, 3933-3943.

# The Determination of Vegetative Development of Side Shoots and Some Characteristics of Second Crop Clusters Formed on the Side Shoots in Some Table Grapes

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## Abstract

Side shoots and clusters (second crops) on side shoots on vines in regions that have high growing degree days can develop. These second crops also have been consumed. Second crop clusters are small, late ripened. They show different characteristics according to cvs. This research was carried out in 'Gelin, 'Osmanca' and 'Alphonse Lavallée' (*Vitis vinifera* L.) grape cvs. located in Adnan Menderes University application vineyards. The aim of the research was the determine of some characteristics of second crop clusters and vegetative development of side shoots. Cluster weight, cluster width, cluster length, cluster compactness, berry width, berry length, berry firmness and berry color values of second crop clusters and side shoot development characters were determined. Cluster characters when compared among the cvs., 'Alfonse' cv. had the lightest and smallest clusters. 'Gelin'cv. had more compact clusters than that of others. Three cvs when compared with berry size and berry weight, 'Osmanca' had the lightest and smallest berries. While 'Alfonse' had the firmest cv. among the cvs., seed numbers did not show any differences. When compared 'L' brightness value of cultivars, 'Gelin' and 'Osmanca' cvs had the brighter than 'Alfonse'. 'a' color value showed that more redness in 'Gelin' cv. than the others. 'b' color value also explained more yellowish in 'Osmanca' cv. Chroma value showed that yellow color saturation in 'Osmanca' and 'Gelin' cvs. According to maturation, there is no differences between cvs. Only in terms of acidity, 'Gelin' second crop clusters had the highest acidity. Among the cvs, side shoot length, internode length, node diameter did not show any differences. Only node number was found the least in 'Gelin' cv.

**Keywords:** Second crop clusters, quality, maturation, side shoot

## Introduction

Turkey is one of first cultivation areas of *Vitis vinifera* L. grown widely in the World. It is accepted that *Vitis vinifera* L. spreads to the World from Anatolia, Turkey (Mullins et al., 1992; Çelik et al., 1998). Turkey is in ranked 5th in terms of vineyard area and 6th in terms of grape production amount. Table grapes production is 52.9% of total grape production. Raisin grapes is 38.4% of total production. Wine grape production is 8.7% of total production (Turkstat, 2023).

Side shoots develop from axillary buds located in the base of the leaves connected to main shoots, and develop at the same time with the main shoots. Side shoots are generally are fruitless, however, in some cultivars and in locations that have long vegetation period, grapes form on side shoots. These grapes are called as second crops. Some characteristics of the second crops in 'Yalova İncisi', 'Cardinal', 'Amasya Beyazı' and 'Kozak Beyazı' grape cvs., have been examined. In the research, main and second crop grapes characteristics of the cvs. were compared (Dardenizet.al., 2020). In all grape cvs., the highest values of cluster width, cluster length and cluster weight were obtained in main crops.

The highest cluster compactness values were obtained in second crops. Main crops showed the higher maturation index values than that of second crops in all grape cvs. (Dardeniz et.al., 2020). After main cops were harvested, Alar and Ethrel plant growth regulators at 0, 500, 1000 and 2000 ppm in dosages applied to second crops by dipping method. Alar and Ethrel applications increased the size and weight of clusters and berries, number of berries/cluster, weight of 100 berries and total soluble solids. Alar at 1000 ppm and Ethrel at 500 and 1000 ppm were the most effective (Eriş and Çelik, S, 1983). In Round Sultani seedless cv., during winter pruning, main canes with 18 buds were left on vine as control. Canes form from second shoots that arise from 5, 6 and 8 nodes were left as applications. Bud fertility, yield, cluster number and total soluble solids were compared. Canes that form side shoots increased bud fertility, yield, cluster number and total soluble solids on vine (Ilgın, 1991).

The objective of this research is to determine of cluster, berry characteristics of second crops and vegetative characteristics of side shoots of Gelin, Osmanca and Alfonse Lavallee grape cvs.

**Materials and Methods**

This experiment was carried out in Gelin, Osmanca and Alfonse Lavallee cvs located in Aydın Adnan Menderes University, Agriculture Faculty. Gelin (Pembe Gemre cvs. types) ripens midseason, prunes as cane, is grown in Aegean region. Berry has red-pink color, round shape, 7-8 g weight, neutral flavor and 2-3 seeds. Cluster has winged conical structure, 500-600g weight and well filled or compact shape. Osmanca cv. ripens midseason, prunes as spur and is grown in İzmir and Aydın province. Berry has green-yellow color, round shape, 3-4 g weight, neutral flavor and 1-3 seeds. Cluster has conical structure, 300g weight and well filled. Alphonse Lavallée cv. ripens midseason, prunes as spur and is grown in Marmara, Aegean, central Anatolia. Berry has purplish-black color, oblong round shape, 8-9g weight, neutral flavor and 1-4 seed. Cluster has winged conical structure, 600-700g weight and Loose or well filled (Çelik, 2006).

Examining of cluster characters are cluster weight (g), cluster length (cm), cluster width (cm), cluster compactness (1-9). Examining of berry characters are berry weight (g), berry width and length (mm), berry firmness (g), berry color (L, a, b), total soluble solid (TSS) (%), titratable acidity (g/100 ml), pH value, maturity index (TSS/Titratable acidity), seed number, must ratio (ml/kg) (Cemeroglu,

1992). Examining of shoot characters are side shoot length (cm), node number, internode length (cm) and diameter of nodes (mm).

This experiment was planned with completely randomized design with three replications, and analyzed with R program (Kaya, 2019).

**Results and Discussion**

In Gelin and Osmanca cvs., second crop clusters were found as heavier and bigger than that of Alphonse cv. In a similarly, Dardeniz et al found that second crops clusters of Amasya Beyazı, Kozak Beyazı Yalova İncisi cvs. had heavier and bigger than that of Cardinal cv. Like Alphonse cv.in this research, second crops of Cardinal cv. had about 70g cluster weight (table1).

In Gelin cv., second crop clusters were found as more compact than that of other cvs. (table1). Dardeniz et al (2020) found that second clusters of Yalova İncisi and Amasya Beyazı had more compact clusters that that of the other cvs.

Table 1. Cluster characteristics of second crops of cultivars

| Cultivars | Cluster weight (g) | Cluster width (mm) | Cluster length (mm) | Cluster compactness |
|---|---|---|---|---|
| **Gelin** | 147.5 a$^*$ | 71.2 a | 108.7 ab | Compact |
| **Osmanca** | 167.2 a | 69.0 a | 119.7 a | Normal |
| **Alfonse Lavallée** | 77.1 b | 57.8 b | 91.1 b | Normal |

*Different letters show significant differences between means. LSD test (p ≤ %5).

In Osmanca cv., the berries were found the smallest and lightest than that of other cvs. In Alphonse cv., the berries were found as firmer than that of other cvs. (table2). Dardeniz et al (2020) found that second crops of Amasya Beyazı had the lightest clusters than that of the others.

Table 2. Berry characteristics of second crops of cultivars

| Cultivars | 100 berry weight (g) | Berry length (mm) | Berry width (mm) | Bery firmness (g) | Seed number |
|---|---|---|---|---|---|
| **Gelin** | 458.7 a[*] | 18.9 a | 17.6 a | 465.5 a | 1.88 a |
| **Osmanca** | 289.3 b | 14.2 b | 14.7 b | 487.2 a | 1.67 a |
| **Alphonse Lavallée** | 401.3 ab | 17.1 ab | 17.6 a | 534.4 a | 1.50 a |

*Different letters show significant differences between means.  LSD test (p ≤ %5).

L value of Gelin and Osmanca cvs was higher than that of Alphonse cv. a value of Osmanca was higher than that of the other cvs. b value of Osmanca was the highest than the other cvs. Chroma and hue values were calculated by using excel packet program. Chroma value showed that highest values in Osmanca cv. because it was high dense yellow color. Hue value was different for all cultivars (Table 3).

Table 3. Berry color characteristics of second crops of cultivars

| Cultivars | L | a | b | Chroma | Hue |
|---|---|---|---|---|---|
| **Gelin** | 33.70 a[*] | 10.73 a | 21.26 b | 23.88 b | 63.06 c |
| **Osmanca** | 37.73 a | 1.68 b | 29.00 a | 29.06 a | 86.67 b |
| **Alphonse Lavallée** | 8.76 b | 0.52 b | -1.41 c | 1.51 c | 290.49 a |

*Different letters show significant differences between means. LSD test (p ≤ %5).

In this research, TSS did not changed between the cvs. Dardeniz et al (2020) found that while Kozak Beyazı had the highest TSS, Yalova İncisi had the lowest TSS.

In this research, acidity was the highest in Gelin cv. with 0.60% value and it was followed by Osmanca and Alphonse cvs respectively. Dardeniz et al (2020) found that Cardinal had the highest acidity, in addition, Yalova İncisi, Kozak Beyazı and Amasya Beyazı cvs had more than 0.60% acidity.

In this research, maturation did not change among the cvs. Ph was higher in Alphonse cv. than that of other cvs. Dardeniz et al (2020) found that Yalova İncisi had the highest Ph.

In this research, Maturity index did not change among the cvs (Table 4). Dardeniz et al (2020) found that maturity index changed between cvs. and while Kozak Beyazı had the highest maturity index, Razakı had the lowest maturity index value.

Must amount was the highest in Alphonse cv. It was followed by Osmanca and Gelin cv. respectively (Table 4).

Table 4. Ripeness characteristics of second crops of cultivars

| Cultivars | TSS (brix) | Acidity (%) | Maturity index (TSS /Acidity) | Ph | Must amount (ml/kg) |
|---|---|---|---|---|---|
| Gelin | 19.6 a* | 0.61 a | 32.3 a | 3.9 b | 203.0 c |
| Osmanca | 20.6 a | 0.47 ab | 46.3a | 3.9 b | 328.0 b |
| Alphonse Lavallée | 19.2 a | 0.39 b | 51.5a | 4.1 a | 395.4 a |

*Different letters show significant differences between means. LSD test (p ≤ %5).

Side shoot vegetative characteristics did not show any significant differences among the cvs. except node number. Node number of Gelin cv. was the lower than the that of other cvs. (Table 5)

Table 5. Vegetative development characteristics of side shoots of cultivars

| Cultivars | Length of the side shoots (cm) | Numbers of nodes | Length of the internode (cm) | Diameter of the nodes (mm) |
|---|---|---|---|---|
| Gelin | 51.5 a* | 11.1 b | 4.64 a | 7.07 a |
| Osmanca | 57.6 a | 16.1 a | 3.57 a | 7.68 a |
| Alphonse Lavallée | 59.4 a | 15.0 a | 3.96 a | 7.29 a |

*Different letters show significant differences between means.  LSD test (p ≤ %5).

**Conclusion**

In this experiment, in terms of cultivar, second crops showed different characteristics. Mostly in Turkiye, People use second crops of grapes as vinegar production. People can use the second crops that have high acidity content in wine production. Second crops of Gelin cv. have high acidity, so it can be used in wine production.

People can use the second crops of Osmanca and Alphonse cvs. as either vinegar or table grape.

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**References**

Cemeroğlu, B. (1992). Basic analyses methods in fruit and vegetable processing industry. Bitvav publications. No:02-2, Ankara, Turkiye, 381p.(In Turkish)

Çelik, H., Ağaoğlu, Y.S., Fidan, Y., Marasalı, B., & Söylemezoğlu, G. (1998). General Viticulture. Sun fidan A.Ş. Ankara. 253p.

Çelik, H. (2006). Grape Cultivar Catalog. Vocational Book Series:3. Ankara, Türkiye.

Dardeniz, A., Gündoğdu, M. A.,Şahin, E., & Ali, B. (2020). The Determination of Some General Characteristics of Second Crop Clusters of Table Grapes. COMU J. Agric. Fac. 2020: 8 (1): 115–123 doi: 10.33202/comuagri.660092.

Eriş, A., & Çelik, S. (1983). Applications of Alar (B-9) and Ethrel (CEPA) on the second crop clusters of Hafizali grape variety. Ankara Univ Annuals 31: 93-101pp.

Ilgın, C. (1991). The Researches on Productivity of Side Shoots left during winter pruning of Round Sultani Seedlees Grape Cultivar. Aegean University, Applied Sciences Graduate School, 60 p. (Unpublished Master Thesis).

Kaya, Y. (2019). Variance analyses in R Program. Information notes:2 (30 pages) Siirt University, Agriculture Faculty, Agronomy Department. Siirt, Turkiye (in Turkish).

Mullins, M.G., Bouquet, A, & Williams, L.E. (1992). Biology of The Grapevine. Cambridge Univ. Press, 239p.

Turkstat. (2003). Turkish Statisticc Institute. https://www.tuik.gov.tr/

# Corn Production And Fertilization Methods in Northwestern Anatolia

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## Abstract

Corn is highly significant for both human and animal nutrition and ranks among the most produced agricultural products worldwide, including in our country. It can be cultivated in all regions of the world except Antarctica. In human nutrition, it can be consumed fresh or used in flour, snacks, and canning, while in animal nutrition, it is consumed fresh, though its use as silage is quite substantial. Additionally, due to its durability and minimal industrial processing, it can be easily traded globally. In terms of cultivation, corn can be easily grown in soils rich in organic matter, well-aerated, with good water retention capacity, and suitable pH and texture. Corn plants primarily require nitrogen, phosphorus, and potassium for fertilization. In this study, fertilization is discussed alongside cultivation, with detailed explanations of the appropriate fertilization methods and timing. Furthermore, the study addresses the micronutrients that corn plants require during the cultivation period, outlining the deficiency symptoms that arise if these nutrients are lacking.

**Keywords**: Fertilization, cultivation, consumption

## Introduction

Corn is a plant that has a wide production capacity in the world and can grow in very different environmental conditions (Kün, 1985).  In terms of production area, it is the most cultivated area after wheat and rice. The production amount has increased rapidly in recent years and has risen to first place. Corn plant, which has widespread planting and usage conditions, is among the top sources of basic nutrients used in animal nutrition, both in human and animal parts (Başer, 1993). It is known that the homeland of the corn plant is the American continent. The widespread use of the corn plant in the world was after the discovery of this continent. It is the only annual warm climate plant that can grow everywhere except Antarctica (Kün and Emekliler, 1987; Anonymous, 2005). Corn (*Zea mays* L.), which is widely grown in our country and in the world, is a monocotyledonous plant belonging to the Poaceae family. Corn, which differs from other species in terms of flowering in the Poaceae family, has monoecious flowers, and male (tassel) and female flowers (cob) are on the same plant but in different places. Corn is a diploid plant (2n=20). Since it has a high adaptability, it can be grown in different regions of the world (Yorgancılar et al., 2019). Corn (*Zea mays* L.) is traditionally used in human nutrition in temperate regions today, but it is largely consumed as animal feed in developed countries. Corn is consumed as grain and silage in animal nutrition, grain corn is especially used in poultry

consumption, and silage is used in large cattle farming. Silage corn; It is the most preferred plant for silage both in the world and in our country due to its high energy value, suitability for mechanized agriculture from planting to harvest, ease of storage and use, low loss rate, high dry matter content, high digestibility, being a quality and delicious silage feed, high yield per unit area, easy availability of seed, and being able to be ensiled without the need for any additives (Açıkgöz et al., 2002). The soil processing done before the planting of corn and during the cultivation period is very important. The first ploughing is done with a plough, and if it is desired to process the soil by tearing it, it can also be done with a chisel. Then, the secondary soil processing tools such as harrow, cultivator or disc harrow are used. Then, the soil is leveled and pressed with a coulter or a tap. Then, the planting process is completed with a planting machine called a seeder. Fertilization to be done on corn plants is divided into 2 parts. These are fertilizers given before planting or together with planting and after planting at certain periods of the cultivation period. Before planting, compound fertilizers containing Nitrogen-Phosphorus-Potassium, which are accepted as the 3 basic elements in cultivation, are used, and after planting, nitrogenous fertilizers in the forms of Ammonium or Nitrate. Apart from these fertilizations, these elements or other macro-micro elements can be supplemented to the plant by drip or foliar applications in case of deficiency. In this study, corn cultivation is examined in general terms, and soil processing, planting, maintenance, irrigation and fertilization are covered in detail. In addition, the areas of use of the corn plant in the world and its importance in human and animal nutrition are mentioned.

### Materials and Methods

The research covers the important corn producing provinces in the Thrace Region of Turkey and its vicinity. The data obtained are the data published by the Turkish Statistical Institute and all interpretations were made according to these data. In this research, previously published sources were used as a result of literature review and formed the main part of the study. The main sources used were studies and journals published in various institutes. In our country, it is cultivated in almost every region. Silage production has a very important share in silage production and different purposed cultivation as grain. Edirne, Kırklareli, Tekirdağ, Çanakkale and Balıkesir, which are the provinces of Turkey close to the Balkans, have significant production potential. When the last 3-year planting area, yield and

production amount data obtained from the Turkish Statistical Institute of these provinces are examined; Kırklareli and Balıkesir provinces have the highest share in grain corn with approximately 42 thousand acres of planting area. Balıkesir ranks first in silage corn production with 336 thousand acres. In general, the yield in grain corn is between 800-900 kilograms and in silage corn it is between 4500-5500 kilograms. Balıkesir has a share of 38%, Kırklareli 33%, Çanakkale 17%, Edirne 11% and Tekirdağ 1% in grain corn production. In silage corn production, Balıkesir has a share of 49%, Çanakkale 25%, Edirne 10%, Kırklareli 10% and Tekirdağ 6%.

### Results and Discussion

Corn can find a place for itself in large planting areas in the world and has an important place in human and animal nutrition. Its place as a planting area after wheat and rice also emphasizes its strategic importance. The provinces included in the study have an important potential in terms of cultivation.

### Conclusion

In this case, all natural conditions should be seriously considered in the cultivation and production, and maximum attention should be paid to human practices (soil processing, maintenance, fertilization) and optimum yield should be achieved. Fertilization practices, which are more important than ever before, should be renewed throughout the cultivation period of the basic elements that serve the corn plant.

### References

Alp. O., & Koca, Y.O. (2020). Determination of Grain and Yields of Some Corn (*Zea mays* L.) Varieties Cultivated in Aydın Region. Agricultural Engineering (369), 30-45, p.31.

Özata. E, Kapar. H. (2017). Determination of Yield and Quality Characteristics of Silage Hybrid Maize Variety Candidates Obtained from Qualified Pure Lines. Journal of Field Crops Central Research Institute 2017, 26 (Special Issue): 161−168 Research Article. p.161.

Yıldız. E., Gözel, U. (2022). Determination of Plant Parasitic Nematode Species in Corn Cultivation Areas of Çanakkale Province. MAS JAPS 7(3): 763–768, p.764.

Yorgancılar et al., 2019; Cengiz.R, Öner.M. (2023). Determination of Chitosan Coating Dose by Priming Method for Improving Germination Period Parameters of Corn (Zea mays L.). Journal of Agricultural Biotechnology (JOINABT) 4(2), 63-74, 2023. p. 64.

# Genetic Divergence for Yield and Yild-Related Traits of Winter Barley Breeding Lines

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## Abstract

Barley (*Hordeum vulgare* L.) is a critical cereal crop with global agricultural and economic significance. Enhancing grain yield is influenced by traits such as spike number per m², spike productivity, and grain weight. This study aimed to assess the genetic divergence among 19 recombinant inbred lines of winter barley, alongside two parent varieties and a standard, over two growing seasons (2021/2022 and 2022/2023). The goal was to identify promising genetic resources for improving yield and yield-related traits. Key traits measured included number of spike per m², plant height, lodging, spike length, spikelet number per spike, grain number per spike, grain weight per spike, 1000-grain weight and grain yield. The experiments were conducted in a randomized complete block design with four replications, and data were analyzed using Principal Component Analysis (PCA) and clustering analysis. Analysis of variance revealed significant genetic variability across the genotypes, with genotype-by-year interactions underscoring the influence of environmental factors on trait expression. PCA showed that three principal components accounted for 80.89% of the total variation. PC1 (49.29% variance) was predominantly influenced by spike productivity traits, while PC2 captured grain weight-related variation, and PC3 revealed a trade-off between grain yield and spike number per m². Cluster analysis grouped genotypes into three clusters, with Cluster II standing out for its high grain yield and superior spike productivity despite lower spike density. The results indicate that optimizing the balance between spike productivity and spike number per m² is key to improving yield potential. This study highlights the significant genetic diversity available for breeding high-yielding winter barley cultivars and emphasizes the importance of considering environmental adaptability in breeding programs.

**Keywords:** Cluster analysis, grain yield, *Hordeum vulgare* L., Principal Component Analysis (PCA)

## Introduction

Barley (*Hordeum vulgare* L.) is a vital cereal crop with substantial agricultural and economic significance globally. Enhancing grain yield is influenced by various traits, such as number of spike per m², spike productivity, and grain weight (Ruzdik et al., 2015; Madić et al., 2019; Ramazani & Abdipour, 2018; Hu et al., 2021). Understanding the interactions between these traits is essential for effective breeding and crop improvement.

Principal Component Analysis (PCA) is a powerful statistical tool used to identify key sources of variation within complex datasets by reducing dimensionality and highlighting the most significant factors (Lever et al., 2017). By examining the principal components, researchers can uncover the underlying patterns of trait variation and determine how different traits contribute to overall productivity.

The analysis was used to uncover the key traits driving variation among the genotypes, evaluate trade-offs between different traits, and guide breeding strategies to enhance barley productivity (Ramzi et al., 2020; Gadissa et al., 2021; Verma et al., 2021; Neykov et al., 2022).

Additionally, clustering analysis was used to group genotypes based on their trait profiles, providing further insights into the relationships between traits and their impact on yield. This approach helps in identifying promising genotypes for breeding programs and tailoring strategies to optimize productivity (Kumar et al., 2020; Kumar et al., 2021).

The aim of this study was to assess the genetic divergence among winter barley breeding lines with respect to yield and yield-related traits, in order to identify promising genetic resources for the improvement of winter barley cultivars.

**Materials and Methods**

The study included 19 recombinant inbred lines of winter barley, along with their parent varieties KT 3027 and Mahigan, and the standard variety Veslets. It was conducted over two growing seasons, 2021/2022 and 2022/2023, at the experimental field of the Institute of Agriculture-Karnobat, Southeastern Bulgaria (42°39' N, 26°59' E). The soil type was slightly acidic Pellic Vertisol (pH 6.2).

The experiments were arranged in a randomized complete block design with four replications, using 10 m² plots sown at a rate of 450 germinated seeds per m². Standard cultivation practices for winter barley breeding at the Institute were followed. Key traits measured included plant height (PH, cm), spike length (SL, cm), spikelet number per spike (SNS), grain number per spike (GNS), and grain weight per spike (GSW, g), which were recorded from 20 randomly selected plants in each replication. Lodging resistance was rated on a scale of 9 to 1, with 9 indicating high resistance. The number of spikes per m² (SPM) was determined by counting spikes in a 0.25 m² area from the center of each plot and converting it to per square meter. Grain yield (GY, t ha$^{-1}$) and 1000-grain weight (TGW, g) were measured on a plot basis, with mechanical harvesting at full grain maturity.

A two-way analysis of variance (ANOVA) was conducted to identify significant differences among the genotypes and across the growing years. Additionally, the data were analyzed using Principal Component Analysis (PCA) to uncover key sources of variation, and cluster analysis to group genotypes based on their trait profiles. All statistical analyses were performed using SPSS version 20.0.

**Results and Discussion**

The analysis of variance (ANOVA) revealed that the mean sums of squares for all nine traits were highly significant across genotypes, indicating substantial genetic variability within the winter barley lines under study (Table 1). This genetic variation highlights the potential for selecting superior lines based on key yield and yield-related traits. Additionally, the significant effects of both the year and the genotype-by-year interaction suggest that environmental factors played a crucial role in trait expression. This interaction highlights the importance of multi-year trials to capture the influence of varying environmental conditions on the performance of different genotypes.

The significant genotype-by-year interaction suggests that some genotypes performed differently across the two growing seasons, possibly due to variations in weather patterns, soil conditions, or management practices. This reinforces the necessity for breeders to consider environmental adaptability in selecting genotypes. Overall, these findings demonstrate that there is ample genetic diversity to support breeding efforts aimed at improving yield, but also underline the complexity of yield formation, which is influenced by both genetics and environment.

Table 1. Mean squares from combined analysis of variance for yield-related traits of barley genotypes assessed for two growing seasons

| Traits | Genotype (G) | Year (Y) | G x Y | Residuals |
|--------|-------------|----------|-------|-----------|
| SNM | 11326.49* | 676792.02* | 17579.64* | 122.17 |
| PH | 300.76* | 7239.07* | 151.52* | 79.15 |
| L | 5.19* | 67.51* | 4.96* | 0.28 |
| SL | 2.88* | 22.87* | 0.49* | 0.11 |
| SNS | 246.40* | 4802.96* | 34.48* | 3.00 |
| GNS | 229.86* | 3730.83* | 34.51* | 3.16 |
| GWS | 0.20* | 0.32* | 0.11* | 0.02 |
| TGW | 81.33* | 778.05* | 24.92* | 0.14 |
| GY | 4.69* | 18.66* | 2.91* | 0.06 |

* Significant level at $p \leq 0.001$; SNM – spike number per $m^2$; PH - plant height, cm; L – lodging (score 9-1), SL - spike length, cm; SNS - spikelet number of per spike; GNS - grain number of per spike, GWS - grain weight per spike, g; TGW - 1000- grain weight, g; GY - grain yield, t ha$^{-1}$

The analysis of the dataset using Principal Component Analysis (PCA) revealed that three principal components with eigenvalues greater than 1 accounted for 80.89% of the total variation (Table 2). Principal Component 1 (PC1) explained 49.29% of the variation, while Principal Component 2 (PC2) and Principal Component 3 (PC3) accounted for 17.85% and 13.74%, respectively.

PC1 contributed the most to the variation and was strongly influenced by several key traits. The spikelet number per spike (0.951), grain number per spike (0.949), and plant height (0.657) contributed positively to PC1. On the other hand, lodging (-0.605) and 1000-grain weight (-0.749) had negative contributions. This suggests that PC1 primarily represents a balance between traits associated with spike productivity (which positively influence PC1) and traits such as lodging resistance and grain weight (which are negatively correlated). The large contribution of PC1 highlights the importance of spike productivity traits, such as the number of spikelets and grains per spike, as key drivers of variation among the genotypes. The inverse relationship with lodging and 1000-grain weight suggests a trade-off between high spike productivity and these traits. Previous studies also highlight the positive correlation between the number of grains per spike and grain yield, indicating that this trait can serve as an effective selection criterion for barley improvement (Carpici and Celik, 2012; Ruzdik et al., 2015; Madić et al., 2019). These findings further support the importance of selecting for spike productivity traits to enhance yield potential in barley breeding programs.

PC2 was predominantly influenced by grain weight per spike (0.808), which contributed significantly to genetic variance within this component. This suggests that PC2 captures variation related to grain size and quality. The strong influence of grain weight per spike on PC2 underscores its importance in differentiating the genotypes and suggests that selecting for this trait could enhance grain quality and overall yield potential.

PC3, which explained 13.74% of the total variation, was positively associated with grain yield (0.705) and negatively associated with the number of spikes per m² (-0.753). This suggests that PC3 captures a trade-off between grain yield and number of spike per $m^2$, where higher grain yield often corresponds to lower number of spike per $m^2$. In other words, genotypes that produce fewer spikes per unit area may compensate by producing higher grain yields per spike, leading to overall higher grain yields.

Notably, while PC3 indicates an inverse relationship between grain yield and number of spike per $m^2$, other studies have identified number of spike per $m^2$ as one of the most important traits for determining grain yield in barley (Protić et al., 2009; Ruzdik et al., 2015; Ramazani & Abdipour, 2018; Hu et al., 2021). These studies suggest that increasing the number of spikes per unit area can enhance

grain yield under certain conditions. This apparent contradiction may reflect the complex nature of yield formation in barley, where different environments, genotypes, and management practices can influence the optimal balance between number of spike per m$^2$ and grain yield.

The results from this analysis suggest that while higher number of spike per m$^2$ may generally contribute to greater yield potential, in this specific dataset, genotypes with fewer spikes but higher yield per spike may outperform those with higher spike densities. This highlights the importance of considering both number of spike per m$^2$ and yield per spike when selecting for high-yielding genotypes. Depending on the breeding objectives and growing conditions, optimizing this balance could be critical for improving overall productivity in barley.

To better visualize the overall variability among the tested genotypes, the scores for PC1 and PC3 were plotted, given the importance of grain yield and its strong association with PC3 (Figure 1). The principal component analysis revealed that line 14/20 demonstrated the most favorable combination of high spike productivity and grain yield. In addition to line 14/20, several other lines - 3/19, 1/19, 1/20, 18/20, 11/20, and 17/20 were located in the upper-right quadrant of the plot. This positioning indicates that these lines also exhibit a strong positive association between spike productivity traits and grain yield, suggesting their potential for high overall productivity.

In contrast, the parent varieties KT 3027 and Mahigan, along with the standard Veslets and line 4/20, were positioned in the lower-left quadrant of the plot. This placement indicates that these lines and varieties have lower values for traits associated with the first and third principal components (PC1 and PC3). The positioning of these lines and varieties suggests that they may have less desirable performance in terms of both spike productivity and grain yield compared to the lines in the upper-right quadrant

Table 2. Principal Component Analysis of winter barley genotypes

| Characters | PC1 | PC2 | PC3 |
|---|---|---|---|
| Eigenvalues | 4.436 | 1.606 | 1.237 |
| Proportion of variance | 49.293 | 17.850 | 13.743 |
| Cumulative variance | 49.293 | 67.143 | 80.886 |
| **Factor loadings** | | | |
| Number of spikes per m$^2$ | -0.428 | -0.172 | **-0.753** |
| Plant height | **0.657** | -0.232 | -0.312 |
| Lodging | **-0.605** | 0.524 | 0.248 |
| Spike length | **0.922** | 0.117 | -0.025 |
| Spikelet number per spike | **0.951** | 0.085 | 0.065 |
| Grain number of per spike | **0.949** | 0.120 | 0.019 |
| Grain weight per spike | 0.479 | **0.808** | 0.092 |
| 1000-grain weight | **-0.749** | 0.469 | -0.002 |
| Grain yield | -0.099 | -0.583 | **0.705** |
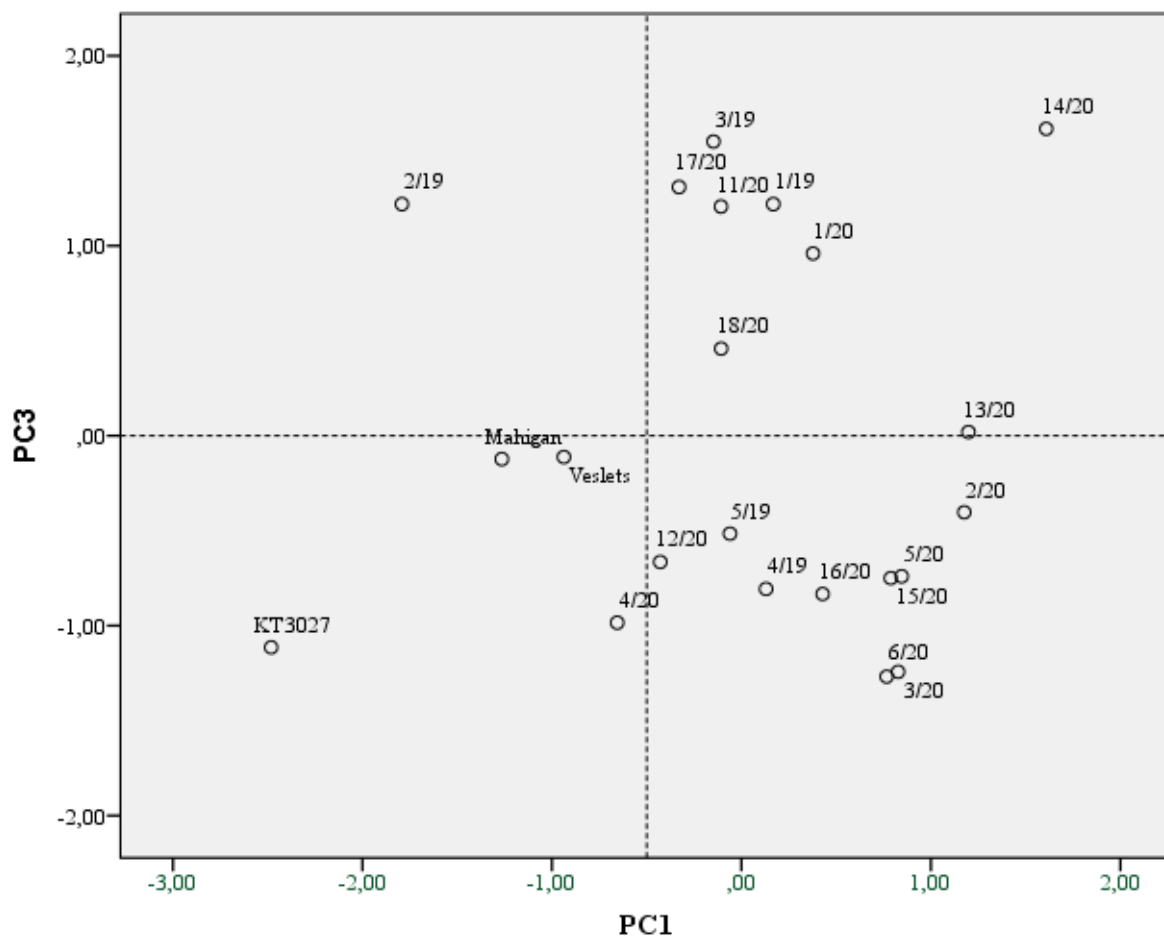


Figure. 1. Scatter diagram for PC1 and PC3 in winter barley genotypes

The clustering analysis grouped the cultivars and lines into three distinct clusters at a distance of 10 units (Figure 2). Cluster I included 10 breeding lines that exhibited intermediate values for most traits compared to the other two clusters. These lines had lower average grain yields (Table 3).

Cluster II stood out with the highest grain yield and superior spike productivity traits, such as spikelet number per spike, grain number per spike, and grain weight per spike, despite having lower means for the number of spikes per m² and plant height. The high yield performance of this cluster suggests that these genotypes compensate for fewer spikes per unit area by achieving greater productivity per spike. This cluster represents a promising group for breeding programs aiming to maximize grain yield, as it offers a favorable combination of high spike productivity and grain yield potential.

Cluster III consisted of nine genotypes, including six breeding lines, parent varieties, and standard variety. This cluster was notable for having the highest number of spikes per m² but lower spike productivity. The high number of spike per $m^2$ in this cluster indicates that these genotypes excel in producing a large number of spikes, but the lower productivity per spike could be limiting their overall grain yield. These genotypes may be more suited to environments where maximizing number of spike per $m^2$ is key to achieving high yields, though improvements in spike productivity could further enhance their performance.

These findings underscore the importance of tailoring breeding strategies to the specific traits and conditions relevant to different environments and production goals. By optimizing the balance between number of spike per $m^2$ and productivity, breeders can enhance overall grain yield and adaptability across diverse conditions.
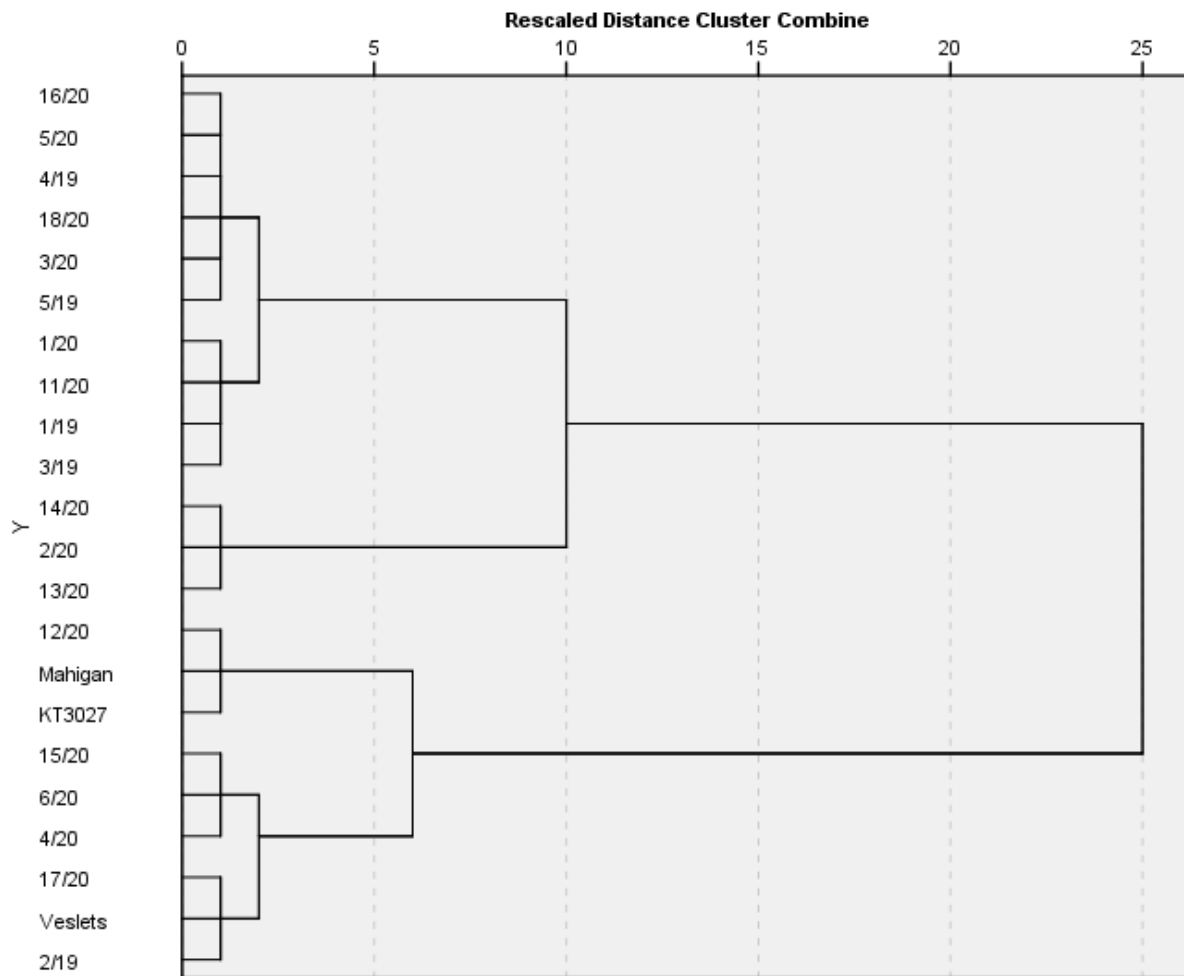
Figure 2. Dendrogram base on 9 traits of 25 six-rowed winter barley genotypes (2010/2011-2011/2012)

Table 3. Cluster mean of characters of winter barley genotypes

| Characters | Cluster | | |
|---|---|---|---|
| | I /10/[*] | II /3/ | III /9/ |
| Number of spikes per m$^2$ | 428.18 | 374.00 | 472.53 |
| Plant height | 107.81 | 105.64 | 107.52 |
| Lodging | 7.84 | 7.80 | 7.52 |
| Spike length | 7.28 | 7.56 | 7.09 |
| Spikelet number per spike | 63.29 | 65.17 | 61.66 |
| Grain number of per spike | 53.48 | 54.64 | 51.93 |
| Grain weight per spike | 2.12 | 2.24 | 2.06 |
| 1000-grain weight | 39.84 | 40.59 | 40.33 |
| Grain yield | 7.74 | 8.08 | 7.92 |

[*] Figures in parentheses indicate number genotypes included in cluster

## Conclusion

The study revealed substantial genetic divergence among winter barley breeding lines, with traits such as spikelet number, grain number per spike, and grain weight per spike being key drivers of variation. Principal Component Analysis highlighted important trade-offs between spike productivity, lodging resistance, and number of spike per m$^2$. High-yielding genotypes with superior spike

productivity were identified. These findings emphasize the importance of optimizing the balance between number of spike per m$^2$ and spike productivity to enhance barley yields across diverse environments and meet different breeding objectives.

### References

Çarpıcı, E., & Çelik, N. (2012). Correlation and Path Coefficient Analyses of Grain Yield and Yield Components in Two-Rowed of Barley (Hordeum vulgare convar. distichon) Varieties. Notulae Botanicae Horti Agrobotanici Cluj-napoca, 4, 128-131. https://doi.org/10.15835/NSB427388.

Gadissa, F., Abebe, M., & Bekele, T. (2021). Agro-morphological traits-based genetic diversity assessment in Ethiopian barley (*Hordeum vulgare* L.) landrace collections from Bale highlands, Southeast Ethiopia. Agriculture & Food Security, 10, 1-14. http://dx.doi.org/10.1186/s40066-021-00335-4

Hu, Y., Barmeier, G., & Schmidhalter, U. (2021). Genetic variation in grain yield and quality traits of spring malting barley. Agronomy, 11(6), 1177. http://dx.doi.org/10.3390/agronomy11061177

Kumar, Y., Niwas, R., Nimbal, S., & Dalal, M. (2020). Hierarchical cluster analysis in barley genotypes to delineate genetic diversity. Electronic Journal of Plant Breeding. https://doi.org/10.37992/2020.1103.122.

Kumar, Y., Sehrawat, K., Singh, J., & Shehrawat, S. (2021). Identification of promising barley genotypes based on morphological genetic diversity. Journal of Cereal Research. https://doi.org/10.25174/2582-2675/2021/108051.

Lever, J., Krzywinski, M., & Altman, N. (2017). Points of Significance: Principal component analysis. Nature Methods, 14, 641-642. https://doi.org/10.1038/nmeth.4346.

Madić, M., Knežević, D., Đurović, D., Paunović, A., Stevović, V., Tomić, D., & Đekić, V. (2019). Assessment of the correlation between grain yield and its components in spring barley on an acidic soil. Acta agriculturae Serbica. https://doi.org/10.5937/aaser1947041m.

Neykov, N., Doneva, M., Chavdarov, P., & Alexiev, I. (2022). Correlation, path-coefficient and principal component analysis of yield and some traits related to the productivity of winter barley accessions with Bulgarian origin. Bulgarian Journal of Agricultural Science, 28 (No 4), 658–661.

Protić, R., Todorović, G., & Protić, N. (2009). Correlations of yield and grain yield components of winter wheat varieties. Journal of Agricultural Sciences, Belgrade, 54, 213-221. https://doi.org/10.2298/JAS0903213P.

Ramazani, S., & Abdipour, M. (2018). Statistical Analysis of Grain Yield in Iranian Cultivars of Barley (Hordeum vulgare). Agricultural Research, 8, 239-246. https://doi.org/10.1007/s40003-018-0360-4.

Ramzi, E., Asghari, A., Sofalian, O., Mehraban, A., & Ebadi, A. (2020). Evaluation of seed yield stability of barley promising genotypes using principal coordinates analysis. Journal of Plant Physiology and Breeding, 10(2), 59-68.

Ruzdik, N., Valcheva, D., Vulchev, D., Mihajlov, L., Karov, I., & Ilieva, V. (2015). Correlation between grain yield and yield components in winter barley varieties. Agricultural Science and Technology, 7, 40-44.

Verma, S., Yashveer, S., Rehman, S., Gyawali, S., Kumar, Y., Chao, S., Sarker, A., & Verma, R. P. S. (2021). Genetic and Agro-morphological diversity in global barley (Hordeum vulgare L.) collection at ICARDA. Genetic Resources and Crop Evolution, 68, 1315-1330. http://dx.doi.org/10.1007/s10722-020-01063-7

# Probiotic Bacteria Changes and Its Dynamics During Ripening Period of Fermented Sausages

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## Abstract

Sausages are the largest and important product group in the meat processing industry. There are several hundred types of sausages and several hundred thousand brands. Dry-cured pork sausage belongs to the group of durable fermented sausages and only these groups contain probiotic bacteria, when produced as functional food. Initially as for probiotics the bacteria such as *Bifidobacterium* and *Lactobacillus* are being used.

The paper presents the dynamics of the *Bifidobacterium longum* BB536 probiotic added to the filling of two groups of fermented sausages produced as functional products. Fermented sausages are produced in industrial conditions according the standard recipe at a local meat factory.

The dynamics was monitored during the entire ripening period up to the 20th day at a strictly controlled conditions and temperature of 18°C and relative humidity of 82% at the beginning of the ripening and decreasing of temperatures at the end of the ripening time such as 14-20th day, (14°C relative humidity of 75%).

Results of the probiotic bacterium *Bifidobacterium longum* BB536, developed to be used in the dairy industry, and in those researches used as probiotic in the productions series, has proven to be well multiplied during the fermentation and the fermented sausages because it reached an amount of 6.63 log10 CFU/gr - 6.03 log10 CFU/gr.

**Keywords:** technology, quality, functional , fermentation

## Introduction

In addition to dairy, meat can also serve as an effective vehicle for probiotics due to its excellent buffering capacity, which protects bacterial cells from low pH. However, before probiotics can be applied in the production of fermented sausages, a thorough selection of strains is required. One approach is to test existing strains within starter cultures for their probiotic properties. For instance, the strains *Lactobacillus sakei* Lb3 and *Pediococcus acidilactici* PA-2 have demonstrated the ability to survive in conditions simulating the intestinal environment (Obradović and Vesković-Moračanin, 2007). Another approach involves isolating intestinal strains capable of competing with the natural microbiota in the production environment of fermented sausages, present in sufficient concentrations to confer probiotic effects. The first probiotic-enriched meat products appeared in 1998, and strains such as *Lactobacillus rhamnosus* GG, *L. rhamnosus* LC-705, *L. rhamnosus* E-97800, and *Lactobacillus plantarum* E-98098 have been successfully utilized in the production of traditional fermented sausages (Erkkilä, 2001).

Lücke (2001) found that strains from species *Lactobacillus casei*, *L. paracasei*, and *L. rhamnosus*, as well as *Bifidobacterium* genus, are well-suited for the production of meat products, as they can survive fermentation and drying processes. Additionally, studies by Muthukumarasamy et al. (2007) indicate the potential for using *Lactobacillus reuteri* (ATCC 55730) and *Bifidobacterium longum* (ATCC 15708) in combination with starter cultures such as *Pediococcus pentosaceus* and *Staphylococcus carnosus* as bioprotective cultures, capable of producing antimicrobial components like lactic acid and bacteriocins, thus inhibiting the growth of *Escherichia coli* O157.

Further studies by Pennacchia et al. (2006) showed that in sausage production, *Lactobacillus plantarum* demonstrated superior water-binding capacity compared to *L. brevis* and *L. paracasei*. It is generally accepted that a measurable probiotic effect requires the intake of at least one million probiotic bacteria per gram of fermented sausage (Vuković et al., 2009).

Despite promising preliminary results, a comprehensive assessment of the health benefits of probiotics delivered via fermented sausages remains elusive. Thus, additional research is necessary to justify the introduction of new probiotic-enriched meat products.

### Materials and Methods

Three different batches of dry-cured pork sausages (A, B and C) were produced according standard technology of the meat factory ″MIK″ – *Sveti Nikole* from Republic of North Macedonia. The basic recipe required 40% first category pork meat (thigh), 40% second category pork meat (shoulder blade), 20% firm fatty tissue (back bacon) and additive Glucon delta-lacton -GDL (15g/50kg) named (A). Second sausage batch (named B) was inoculated with freeze dried starter culture Bactoferm F-SC-111, Chr.Hansen (15g/50kg) and batch (named C) was made by substitution of firm fatty tissue with palm fat (the content of total fat in the filling at the beginning of the ripening was equaled and it was 20%) and addition of starter culture. The starter culture Bactoferm F-SC-111, Chr.Hansen was mixed culture composed of *Lactobacillus sakei* and *Staphylococcus carnosus*.

The probiotic culture Bifidobacterium longum BB536 (35g), a product of the Danisso company, was added to the filling of the fermented sausages from the B and C production batches. The following additives were used: nitrite curing salt (2.2%), sodium erythorbate (0.05%), dextrose (0.5%), grinded pepper (0.025%), garlic in powder (0.015%) and a mixture of spices ″*Koleks*″ for dry-cured pork

sausage. The filing for the experimental sausages was made from frozen pork meat and fat relation 80:20. The frozen meat, the fatty tissue and the frozen palm fat were chopped in pieces of 10cm. and grounded through a 10 mm diameter mincing plate at –3 °C temperature. Than spices and GDL (batch A) and starter culture (bathes B and C) were added. The mixture was then filled with vacuum machine in collagen skin with a diameter of 36 mm. The filled sausages were hanged on metal rails and washed with cold water and then, were transported to thermo-chambers where they were drained for 24 hours at a temperature of 16 ºC. Then, there was a phase of smoking for 12 hours at a temperature of 15-20 ºC, and relative humidity of 95%. After the smoking, the sausages were left to ripening until the 20th day, with two more phases of smoking at the 7th day, for 5 to 10 hours (5 hours of smoking with 5 hours of pause), at temperature of 18 ºC and humidity of 82% and at the 14th day for 5 hours at temperature of 14 ºC and relative humidity of 75%. The batches were manufactured in triplicates.

Samples (n=10) were taken from each batch at the day of filling, and then at the 3rd, 7th, 14th and 20th day during the period of ripening. The total count of Bifidobacterium longum BB536 was determined using MRS agar (Merck), incubated at 37ºC for 48 hours under anaerobic conditions. Sample preparation and dilution followed ISO 6887-2:2008 standards. Colony enumeration was performed using a Funke Gerber 8500 colony counter.

**Results and Discussion**

In functional fermented sausages, the amount and viability of added probiotics during the maturation process are of particular importance. The quantity of probiotics correlates with their health impact. A recommended intake of 10-100 g of fermented products containing a concentration of $10x^8$ CFU/g of viable probiotic bacteria is suggested. Additionally, the dynamics of probiotic growth during fermentation are influenced by several factors, including ingredient composition, the type and amount of added prebiotics, and environmental conditions such as temperature and humidity in the maturation chambers.

Our research monitored the dynamics of *Bifidobacterium longum* BB536 in two production batches of functional fermented sausages (B and C), Table 1,2. Initial values on the day of filling were 5.40 x $10^4$ CFU/g for FFP and 4.36 x $10^4$ CFU/g for FPM. By day 3, the probiotic counts increased to 7.30 x $10^4$ CFU/g (FFP) and 6.10 x $10^4$ CFU/g (FPM). This upward trend continued through day 7, reaching 8.86

x $10^4$ CFU/g (FFP) and 8.06 x $10^4$ CFU/g (FPM). A slight decrease was observed by day 14, with counts

of 7.96 x $10^4$ CFU/g and 6.56 x $10^4$ CFU/g for FFP and FPM, respectively. At the end of the maturation

process, average values of *B. longum* BB536 were 6.63 x $10^4$ CFU/g for FFP and 6.03 x $10^4$ CFU/g for

FPM. Statistically significant differences ($p < 0.01$) were observed between the two production series

throughout the fermentation process.

Table 1. Dynamics of the Total Number of *Bifidobacterium longum* BB536 in fermented sausages from the (B) production batches

| | | Ripening period | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 3 | 7 | 14 | 20 |
| **Fermented sausages – (B) production batches** | Repetitions | x$10^4$ | x$10^4$ | x$10^4$ | x$10^4$ | x$10^4$ |
| | I | 4.8 | 6.0 | 7.6 | 6.5 | 5.9 |
| | II | 5.4 | 7.7 | 9.0 | 7.8 | 7.0 |
| *CFU/gr* | II | 6.0 | 8.2 | 10.0 | 9.6 | 7.0 |
| | $\bar{x}$ | **5.40** | **7.30** | **8.86** | **7.96** | **6.63** |

*$F_{0,05}= 3.55$ /p<0,05
$F_{0,01}= 6.01$/ p<0,01

Table 2. Dynamics of the Total Number of *Bifidobacterium longum* BB536 in fermented sausages from the (C) production batches

| | | Ripening period | | | | |
|---|---|---|---|---|---|---|
| | Repetitions | 0 | 3 | 7 | 14 | 20 |
| **Fermented sausages – (C) production batches** | | x$10^4$ | x$10^4$ | x$10^4$ | x$10^4$ | x$10^4$ |
| | I | 3.4 | 4.5 | 6.3 | 4.5 | 4.2 |
| | II | 4.9 | 6.7 | 8.5 | 7.2 | 6.7 |
| | II | 4.8 | 7.1 | 9.4 | 8.0 | 7.2 |
| *CFU/gr* | $\bar{x}$ | **4.36** | **6.10** | **8.06** | **6.56** | **6.03** |

*$F_{0,05}= 3.55$ /p<0,05
$F_{0,01}= 6.01$/ p<0,01

The growth dynamics of *B. longum* BB536 suggest that probiotic bacteria thrive during the initial stages

of fermentation, particularly up to day 7, as their activity is critical for sugar fermentation and the

creation of favorable conditions for sausage maturation. Although the overall count declines toward the

end of fermentation, sufficient levels of viable probiotics are maintained.

The viability of *B. longum* BB536 is also influenced by the presence of the prebiotic inulin, which plays

a significant role in both production series. Our results are largely similar to those of Moyano et al.

(2008), who found a probiotic bacteria count from the *Bifidobacterium* genus of >7 log10 CFU/g in

inoculated traditional fermented sausages at the end of the ripening process.
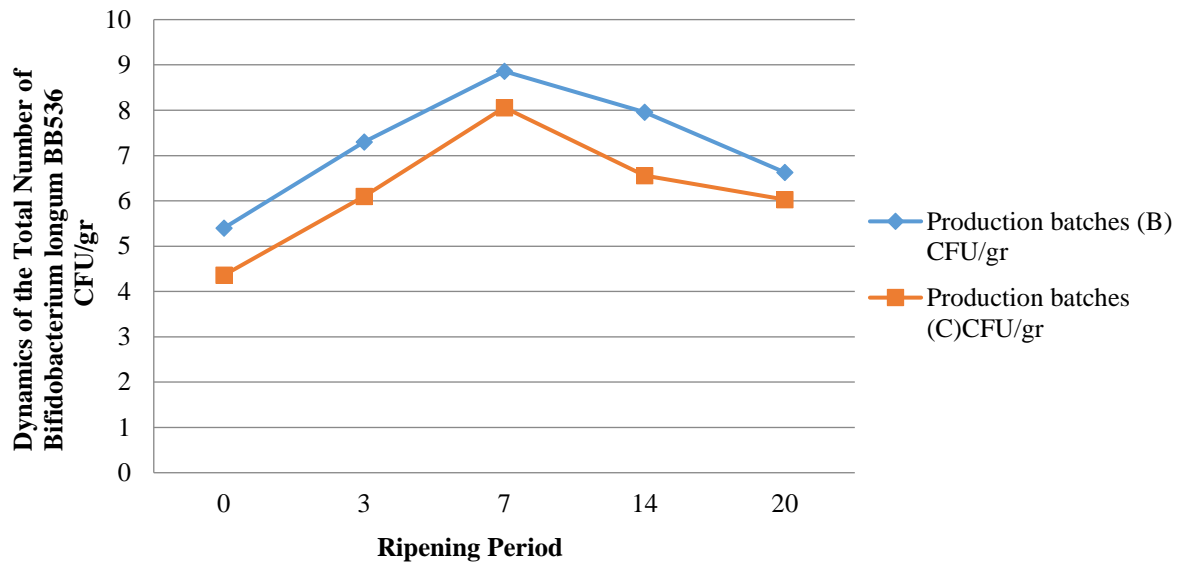
Figure 1. Dynamics of the Total Number of *Bifidobacterium longum* BB536 in fermented sausages during ripening

Goderska et al. (2008) conducted studies on the growth dynamics of *Bifidobacterium bifidum* DSM 20082, *Bifidobacterium bifidum* DSM 20215, *Bifidobacterium bifidum* DSM 20239, *Bifidobacterium bifidum* DSM 20456, and *Lactobacillus acidophilus* DSM 20079, *Lactobacillus acidophilus* DSM 20242 in a medium with added prebiotics.

The behavior of these bacteria, which are obligate anaerobes, is highly dependent on the specific technological conditions during production (Trombeva, 2010). Despite being originally developed for the dairy industry, *B. longum* BB536 performed well in fermented sausages, achieving counts of 6.63/6.03 log10 CFU/g, meeting the required standard for functional fermented products (Vuković et al., 2009).

### Conclusion

The changes that occur in the functional properties of fermented sausages can be observed through the dynamics of probiotic bacteria. The probiotic bacterium *Bifidobacterium longum* BB536 grows intensively in both production batches up to the 7th day from the start of the ripening process. Its count then decreases, but it remains present in sufficient numbers at the end of the production process, reaching $6.63 \times 10^4$ CFU/g in the GMP group and $6.03 \times 10^4$ CFU/g in the FPM group.

**References**

Goderska K., Jacek N., & Zbigniew, C. (2008). Comparision of growth of Lactobacillus acidophilus and Bifidobacterium Bifidum species in media suplemented with selected saccharides including prebiotics. Acta Scientiarum Polonorum, Technologia Alimentaria 7(2),5-20.

Erkkilä, S., Suihko, M.J., Eerola, S., Petäjä, E., & Mattila-Sandholm, T. (2001). Dry sausage fermented by Lactobacillus rhamnosus strains, International Journal of Food Microbiology, 64, Issues 1–2, 205-210 https://doi.org/10.1016/S0168-1605(00)00457-8

Lücke F.K. (2001). Starter and protective cultures for meats - recent developments. Tehnologija mesa, 42, 5-6: 356-374.

Muthukumarasamy,P., & Holley.A. R. (2007). Survival of Escherichia coli O157:H7 in dry fermented sausages containing micro-encapsulated probiotic lactic acid bacteria. Food Microbiology, Vol. 24 Iss.1,82-88.

Moyano Ruiz S., Martín, A., Benito, M. J., Perez Nevado F., & Córdoba, M. G. (2008). Screening of lactic acid bacteria and bifidobacteria for potential probiotic use in Iberian dry-fermented sausages. Meat Science, 80,715-721 https://doi.org/10.1016/j.meatsci.2008.03.011

Obradović, D., & Vesković – Moračanin, S. (2007). Funkcionalne fermentisane kobasice- sadašnje stanje i perspective. Tehnologija mesa 48, 93-98

Pennacchia C., Vaughan E.E., & Villani F. (2006). Potential probiotic *Lactobacillus* strains from fermented sausages: Further investigations on their probiotic properties. Meat Sci.,73,1,90-101 https://doi.org/10.1016/j.meatsci.2005.10.019

Trombeva D. (2010). Dynamics of the influence of prebiotics on the technological parameters in fermented milk with probiotics. Master's thesis, Faculty of Biotechnical Sciences, University St.″Kliment Ohridski″ Bitola, R.N.Macedonia

Vuković, I., Saičić, S., Vasilev, D., Tubić, M., Vasiljević N., & Milanović-Stevanović, M. (2009). Neki parametric kvaliteta i nutritivna vrednost funkcionalnih fermentisanih kobasica. Tehnologija mesa, 50, 1-2, 68-74.

# Effect of Polylactic Acid (PLA) Coated Urea Fertilizer on Growth Characteristics of Silage Corn Plant

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## Abstract

Important research has been carried out for the effective use of urea fertilizer and new technologies have been developed in recent years to improve urea performance. The aim of this study is to reduce the solubility of urea fertilizer applied to soil by coating it with biodegradable PLA material and to prevent nitrogen losses. For this purpose, urea coated with PLA, 46% standard urea and 46% slow-release urea fertilizers were applied at 120 ppm in 2 equal amounts as base and top fertilizer to corn plants grown in pots in the greenhouse. Maize plants were grown until silage maturity and the plant growth characteristics (plant height, plant diameter, number of leaves, number of cobs, cob diameter, tassel length, root wet/dry weights, cob wet/dry weights and total upper part wet/dry weights) of the harvested plants were examined. According to the data obtained, while the highest values were obtained in plant diameter and peak tassel length in normal urea application, it showed lower values in cob diameter, cob wet/dry weights and dry weight of upper parts compared to other fertilizers. The differences between Super Pearl and PLA-coated urea fertilizer treatments in cob diameter, tassel length and root dry weights were significant; however, the differences between all of the topsoil wet and dry weights in terms of silage yield were not significant ($p<0.05$). As a result, fertilizer applications had a significant positive effect on all developmental traits of silage maize plants. Although there were differences between the fertilizers applied according to control, the differences between fertilizers in terms of total silage yield were insignificant. According to these results, it is understood that urea fertilizer coated with PLA material can also be used in silage corn plant cultivation. It is recommended to support the researches on this subject with other plants and coating materials.

**Keywords**: Polylactic acid, urea, corn plant

## Introduction

Developing countries use most of the global urea production with a nitrogen use efficiency of 20-35% (Naz and Sulaiman, 2016). Nitrogen fertilizers constitute the largest share among the plant nutrient materials used in our country and the most widely used fertilizer among these nitrogen fertilizers is urea fertilizer (TUIK, 2022). Controlled and slow-release fertilizers are of great interest as they provide sustainable nutrients that reduce nutrient loss, increase crop yields and conserve natural resources. Excess nitrogen release in the soil not only harms the environment but also reduces the effectiveness of conventional urea. The effectiveness of urea fertilizers can be increased by coating the urea fertilizer with slow-release coating materials and matching nitrogen release from these capsules to plant uptake (Naz and Sulaiman, 2016).

Slow-release coating technology is considered to be the most appropriate method to provide nitrogen to plants in a consistent manner to reduce losses and pollution impacts. The coating technology is designed to gradually release the nutrient content of fertilizers and match the release rate to the nutrient demand of the plants (Bröckel and Hahn, 2004).

According to Thind et al. (2010), coated urea reduces plant toxicity due to the low leaching rate of nitrogen in the soil solution, and a number of nitrogen release mechanisms are conceivable, depending on the structure and physical properties of the coating material.

Ni et al. (2009) produced a double-coated urea for slow-release applications. They reported using ethylcellulose and cross-linked poly (acrylic acid-Co-acrylamide) for the production of the inner and outer coatings, respectively. The researchers reported that in general, the product consists of a three-layer structure, the nitrogen release data of the urea coated in this way in the soil predicted 75% release after 30 days of incubation and proposed the material obtained by this coating method as a multifunctional slow-release urea fertilizer.

Han et al. (2009) reported that they prepared a biodegradable starch-polyvinyl alcohol (PVA) blend film for coating granular fertilizer and investigated the effects of starch-PVA blend ratio and formaldehyde content on coating film properties using FTIR, IFM and XRD techniques. They reported a significant increase in water permeability, water absorbency and $NH_4$ permeability of the coated film, however, a decrease in the amount of starch in the formulations negatively affected the coating compatibility.

Nooeaid et al. (2021) reported that Polyvinyl alcohol/Poly Lactic acid core/shell fibers with micro-sized diameters provide higher encapsulation efficiency compared to PVA monolithic fibers and that core/shell fibers increase the stability and release properties of plant nutrients in a controlled manner.

Mulder et al. (2011) suggested that high efficiency of coated fertilizer urea can be achieved by producing semi-permeable polyolefin or polyurethane coating layers on granular fertilizer.

Rasal et al. (2010) stated that PLA has four main advantages; low energy use in production, biocompatibility, renewability and easy processability and emphasized that due to these features, the

application areas of PLA-based plastics are gradually expanding and they can replace petroleum-based plastics.

According to Anonimous (2021), Poly Lactic Acid (PLA) is a polyester produced by fermentation under regular conditions from carbohydrate sources such as corn starch or sugar cane. The building blocks can be in the form of lactic acid or lactide monomers. PLA monomers can be depolymerized as well as biodegradable and can be broken down to $H_2O$ and $CO_2$ or transformed into other mixed natural materials.

In the light of the above information, in this study, since urea fertilizer is the most widely used fertilizer among nitrogen fertilizers in the world and in Turkey (TUIK, 2022), our main objective was coating urea fertilizer with a kind of corn starch based polylactic acid and to determine the developmental characteristics of the corn plant. This study may provide new contributions to the literature of our country and the world and may shed light on future studies.

### Materials and Methods

Soils of ÇOMÜ Faculty of Agriculture Dardanos Research and Application Farm were used in the study. After the soils were dried in the shade and sieved through a 2 mm sieve, basic soil analyses and soil moisture were performed and evaluated according to Müftüoğlu et al. (2014) (Table 1).

**Table 1.** Soil properties of the trial soil

| Element/Analysis | Analysis results |
|---|---|
| Sand (%) | 40 |
| Clay (%) | 29 |
| Loam (%) | 31 |
| pH (1/ 2.5 soil / water) | 7.07 |
| EC (1/ 2.5 soil / water, µS/cm) | 363 |
| Carbonate (%) | 15.99 |
| Organic matter (%) | 1.81 |
| Total nitrogen (%) | 0.09 |
| Available $P_2O_5$ (mg kg$^{-1}$) | 6,291 |
| Available $K_2O$ (mg kg$^{-1}$) | 269,5 |
| Field capacity (%) | 22 |
| Wilting point (%) | 13 |
| Available moisture (%) | 3.30 |

After soil analysis, equal amounts of soil (15 kg) were filled into 18-liter pots from the sieved soils according to the dry matter basis. The experiment was carried out by growing silage maize plants in a total of 16 pots with 3 different fertilizer treatments- other than the control- and 4 replications. The

PLA coated urea fertilizer used in the experiment was produced in the laboratory of ÇOMÜ Faculty of Science, while the other fertilizers were purchased. To obtain PLA-coated urea fertilizer, 99.9% purity urea material and PLA material were dissolved in Dimethylformamide (DMF) solvent. Polyvinyl alcohol (PVA) with water, then the PLA and urea solution was homogenized and encapsulated drop by drop into the polyvinyl alcohol (PVA) medium with a syringe. The capsules were placed in a petri dish and sterile dried at room temperature. The experiment was conducted in the semi-controlled plastic greenhouse of Çanakkale Onsekiz Mart University, Faculty of Agriculture. Other urea fertilizers were used in this experiment were urea fertilizers containing 46% N known as White Pearl and Super Pearl in the market. All fertilizers were applied to the pots in two times (as base and top fertilizer) at equal doses and 120 ppm in total. After the first half of the fertilizers were applied homogeneously to the bottom of the pots, silage maize seeds were planted in the pots and kept at field capacity moisture until the plants reached silage maturity. Weed control and pest control were carried out manually until the plants reached harvest maturity. Immediately after harvesting, plant growth parameters such as plant height, plant diameter, number of leaves, wet/dry weights of plants, number of cobs, wet/dry weights of cobs, cob length, cob diameter, total wet/dry weights of upper part of plants and wet/dry weights of roots were determined. The data obtained were subjected to analysis of variance using SAS 9.0 statistical analysis program and significant differences between treatments were evaluated according to Duncan multiple comparison test at $p < 0.05$ level.

**Results and Discussion**

According to the data obtained, statistically significant differences were observed between the control group and the treatments in all traits except the number of leaves and cobs in the plant, and these differences were in the form of increases in favor of fertilizer-treated plants. (Table 2, Table 3).

**Table 2.** Changes in corn plant growth characteristics

| Aplications Properties | Plant Height (cm) | Plant Diameter (cm) | Cob Diameter (cm) | Top Tassel length (cm) | Root Wet Weight (g) | Root Dry Weight (g) |
|---|---|---|---|---|---|---|
| Control | 223.0 B | 18.80 C | 27.15 C | 26.00 D | 179.2 C | 24.70 C |
| White Pearl | 248.3 A | 23.65 A | 36.60 B | 44.50 A | 352.0 A | 59.28 A |
| Super Pearl | 242.7 A | 21.33 B | 36.89 B | 40.67 B | 296.8 B | 50.16 A |
| PLA-Coated Urea | 247.6 A | 22.15 B | 40.35 A | 36.25 C | 278.2 B | 37.84 B |

While the differences in plant height, number of leaves, number of cobs and fresh weight of plant top parts were insignificant, the differences in plant diameter, cob diameter, tassel length, root wet/dry weights and cob wet/dry weights were found significant. According to the data obtained from plant growth traits, plant diameter and tassel length were obtained at the highest level with urea fertilizer application containing 46% N, while cob diameter, cob wet/dry weights and top part dry weights were significantly lower than the other fertilizers. While the differences in cob diameter, tassel length and root dry weights between Super Pearl and PLA coated urea fertilizer treatments were found to be significant, the differences between all top wet and dry weights in terms of silage yield were not significant ($p < 0.05$). According to Rasal et al. (2010), PLA's low energy use in production, biocompatibility, renewability and easy processing are great advantages. The fact that PLA coatings are biodegradable and that such fertilizers can be used will make significant contributions to the sustainability of agriculture. PLA-coated fertilizers appear to positively affect soil structure and plant growth compared to conventional fertilizers. The findings suggest that PLA coating optimizes nitrogen release and increases plant nutrient availability. These results support the feasibility of PLA-coated fertilizers as an innovative approach to sustainability. However, production costs and production methods should be considered and improved. PLA-coated fertilizer should be tested on different crops grown in different climates and its performance in both climatic and crop variables should be examined. In future studies, PLA coated fertilizers should be used and developed in different soil and climate conditions.

**Table 3.** Changes in corn plant growth characteristics

| Aplications Properties | Cob Wet Weight (g) | Cob Dry Weight (g) | Upper Wet Weight (g) | Upper Dry Weight (g) |
|---|---|---|---|---|
| Control | 58.44 C | 148.4 C | 325.0 B | 89.97 C |
| White Pearl | 118.8 B | 251.2 B | 523.2 A | 132.5 B |
| Super Pearl | 157.4 A | 311.2 A | 539.8 A | 153.8 A |
| PLA-Coated Urea | 166.6 A | 311.8 A | 523.9 A | 145.2 BA |

**Conclusion**

According to the data obtained, it was observed that the effects of different urea fertilizer treatments on maize plant growth traits were different. While the differences between the fertilizers other than the control on plant growth traits such as plant height, number of leaves, number of cobs and

top wet weights were not statistically significant, the differences between plant diameter, cob diameter, top tassel length, root wet/dry weights and cob wet/dry weights were statistically significant. ($p < 0.05$). While the highest values were obtained in plant diameter and tassel length with normal urea application; cob diameter, cob wet/dry weights and topsoil dry weight were lower than those obtained from fertilizers. The differences between Super Pearl and PLA coated urea fertilizer treatments in cob diameter, tassel length and root dry weights were found to be significant ($p < 0.05$). ; however, the differences between all above ground wet and dry weights in terms of silage yield were not statistically significant ($p > 0.05$). In the light of this information, it can be stated that the effectiveness of PLA coated urea fertilizer is similar to other commercial fertilizers used by our farmers, especially in terms of corn silage yield. In order to obtain more detailed information on PLA coating of urea fertilizer and its reflections on plant yield, experiments should be carried out under different climatic conditions, in different soil structures and on different plants. When the studies on urea coatings are examined, problems such as the negative effects of coating materials on soil organisms, the cost of coating materials and insufficient dissolution rates of coating materials are generally encountered. This situation shows that such studies should be increased.

### Acknowledgements

### References

Anonimous (2021). https://all3dp.com/2/what-is-pla-plastic-material-properties/ date of acces; 24.11.2024.

Bröckel, U., & Hahn, C. (2004). Product design of solidfertilizers. Chemical Engineering Research and Design, 82(11), 1453-1457. https://doi.org/10.1205/cerd.82.11.1453.52039

Han, X., Chen, S., & Hu, X. (2009). Controlled-release fertilizer encapsulated by starch/polyvinyl alcohol coating. *Desalination*, *240*(1-3), 21-26. https://doi.org/10.1016/j.desal.2008.01.047

Mulder, W. J., Gosselink, R. J. A., Vingerhoeds, M. H., Harmsen, P. F. H., & Eastham, D. (2011). Lignin based controlled release coatings. Industrial Cropsand Products, 34(1), 915-920. https://doi.org/10.1016/j.indcrop.2011.02.011

Naz, M.Y., & Sulaiman, S. A. (2016). Slow release coating remedy for nitrogen loss from conventional urea: a review. Journal of ControlledRelease, 225, 109-120. https://doi.org/10.1016/j.jconrel.2016.01.037

Ni, B., Liu, M., & Lü, S. (2009). Multifunctional slow-release urea fertilizer from ethyl cellulose and super absorbent coated formulations. Chemical Engineering Journal, 155(3), 892-898. https://doi.org/10.1016/j.cej.2009.08.025

Nooeaid, P., Chuysinuan, P., Pitakdantham, W., Aryuwananon, D., Techasakul, S. & Dechtrirat, D. (2021). Sürdürülebilir tarım için kontrollü salınımlı gübreler olarak çevre dostu polivinil alkol/polilaktik asit

çekirdek/kabuk yapılı lifler. *Polimerler ve Çevre Dergisi* , *29* (2), 552-564. https://doi.org/10.1007/s10924-020-01902-9

Rasal, R. M., Janorkar, A. V., & Hirt, D. E. (2010). Poly (lacticacid) modifications. Progress in polymerscience, 35(3), 338-356. https://doi.org/10.1016/j.progpolymsci.2009.12.003

Thind, H. S., Pannu, R. P. S., Gupta, R.K., Vashistha, M., Singh, J., & Kumar, A. (2010). Relative performance of neem (Azadirachtaindica) coated urea vis-a-visordinary urea applied torice on the basis of soil test or following need based nitrogen management using leaf colour chart. Nutrientcycling in agroecosystems, 87(1), 1-8. https://doi.org/10.1007/s10705-009-9307-2

TUİK, 2022. Kimyasal gübre kullanımı, erişim tarihi; 12 Haziran 2023, erişim adresi https://data.tuik.gov.tr/Kategori/GetKategori?p=Tarim-111.

# Impact of Different Starter Cultures on Quality Parameters of Kashkaval During Ripening

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## Abstract

Kashkaval is our traditional dairy product and holds a significant place in the dairy industry. This study examines the impact of different starter cultures on all significant quality parameters of three varieties of Kashkaval (A, B, C). For the production of Kashkaval Variant A, we used starter culture (TCC 4) from Chr. Hansen, which contains *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. For Variant B, starter culture (SH 092 E) from Sacco Clerici was used, containing *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, and *Lactobacillus helveticus*. For Variant C, we used starter culture (TREDMIX K) from Tredmix, which includes *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, *Streptococcus lactis*, and *Lactobacillus helveticus*. All key quality parameters such as active and titratable acidity, dry matter percentage, moisture content, lactic acid concentration, salt percentage and ash content, were monitored on the 1st, 10th, 30th, and 60th days of ripening period. The findings indicate that the composition of the starter culture significantly affects the development of desirable characteristics of final product-Kashkaval. This study provides valuable insights into optimizing starter cultures to enhance Kashkaval quality and offers practical recommendations for dairy producers aiming to improve production.

**Keywords: M**ilk, starter cultures, Kashkaval, quality parameters, ripening

## Introduction

Kashkaval cheese is a traditional dairy product with significant cultural and economic importance in the Republic of North Macedonia, with a centuries-old tradition. Known for its distinctive flavor, texture, and nutritional value, it represents a cornerstone of the local dairy industry. The production of Kashkaval involves complex biochemical and microbiological processes, where starter cultures play a critical role in determining the quality, sensory properties, and consistency of the final product (Fox et al., 2017; Cogan and Hill, 1993). It is a typical representative of the Pasta Filata cheeses, characterized by the cheddaring process of the curd and its stretching at high temperatures, resulting in a plastic-elastic consistency and a layered structure., (Matkovski, 1996).

Starter cultures, composed of selected strains of lactic acid bacteria (LAB), are pivotal in standardizing cheese production and ensuring desirable fermentation, acidification, and flavor development (Raynal-Ljutovac et al., 2008). Previous studies have highlighted the variability in Kashkaval cheese characteristics depending on the choice of starter culture, milk composition, and ripening conditions (Ivanova et al., 2021). However, limited research has focused on comparing the

sensory and chemical profiles of Kashkaval cheese produced with different starter cultures over ripening stages.

The company Chr. Hansen, as one of the largest producers of DVS (Direct Vat Set) cultures in the world, has launched several types of starter cultures for the production of cheeses from the Pasta Filata group. The combination of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* is commercially known under the names TCC-3, TCC-4, TCC-5, and TCC-6. The TCC-20 starter culture includes *Str. thermophilus* and *L. helveticus*, while the monoculture composed solely of *Str. thermophilus* encompasses the variants ST-M3, ST-M4, ST-M5, and ST-M6 (Chr. Hansen, 2002).

By exploring the influence of starter cultures on Kashkaval cheese, this research aims to provide valuable insights into improving cheese standardization and enhancing product quality for the dairy industry.

**Materials and Methods**

The subject of this research was the evaluation of kashkaval cheese variants (A, B, and C) produced from cow milk in a dairy processing facility located in the Pelagonia region. The study focused on analyzing milk quality parameters used for kashkaval production. The analyzed milk parameters included milk fat, proteins, lactose, and non-fat dry matter, determined according to the accredited method IDF 141C:2000. Active acidity was measured using a Mettler Toledo pH meter, and titratable acidity was determined by the Soxhlet-Henkel method. Additional analyses included the percentage of added water and freezing point (MK EN ISO 5764:2010), the presence of antibiotics (Twin Sensor method), total bacterial count (TBC) using a Bactoscan instrument, and somatic cell count (SCC) determined by ISO 13366-2:2006.

The quality parameters of kashkaval cheese were monitored at four stages of the ripening period: days 1, 10, 30, and 60. The analyzed parameters included dry matter content (determined using the standard drying method at $102 \pm 2°C$, IDF 4A:1982), moisture content (calculated), ash content (standard incineration method at $550°C$), milk fat (Gerber method, IDF 105:1981), fat in dry matter (calculated), active acidity (Mettler Toledo pH meter), titratable acidity (Soxhlet-Henkel method), salt percentage (standard method), salt in the water phase (calculated), yield, and losses (calculated using W. Peter's formula as cited by Sabados, 1996).

The obtained data were statistically analyzed using Microsoft Excel. Statistical indicators, including minimum, maximum, arithmetic mean, standard deviation, and coefficient of variation, were calculated. Fisher's test was applied to determine the statistical significance of differences among the kashkaval variants (A, B, and C).

**Results and Discussion**

Table 1 presents the values for all physicochemical parameters, as well as the milk's compliance with hygienic standards and its microbiological characteristics used in kashkaval production.

Table 1. **Physicochemical Properties and Microbiological Quality of Milk**

| Parameter | Min | Max | x | Sd | Cv |
|---|---|---|---|---|---|
| Milk fat % | 3,64 | 3,85 | 3,76 | 0,2114 | 5,63 |
| Protein% | 3,19 | 3,3 | 3,25 | 0,0406 | 1,25 |
| Lactose% | 4,31 | 4,44 | 4,38 | 0,0466 | 1,06 |
| Dry matter% | 12,7 | 12,23 | 12,17 | 0,0638 | 0,52 |
| Non-fat dry matter | 8,36 | 8,51 | 8,41 | 0,061 | 0,72 |
| % added water | 0 | 0,8 | 0,26 | 0,3715 | 142,87 |
| Freezing point | -0,51 | -0,52 | -0,523 | 0,0093 | -1,78 |
| Specific weight | 1,03 | 1,032 | 1,031 | 0,0008 | 0,081 |
| Active acidity pH | 6,59 | 6,66 | 6,62 | 0,0286 | 0,43 |
| Titratable acidity SH | 6,6 | 7 | 6,76 | 0,1673 | 2,47 |
| Total bacteria count (TBC/ml) | 352000 | 647000 | 509000 | 127169,1787 | 24,9841 |
| Total somatic cells (SCC/ml) | 169000 | 394000 | 282200 | 94123,3234 | 33,3534 |

The milk used in the production of kashkaval cheese exhibited average fat content of 3.76%, protein content of 3.25%, and lactose content of 4.38%, with these values remaining stable throughout the study. The average dry matter content was 12.17%, while the percentage of added water was minimal at 0.26%. The freezing point ranged from -0.51°C to -0.52°C, with the specific gravity averaging 1.031, and the pH value measured at 6.62. Total bacterial counts varied between 352,000 and 647,000 CFU/mL, while somatic cell counts ranged from 169,000 to 394,000 cells/mL.

Although the milk demonstrated favorable physicochemical properties, its microbiological quality did not meet legal standards, corroborating findings reported by Talevski (2013) and Angelovski et al. (2009).

Table 2 presents the detailed results of all quality parameters for the analyzed kashkaval variants (A, B, and C) over the examined ripening period.

Table 2. **Chemical composition of Kashkaval variants (A,B and C)**

| Parameter | Fermentation period | Variant A | Variant B | Variant C |
|---|---|---|---|---|
| Active acidity (pH) | 1 day | 5,13±0,03 | 5,14±0,03 | 5,15±0,03 |
| | 10 day | 5,26±0,03 | 5,28±0,03 | 5,28±0,04 |
| | 30 day | 5,38±0,03 | 5,39±0,04 | 5,38±0,03 |
| | 60 day | 5,37±0,03 | 5,37±0,04 | 5,36±0,04 |
| Titratable acidity (°SH) | 1 day | 27,96±0,97 | 29,3±0,08 | 28,22±0,71 |
| | 10 day | 30,88±0,68 | 32,08±0,34 | 31,32±0,49 |
| | 30 day | 35,68±0,65 | 36,14±0,76 | 35,98±0,89 |
| | 60 day | 45,14±1,01 | 45,94±0,93 | 45,7±1,26 |
| Moisture (%) | 1 day | 45,78±0,93 | 45,93±1,03 | 45,97±1,06 |
| | 10 day | 42,26±0,68 | 42,39±0,68 | 42,39±0,65 |
| | 30 day | 39,18±0,72 | 39,24±0,70 | 39,28±0,56 |
| | 60 day | 37,15±0,64 | 37,26±0,47 | 37,24±0,49 |
| Dry matter (%) | 1 day | 54,22±0,64 | 54,06±1,04 | 54,02±1,06 |
| | 10 day | 57,73±0,64 | 57,60±0,68 | 57,60±0,65 |
| | 30 day | 60,81±0,72 | 60,75±0,70 | 60,71±0,56 |
| | 60 day | 62,84±0,64 | 62,73±0,47 | 62,75±0,49 |
| Fat (%) | 1 day | 27,79±0,35 | 28,04±0,21 | 28,00±0,14 |
| | 10 day | 28,18±0,29 | 28,21±0,34 | 28,11±0,17 |
| | 30 day | 28,23±0,46 | 28,27±0,54 | 28,15±0,39 |
| | 60 day | 28,59±0,47 | 28,56±0,48 | 28,53±0,41 |
| Fat in dry matter (%) | 1 day | 51,27±0,56 | 51,88±1,00 | 51,84±1,01 |
| | 10 day | 48,82±0,96 | 49,98±0,68 | 48,81±0,53 |
| | 30 day | 46,42±0,83 | 46,54±0,90 | 46,37±0,59 |
| | 60 day | 45,51±1,04 | 45,54±0,76 | 45,48±0,76 |
| Salt (%) | 1 day | 1,30±0,19 | 1,40±0,13 | 1,32±0,19 |
| | 10 day | 1,76±0,14 | 1,84±0,15 | 1,76±0,12 |
| | 30 day | 2,10±0,12 | 2,21±0,07 | 2,11±0,09 |
| | 60 day | 2,36±0,12 | 2,52±0,07 | 2,46±0,08* |
| Ash (%) | 1 day | 2,44±0,15 | 2,42±0,15 | 2,41±0,16 |
| | 10 day | 2,78±0,10 | 2,82±0,10 | 2,76±0,10 |
| | 30 day | 3,83±0,16 | 3,84±0,17 | 3,84±0,11 |
| | 60 day | 4,26±0,19 | 4,21±0,16 | 4,21±0,17 |

**\*significant at p<0.05;**

Active acidity (pH) exhibited a continuous increase until the 30th day of ripening, with averages ranging from 5.13 to 5.38 in variant A, 5.14 to 5.39 in variant B, and 5.15 to 5.39 in variant C. Afterward, a slight decrease in pH values was observed. The standard deviations for pH ranged from 0.52 to 0.62% (variant A), 0.66 to 0.77% (variant B), and 0.72 to 0.78% (variant C). The most notable changes in pH

occurred within the first 30 days of ripening. Similar pH trends have been reported in Galichki kashkaval by Santa and Srbinovska (2014), while the results are consistent with those of Talevski (2013) and Akin (2012). Comparatively, Succi et al. (2016) reported slightly higher pH values (5.40–5.75), and Tohamy et al. (2011) observed significantly higher pH values (5.51–6.44) on the 30th day. According to the obtained results, different starter cultures showed no significant differences in active acidity level at $p<0.05$.

Titratable acidity (TA) increased progressively during ripening. Initially, the TA values were 27.96°SH (variant A), 29.3°SH (variant B), and 28.22°SH (variant C). By the 10th day, the TA increased to 30.88°SH (A), 32.08°SH (B), and 31.32°SH (C), likely due to the effect of high scalding temperatures on lactic acid bacteria. The TA continued to rise, reaching 35.68–36.14°SH by the 30th day and 45.14–45.94°SH by the 60th day, with variant B exhibiting the highest value (45.94°SH). These findings align with those of Talevski (2013), who noted a steady increase in TA due to lactose breakdown, lactic acid formation, and partial protein degradation, as described by Fox (1993). According to the obtained results, different starter cultures showed no significant differences in titratable acidity level at $p<0.05$.

Moisture content, a critical parameter affecting shelf life, sensory properties, and yield, decreased significantly during ripening. On the first day, moisture content ranged from 45.78% to 45.97%, which decreased slightly by the 10th day and significantly by the 60th day, reaching 37.15–37.26%. Standard deviation declined over time, ranging from 2.02–1.72% (variant A) to 2.32–1.3% (variant C). These results are consistent with Antifantakis (1991), who reported 35–42% moisture in Greek Kasseri, and Pejič (1952), who observed 37.90% in Balkan kashkaval. It is worth noting that higher moisture content enhances yield but may lead to bitterness due to proteolytic changes during ripening. According to the obtained results, different starter cultures showed no significant differences in mousture level at $p<0.05$

Dry matter content increased during ripening, rising from 54.22% to 62.84% (variant A), 54.06% to 62.73% (variant B), and 54.02% to 62.75% (variant C) between the 10th and 60th days. Comparable initial dry matter values were observed in Turkish Kashar cheese (54.5 ± 3.21%), but final values were higher (70.49 ± 4.55%). Conversely, Balkir and Metin (2010) reported lower values (46.34–

56.32%). According to the obtained results, different starter cultures showed no significant differences in dry matter level at $p < 0.05$.

Milk fat content showed minimal variation during ripening. Initial values were 27.79% (variant A), 28.04% (variant B), and 28.00% (variant C). By the 10th day, these values slightly increased to 28.18% (A), 28.21% (B), and 28.11% (C). On the 30th day, milk fat content reached 28.23% (A), 28.27% (B), and 28.15% (C), and by the 60th day, the content increased slightly to 28.59% (A), 28.56% (B), and 28.53% (C). These results are consistent with findings for Kashar cheese (Tarakci, 2006) and kashkaval (Talevski, 2013), as well as with data from Egyptian kashkaval (Tohamy et al., 2011). According to the obtained results, different starter cultures showed no significant differences in fat level at $p < 0.05$.

Fat in dry matter content decreased during ripening. On day 1, the values were 51.27% (variant A), 51.88% (variant B), and 51.84% (variant C). By day 30, these values declined to 46.32% (A), 46.54% (B), and 46.37% (C), and by day 60, they decreased further to 45.51% (A), 45.54% (B), and 45.48% (C). These findings align with the results of Sulejmani et al. (2014), Mijačević et al. (2005), and Çetinkaya and Soyotemiz (2005), who reported values ranging from 44% to 49%. According to the obtained results, different starter cultures showed no significant differences in fat in dry matter level at $p < 0.05$.

Salt content increased consistently during ripening. On day 1, salt content was 1.30% (variant A), 1.40% (variant B), and 1.32% (variant C). By day 10, it rose to 1.76% (A), 1.84% (B), and 1.76% (C). On day 30, the values reached 2.10% (A), 2.21% (B), and 2.11% (C), and by day 60, salt content further increased to 2.36% (A), 2.52% (B), and 2.46% (C). Comparatively, higher salt levels were observed in Turkish Kashar cheese, with values ranging from $3.46 \pm 0.06\%$ to $3.94 \pm 0.22\%$ on day 60 (Tarakci et al., 2006) and $2.95 \pm 0.09\%$ on day 30 (Sert et al., 2007). M. S. Akin (2012) reported salt content in Kashar cheese ranging from 51.58% to 52.22%. According to the obtained results, different starter cultures showed significant differences in salt level at $p < 0.05$.

Ash content increased progressively throughout ripening. On day 1, ash content was 2.44% (variant A), 2.42% (variant B), and 2.41% (variant C). By day 60, ash content reached 4.26% (A), 4.21% (B), and 4.21% (C). These results are consistent with Talevski (2013), who reported ash content ranging

from 3.66% to 4.45%, and Santa and Srbinovska (2014), who observed a value of 4.24% ash in Galichki kashkaval on day 60. According to the obtained results, different starter cultures showed no significant differences in ash level at p<0.05.

**Conclusion**

This study highlights the dynamic physicochemical and microbiological changes occurring in kashkaval cheese during a 60-day ripening period. The findings underscore the critical role of milk quality, starter cultures, and ripening conditions in shaping the final product's quality. While the milk used had favorable physicochemical properties, its microbiological quality fell short of legal standards, emphasizing the need for stricter controls during production.

Starter cultures were pivotal in driving fermentation, promoting acidification, and facilitating biochemical processes that enhanced flavor, texture, and preservation. Key changes included a steady rise in titratable acidity, a reduction in moisture content, and increases in dry matter, salt, and ash content. These transformations contributed to the development of a high-quality cheese with desirable sensory attributes. However, the slight decline in active acidity after 30 days and the stability of milk fat suggest nuanced interactions between components during ripening.

Overall, the kashkaval variants exhibited good quality, reinforcing the importance of starter cultures in cheese production. These findings provide valuable insights for improving kashkaval cheese production by addressing microbiological challenges and optimizing ripening conditions to ensure consistent quality.

**References**

Fox, P. F., Guinee, T. P., Cogan, T. M., & McSweeney, P. L. H. (2017). Cheese: Chemistry, physics and microbiology (4th ed.). Academic Press.

Raynal-Ljutovac, K., Lagriffoul, G., Paccard, P., Guillet, I., & Chilliard, Y. (2008). Composition of goat and sheep milk products: An update. Small Ruminant Research, 79(1), 57–72. https://doi.org/10.1016/j.smallrumres.2008.07.009

Ivanova, M., Markova, A., & Ivanov, G. (2021). Physicochemical, microbiological and sensory characteristics of cow's milk Kashkaval cheese ripened at different temperatures. Food Research 5 (2), 308 - 313 https://doi.org/10.26656/fr.2017.5(2).552

Cogan, T. M., & Hill, C. (1993). Cheese starter cultures. In *Cheese: Chemistry, physics and microbiology: Volume 1 general aspects*. pp. 193-255. Boston, MA: Springer US.

Talevski, G. (2013). Kashkaval changes by using different protective surface agents. PhD-thesis, Faculty of Food and Agriculture-Skopje;

Santa, G., & Srbinovska, M. (2014). *Traditional production and main characteristics of Galichki kashkaval,* Mljekarstvo 64 (2), 119-126 (2014).

Succi, M., Aponte, M., Tremonte, P., Niro, S., Sorrentino, E., Iorizzo, M., Tipaldi, L., Pannella, G., Panfili, G., Fratianni, A., &Coppola R. (2016). Variability in chemical and microbiological profiles of long-ripened Caciocavallo cheeses. J Dairy Sci. Dec;99(12):9521-9533. https://doi.org/10.3168/jds.2016-11585.

Tohamy, M.M., Ali, M.A., Shaaban, H.A., Mohamad, A.G.,& Hasanain, A.M. Production of functional spreadable processed cheese using Chlorella vulgaris. Acta Sci Pol Technol Aliment. 2018 Oct-Dec;17(4):347-358. DOI: 10.17306/J.AFS.0589

Balkir, P., &Metin, M. (2010). Physicochemical and Textual properties of imitation fresh KASHAR Cheeses prepared from casein, caseinates and soy protein, GIDA (2011) 36 (1): 17-24

Pejič (1952): Prilog izučavanja tehnologije kačkavalja. Godišnjak Poljoprivrednog fakulteta u Zemunu br. 4, Beograd.

Miječevič, Z., Bulajič, S., Bozič, T., & Niketič, G. (2005). Pirotski kačkavalj. Mlekarstvo 55 (3): 203 – 213.

Çetinkaya, F. (2005). Microbiological and Chemical Changes throughout the Manufacture and Ripening of Kashar: A Traditional Turkish Cheese. Department of Food Hygiene and Technology, Faculty of Veterinary Medicine. Uludag University, 16059 Gorukle, Bursa – Turkey.

Fox, P. F. (1993). Cheese: chemistry, physics and mictobiology. Vol 1.2 edition. Chapman and Hall, London.

Sert, D., Ayar, A., & Akın, N. (2007). The effects of starter culture on chemical composition, microbiological and sensory characteristics of Turkish Kaşar Cheese during ripening, Int. J. Dairy Technol., 60 (4) (2007), pp. 245-252
https://doi.org/10.1111/j.1471-0307.2007.00339.x

M. S. Akin (2012). Accelerated ripening Kashar cheese with encapsulated protease. African Journal of Biotehnology, 11(66), 13007 – 13015. https://doi.org10.5897/AJB12.1630

# A Study of the Biological Characteristics of Grape Erineum Mite (*Colomerus Vitis*) in the Region of Southwestern Bulgaria

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## Abstract

The protection of the foliage and shoots of vines (*Vitis vinifera* L.) from a variety of pests represents a significant challenge in the pursuit of optimal grape yield and quality. The vineyards are attacked by a number of pests. The most significant herbivorous mites are those belonging to the family Eriophyidae (eryophid mites), as they frequently cause economic damage. In this regard, the aim of the present research was to follow the occurrence and development of the grape erineum mite *Colomerus vitis* (Pagenstecher, 1857) in two cultivars, 'Shiroka Melnishka Loza' and 'Keratsuda', within the southwestern region of Bulgaria. These are wine cultivars that are indigenous to the Southwest wine-growing region of Bulgaria. The studies were carried out during the growing seasons from 2019 to 2021 at an altitude of 128 metres, at 41.6413069 N, 23.2049110 E. It was established that the grape erineum mite can overcome the sudden changes of the abiotic factors in the area. Its annual development cycle includes three generations, although it can be assumed that a fourth may also develop. The mite attacks both cultivars of vines, namely 'Shiroka Melnishka Loza' and 'Keratsuda', although it prefers the cv. 'Keratsuda'. The damage in the cv. 'Keratsuda' can reach up to 55%, and in the cv. 'Shiroka Melnishka Loza' - up to 20%.
The data obtained would provide a basis for forecasting the occurrence and development of the grape erineum mite, thus facilitating the making of informed decisions regarding the most appropriate treatments.

**Keywords:** Biological characteristics, *Colomerus vitis*, grape erineum mite

## Introduction

The grapevine (*Vitis vinifera* L.) is a plant indigenous to temperate latitudes and is successfully cultivated in a number of regions worldwide, including Europe, the Balkans, Asia, the Mediterranean, South Africa, South Australia, New Zealand, most of North America and numerous locations in South America (Mattia et al., 2008; García and Revilla., 2013). In accordance with the International Standards for Phytosanitary Measures (ISPM), pests represent a significant limiting factor in grape production. A number of pests are known to attack vineyards. Among these are plant-eating mites, of which the most significant are those belonging to the eriophyid mites (Eriophyidae). These mites are often responsible for economic damage to vineyards (Vermaak et al., 2021). Two species are particularly dangerous to the vine: *Colomerus vitis* (Pagenstecher) and the grape leaf rust mite *Calepitrimerus vitis* (Nelepa). Both species are exclusively phytophagous and are widespread in regions where vines are cultivated (Mani, 2022). As a species, *Colomerus vitis* is considered an economically important grapevine pest and is found in the world's major wine-growing regions (Tomoioaga and Comsa, 2010; Stoeva, 2014). In

addition to direct feeding damage, *C. vitis* has also been demonstrated to transmit the grapevine inner necrosis virus (GINV) (Kunugi et al., 2000) and the grapevine pinot gris virus (GPGV) (Malagnini et al., 2016). Three biotypes of this species are known, «erineum strain», «bud mite strain») and «leaf-curl strain») (Smith and Stafford, 1948). The biotype forming the erineum is widely distributed across Europe (Duso et al., 2012). In a study conducted by Carew et al. (2004), molecular markers were employed to ascertain the identity of biotypes, specifically the «erineum strain» and the «bud mite strain», in Australia. The genetic variation patterns observed by PCR-RFLP of ITS 1 indicated the presence of two distinct species. The use of microsatellite markers revealed a significant degree of genetic differentiation between the two populations (species), even at the micro-geographical level. Despite the existence of three biotypes of *C. vitis* based on behavioural and damage symptoms, no morphological differences were observed between them, indicating that they may constitute a cryptic species complex (Craemer and Saccaggi, 2013; Saccaggi et al., 2022). By studying the genetic divergence between populations of the erineum strain of *C. vitis* collected in Serbia, Greece and Croatia, the authors Marinković et al. (2024) established the presence of two cryptic species of *C. vitis* in the Balkans.

The protection of the foliage and developing shoots of the vines from various pests represents a significant challenge in the pursuit of an optimal yield and quality of grapes. In recent decades, there has been a growing interest in the development of integrated protection systems in vineyards and the study of the side effects of pesticides on mites (Duso et al., 2012). Eriophyid mites have demonstrated resistance to fungicides with acaricidal properties and to acaricides (Van Leeuwen et al., 2010). It seems reasonable to posit that the use of pesticides is a significant contributing factor to the mass reproduction of these mites (Gulyaeva et al., 2021). The management and control of eriophyid mites in vineyards necessitates the appropriate application of plant protection products, with a reasonable limit on the number of treatments. It also requires compliance with the strategy for managing acquired resistance to pesticides, the use of biologically active agents, and the utilisation of cultivars resistant to pests that meet local quality requirements.

The cultivars 'Shiroka Melnishka Loza' and 'Keratsuda' are wine varieties that are characteristic of the South-West wine-growing region. The area is characterised by the presence of suitable soils,

which, when considered alongside the prevailing climatic conditions, make it an optimal location for their cultivation. The eriophyd mite *C. vitis* is a species that is widely distributed throughout the region (Mateeva, 2003). Every organism is a constituent part of the environment in which it exists and is in mutual relation with all the elements that comprise that environment. The development, reproduction and spread of *C. vitis* are influenced by a complex interplay of biotic, abiotic and anthropogenic factors, which are all equally important in this process. A plethora of studies have been conducted to assess the impact of infestation of this mite on vine physiology and yield parameters. However, these reports also underscore the dearth of data concerning the influence of changing environmental factors on the bioecological characteristics of eriophyid mites.

In this regard, the main objective of the present paper is to trace the biological development and ecological characteristics of the eriophyid mite *C. vitis* in southwestern Bulgaria based on phenological observations under modern conditions of vine pest control.

**Materials and Methods**

*Characteristics of the monitored areas*

The studies were carried out from the 2019 to 2021 during the growing seasons in the village of Strumyani (41.63°N and 23.2°E), southwestern Bulgaria, Blagoevgrad region, at an altitude of 128 meters. The observation of grape erineum mite was carried out in two 35-year-old vineyard plantations with two wine grape varieties 'Shiroka Melnishka Loza' and 'Keratsuda', which are important for wine production in the region. For each cultivar, an observation area of 200 m² was designated, comprising 111 plants arranged according to a planting scheme with 1.80 m intra-row and 1.0 m inter-row spacing, oriented east-west and a cup-shaped formation. The pruning process was completed in February. Soil cultivation was conducted using mechanical methods. During the period of vegetation, the plantation was treated solely with Bordeaux mixture.

*Climatic features of the area*

According to the country's climate classification, the village of Strumyani belongs to the South Bulgarian sub-region of the transitional Mediterranean climatic region. The winter is mild and there is almost no snowfall. The driest months are July and August. The relief is varied and includes the valley

of the Struma River in the northern part of the Sandansko-Petrichka Valley. The geographical position makes Strumyani part of the south-western wine-growing region.

*Methods for the monitoring of the development of Colomerus vitis*

Route surveys were the first stage of the observations. They aimed to determine the occurrence and distribution of the mite in the vineyard. The procedure was conducted by traversing the plantation from one end to the other, with a predominantly diagonal trajectory. The surveys were carried out during the period when the causal agent of grape erineum be detected, i.e. at the beginning of the appearance of the overwintering females and the beginning of their migration to the leaves (BBCH 11-15). The visual method was employed to ascertain the precise damage wrought by the mite. Observations were conducted at two-to-three-week intervals. Once it was confirmed that the movement of overwintering females from the overwintering sites had commenced, the relative proportion of the affected plants was recorded. The findings of the observation are presented as an average per leaf and as a relative proportion of damaged leaves. Observations were made to determine the extent of damage caused by the *C. vitis* population as a function of the time of attack on the vines and the cultivar.

The experimental sites were selected and divided into 4 observation points for each cultivar; 5 plants (vines) with the same habit were identified. The studies started at the time of bud burst of BBCH 07 and for this purpose shoots of 25 cm length were taken from the observation points (5 from 5 vines or 25 shoots for each cultivar). Leaf samples (10 leaves from 5 vines or 50 leaves for each cultivar) were taken every 10 days after leafing out of vines BBCH 11-15. The leaves were placed in polyethylene bags and stored in a refrigerator until the samples were processed.

The number of larvae and adults of eriophyid mites was determined using a stereomicroscope (macroscopic method) in a laboratory setting. The mean number of mites per leaf or plant was calculated based on the total number counted for a specific growth stage of the grapevine (BBCH) over the entire 2019-2021 research period. The following 4-point scale was used to determine the degree of leaf damage: 0: no leaf damage; 1: 10% of the leaf blade is damaged; 2: 11-35% of the leaf blade is damaged; 3: 36-65% of the leaf blade is damaged; 4: 66-100% of the leaf blade is damaged (Bahadiroglu and Avgin, 2003). The microscopic method was used to prove the species belonging to the mite (Mathez 1965, Balevski et al., 1982; Lyubenova and Kostadinova, 2008; Valenzano et al., 2020).

*Statistical analysis*

The data were subjected to one-way analysis of variance (ANOVA) and differences of means (were determined by Tukey's test (P ≤ 0.05) using the statistical software package SYSTAT 13.

**Results and Discussion**

*Monitoring the development of Colomerus vitis*

Observations cover from the growing season of 2019 to September 2021. It is known that mites overwinter as female individuals at the base of annual shoots, collected in large numbers (400-500) in the fibrous sheath of the winter eyes or further in the direction of the vegetative cone (Prodanova and Velichkova 2014, 2016, Popov 2017). Therefore, the presence of overwintering forms of the mite C. vitis was studied under laboratory conditions on vine material of the two grape cultivars 'Shiroka Melnishka Loza' and 'Keratsuda'. The following values were recorded: 0 to 100 mites/bud for the cv. 'Shiroka Melnishka Loza' and 2 to 201 mites/bud for the cv. 'Keratsuda'. The presence of successfully overwintered individuals has been confirmed by further research. During the 2021 growing season, the mites became active early, even before the visible development of the buds (in the first ten days of April), while in 2020 the mite activity started later (in the second ten days of April) in both varieties 'Shiroka Melnishka Loza' and 'Keratsuda'. Our observations show that the mites first settle under the stipules of developing leaves and later on the petiole and other growing parts of the vine. They begin to feed and cause damage characteristic of the species. According to Mateeva (2003, 2004), some of the mites remain under the outer scales of the buds, at the base of the shoots. From here they move continuously to the top and to the newly formed leaves. This mite is slow-moving and does not move to the neighbouring leaves. During the months of June and July 2021, we found mites on other green parts of the vine, but mainly on the underside of the leaf. The annual development cycle of *C. vitis* is represented visually by a graphical diagram (Fig. 1). Balevski et al. (1982) indicate that the mite develops one generation in approximately 15 days and three generations per year. During the observation period we were able to distinguish 3 generations, but we assume that a 4th generation is also developing. The development of the grapevine mite depends on the microclimate of the area, for example a warm spring can stimulate damage. There are reports that the first 5-6 leaves are colonised and the mites reproduce there. The following generations live on the 10-13th leaf and on the tassels.

Usually 4-7 generations develop. In hot climates the number of generations can reach 10. The mites of these generations also reproduce on the leaves around the inflorescences. New buds are attacked in August and in autumn the females move to their overwintering sites (Baillod et al., 1996).
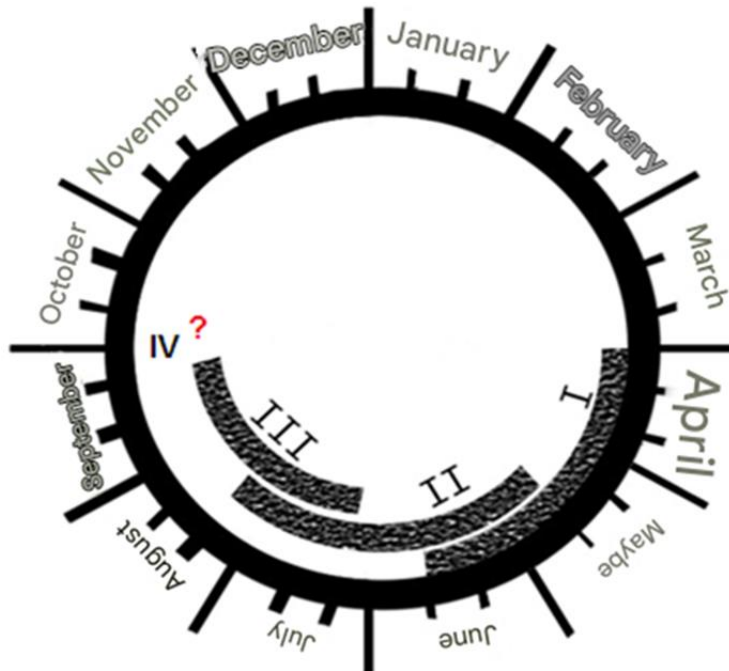


Figure 1. Annual development cycle of *C. vitis* for the Strumyani village area during the period 2019-2021

According to our studies, the development of grape erineum mite can be roughly divided into 3 periods. The first period coincides with the opening of the winter buds and lasts until flowering (BBCH 01÷69). Galls form on the second and third leaves at the base of the shoot (BBCH 12÷13). The mites also damage the flowers on the inflorescences (BBCH 53÷57). The second period coincides with the growth of the berries and galls form on the 5th and 7th leaves of the shoot (BBCH 71÷79). The third period coincides with the ripening of the berries and the mites move to the top, youngest leaves and form erineums (BBCH 81÷89). With the beginning of leaf fall, the mites hide at the base of the buds (BBCH 99).

**Assessing the damage caused by *Colomerus vitis* and its cultivar preferences**

In the springs of the research period, when 50% of the plants were in the growth stage of bud swelling (BBCH 07), the observations of the pre-selected shoots were started. Until flowering, symptoms were concentrated on the lowermost leaves of the main shoot (Fig. 1 A, B). During flowering

(Fig. 2 C, D), only a few erineum were visible in the central part of the shoot, while the attack increased at the tips of the shoots. Similar results were reported by (Linder et al. 2013), who found that the attack on leaves around the nflorescences was much more pronounced than on central shoots.
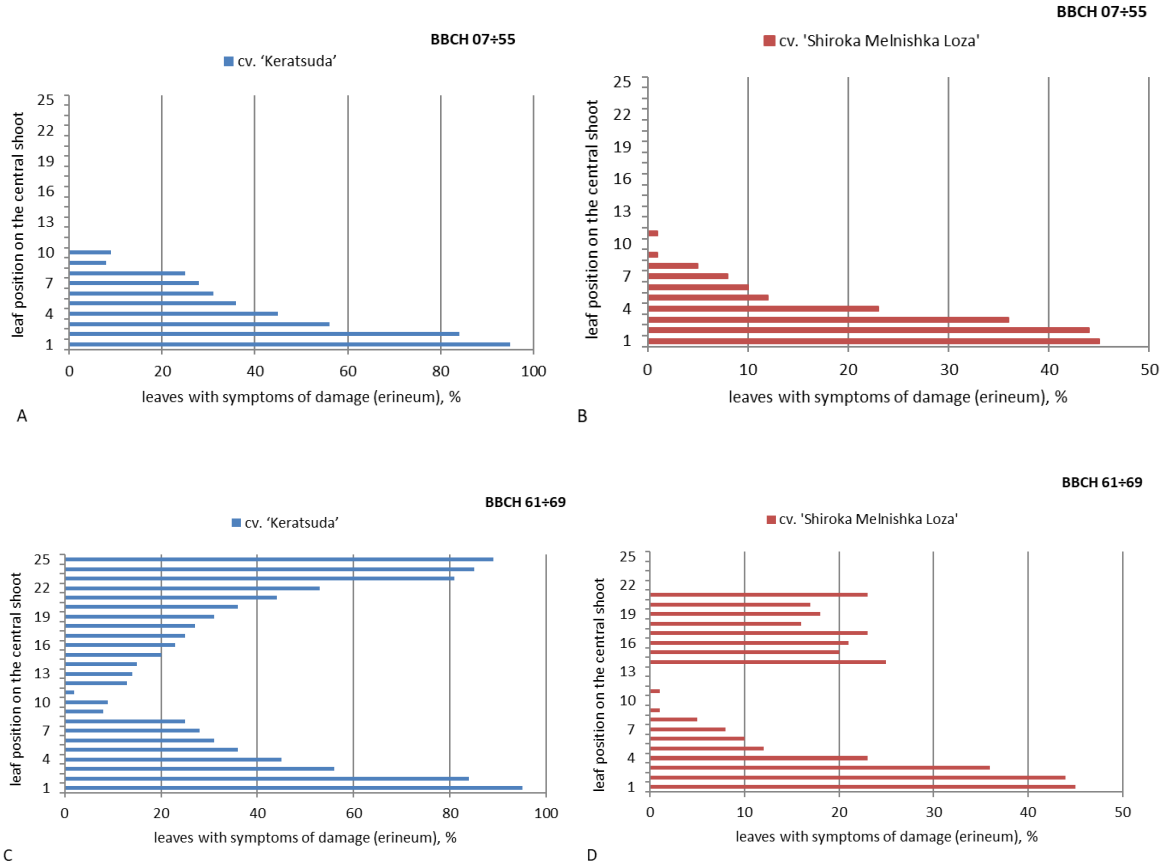


Figure 2. Relative proportion of leaves with damage symptoms (erineum) and their position on the central shoot before and during flowering; A, B: before flowering and C, D during flowering

The studies clearly show that there are differences between cultivars and years of observation. The highest degree of damage /3/ at the end of the vegetation period was recorded in 2019 in cv. 'Keratsuda', where 55% of the leaves on the central shoots showed symptoms of damage, and only 20% or 2 degree of damage were observed in cv. 'Shiroka Melnishka Loza'. In 2020, the proportion of damaged leaves decreased to 49% for cv. 'Keratsuda' and 17% for cv. 'Shiroka Melnishka Loza'. The percentage of attacked leaves in 2021 was, in general, of the 2 degree of damage. However, the relative share of damaged leaf area did not exceed 25% of all leaves on the shoots in the cv. 'Keratsuda' and 11% in the cv. 'Shiroka Melnishka Loza'. The statistical analysis revealed that the incidence of attack on the cv.'Keratsuda' was markedly higher than that on the cv.'Shiroka Melnishka Loza' throughout the entire

research period with medium degree of damage between 2 and 3. The different degree of damage over the years can be explained by changing weather conditions. The warm and dry spring of 2021 led to a reduction in damage because of rapid and strong shoot growth (Fig. 3).
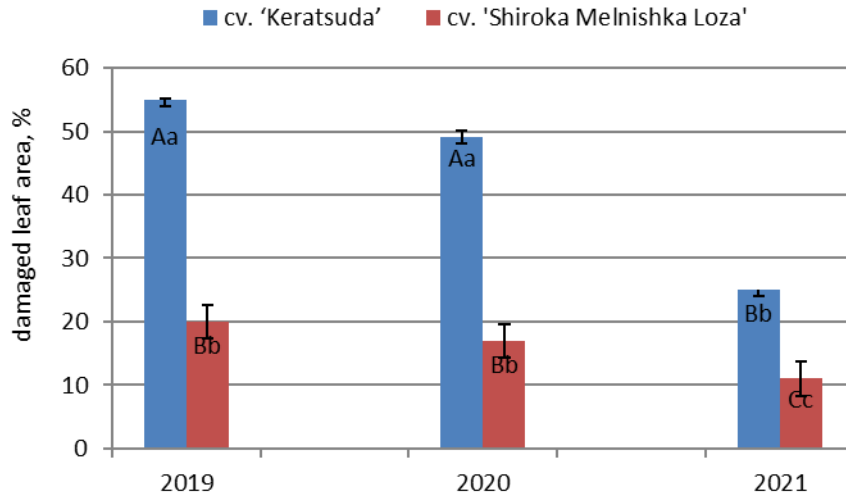


Figure 3. Degree of damage caused by Colomerus vitis during the growing season of 2019 ÷2021 in the cv. 'Keratsuda' and the cv. 'Shiroka Melnishka Loza'; Mean±SE; different letters=statistically significant differences; uppercase letters for years; lowercase letters for cultivar; P< 0.05; Tukey's test

In order to predict the expected attack for the following year, studies were carried out on the influence of overwintering mites on spring attack. Baur (2000) found a correlation between the presence of overwintering forms in winter and leaf damage in the following spring. In our experiments, the correlation between leaf damage and the number of overwintering mites at the end of the non-vegetation period was weak $R^2=0.0315$ and $R^2=0.0134$ respectively (Fig. 4).
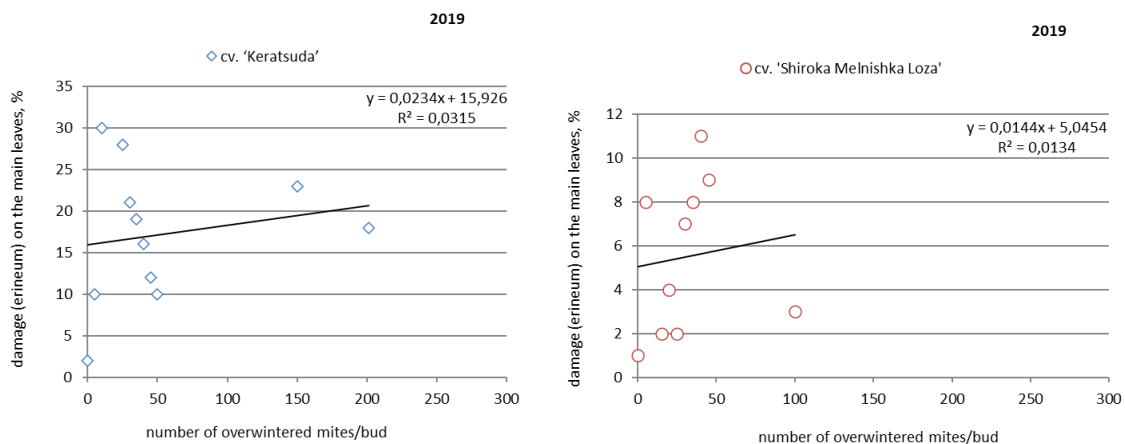
Figure 4. Relationship between the number of overwintering mites in a bud and the damaged leaf area during the growing season

The results of the first year of monitoring showed that observations of the attack did not allow an accurate prediction of infection in the following year (Fig. 3). The attack could be influenced by various biotic and abiotic factors and is subject to significant annual variation (Linder et al. 2013).

The results of experiments and the findings of literature reviews indicate the necessity to elucidate the lateral influences on the bio-ecological characteristics of eriophyid mites in grapevines as a crucial step in the implementation of Integrated Plant Management (IPM) strategies.

**Conclusion**

The annual development cycle of *C. vitis* in the region of southwestern Bulgaria includes 3 generations, and it can be assumed that it also develops a 4th generation. The mite migrates to newly emerged leaves and up to the flowering growth stage of the vines, damage symptoms were concentrated on the lowest leaf layers, and during flowering the attack increased on the tops of the shoots. The grape erineum mite attacks both the 'Shiroka Melnishka Loza' and the 'Keratsuda' cultivars, but it prefers the cv.'Keratsuda'.

**References**

Bahadiroglu, C., & Avgin, S. (2003). Experimential infestation and seasonal variations in density of Eriophyes vitis Pgst.(Acarina: Eriophyidae) in Turkey. Consequences on earliest treatment. *Acarologia*, *43*(3), 261-265.

Baillod, M., Remund, U., Boller, E., & Arias Giralda, A. (1996). [Blister mite (Colomerus vitis [Pagenstecher])]. *Revue suisse de viticulture, arboriculture, horticulture (Switzerland)*, *28*(1).

Balevski A., P. Nachev, Magazine. Darshan. (1982). Mites on agricultural plants. Zemizdat.

Baur, R. (2000). Verteilung von überwinternden Pockenmilben auf Rebholz. *Schweiz. Z. Obst-Weinbau*, *5*, 84-86.

Carew, M. E., Goodisman, M. A., & Hoffmann, A. A. (2004). Species status and population genetic structure of grapevine eriophyoid mites. *Entomologia Experimentalis et Applicata*, *111*(2), 87-96. https://doi.org/10.1111/j.0013-8703.2004.00149.x

Craemer, C., & Saccaggi, D. L. (2013). Frequent quarantine interception in South Africa of grapevine Colomerus species (Trombidiformes: Prostigmata: Eriophyidae): taxonomic and distributional ambiguities. International Journal of Acarology, 39(3), 239-243. https://doi.org/10.1080/01647954.2013.767856

Duso, C., Pozzebon, A., Kreiter, S., Tixier, M. S., & Candolfi, M. (2012). Management of phytophagous mites in European vineyards. *Arthropod management in vineyards: pests, approaches, and future directions*, 191-217.

Gulyaeva, I. I., Kraynov, O. O., Hubych, O. Y., Stankevych, S. V., Zabrodina, I. V., & Matsyura, A. V. (2021). Dominant sucker pests on industrial vineyards and protective measures in the regulation of their abundance in the conditions of the northern Black sea. *Ukrainian Journal of Ecology*, *11*(3), 373-384. doi:10.15421/2021_186

Kunugi, Y., Asari, S., Terai, Y., & Shinkai, A. (2000). Studies on the grapevine berry inner necrosis virus disease, 2: Transmission of grapevine berry inner necrosis virus by the grape erineum mite, Colomerus vitis in Yamanashi [Japan]. *Bulletin of the Yamanashi Fruit Tree Experiment Station (Japan)*, (10). 57-63.

Linder, C., Jermini, M., Zufferey, V., & Wädenswil, A. C. W. (2013). Pockenmilbe: auffällige Symptome, geringes Risiko. *Schweizerische Zeitschrift für Obst-und Weinbau*, *1*(10), 6.).

Lyubenova Ts., Kostadinova M., (2008). Scab as an enemy on the vine. Viticulture and Winemaking, 2, 28-29.

Malagnini, V., de Lillo, E., Saldarelli, P., Beber, R., Duso, C., Raiola, A., ... & Gualandri, V. (2016). Transmission of grapevine Pinot gris virus by Colomerus vitis (Acari: Eriophyidae) to grapevine. *Archives of Virology*, *161*, 2595-2599. doi:10.1016/j.virusres.2011.10.010

Mani, M. (2022). Pests of Grapevine and Their Management. *Trends in Horticultural Entomology*, 625-653.

Marinković, S., Cvrković, T., Vidović, B., & Petanović, R. (2024). Population genetics of the global grapevine pest Colomerus vitis (Pagenstecher)(Acari: Cecidophyinae: Colomerini). *Integrated Control of Plant-Feeding Mites IOBC-WPRS Bulletin*, *169*, 85-86.

Mateeva A. (2003). Harmful mites on the vine. Agriculture Plus, 8, 21.

Mathez, F. (1965). Contribution a l'étude morphologique et biologique d'Eriophyes vitis Pgst., agent de l'Erinose de la vigne. Bull Soc Entomol Suisse, 37, 233–283.

Mattia, F., S. Imazio, F. Grassi, H. Doulati, A. Scienza, and M. Labra, (2008). Study of genetic relationships between wild and domesticated grapevine distributed from Middle East regions to European countries. Rendiconti Lincei, 19, 223-240.

Popov K. (2017). Viticulture. Publishing House at the University of Forestry, Sofia, 475.

Prodanova S. & Velichkova T. (2014). Information bulletin on occurrence, distribution, density, development, degree of infestation, ways and means of pest control of agricultural crops.

Prodanova S. &Velichkova T. (2016), National Bulletin on Plant Protection.

García, R. A. A., & Revilla, E. (2013). The current status of wild grapevine populations (Vitis vinifera ssp sylvestris) in the Mediterranean basin. *Agricultural and Biological Sciences."The Mediterranean Genetic-Code-Grapevine and Olive*, 51-72. http://dx.doi.org/10.5772/52933

Saccaggi, D. L., Maboeei, P., Powell, C., Ngubane-Ndhlovu, N. P., Allsopp, E., Wesley-Smith, J., & van Asch, B. (2022). Towards solving the "Colomerus vitis conundrum": Genetic evidence reveals a complex of highly diverged groups with little morphological differentiation. *Diversity*, *14*(5), 342. https://doi.org/10.3390/d14050342

Smith, L. M., & Stafford, E. M. (1948). The bud mite and the erineum mite of grapes. *Hilgardia* I8 (7), 3I7-34·

Valenzano, D., Tumminello, M. T., Gualandri, V., & de Lillo, E. (2020). Morphological and molecular characterization of the Colomerus vitis erineum strain (Trombidiformes: Eriophyidae) from grapevine erinea and buds. *Experimental and Applied Acarology*, *80*, 183-201.

Van Leeuwen, T., Witters, J., Nauen, R., Duso, C., & Tirry, L. (2010). The control of eriophyoid mites: state of the art and future challenges. *Experimental and Applied Acarology*, *51*, 205-224.

Vermaak, M., Ueckermann, E. A., Veldtman, R., & Addison, P. (2021). An overview of mites on grapevine and the discovery of a new Phytoseiidae species: Typhlodromus (Typhlodromus) spiceae. *South African Journal of Enology and Viticulture*, *42*(1), 91-99. http://dx.doi.org/10.21548/42-1-4297

Tomoioaga, L., & Comsa, M. (2010). Monitoring the population of Eriofizi mites, the species Calepitrimerus vitis and Colomerus vitis, in the vineyards specific conditions of Central Transylvania. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Horticulture, 67 (1), 499.

# Evaluation of ICARDA Winter Barley Breeding Lines Under Southeastern Bulgarian Conditions

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## Abstract

The objective of this study was to assess the performance of winter barley breeding lines developed by the International Center for Agricultural Research in the Dry Areas (ICARDA) under the agro-ecological conditions of Southeastern Bulgaria. Nineteen ICARDA winter barley breeding lines were evaluated alongside four Bulgarian standard varieties: two 2-rowed varieties, Obzor and Emon, and two 6-rowed varieties, Veslets and Izgrev. The study was conducted over two growing seasons (2021/2022 and 2022/2023) at the experimental field of the Institute of Agriculture in Karnobat, Southeastern Bulgaria. A complete block design with four replications was implemented on 10 m² plots, using a sowing rate of 450 germinated seeds per m². Standard cultivation practices were applied. Key agronomic traits measured included plant height (PH), spike length (SL), spikelet number per spike (SNS), grain number per spike (GNS), grain weight per spike (GWS), lodging resistance, grain yield (GY), and 1000-grain weight (TGW). Significant phenotypic variation was observed between the ICARDA lines and Bulgarian varieties, particularly in traits related to yield components and lodging resistance. Notably, several ICARDA lines exhibited shorter plant height, indicating a potential for enhanced lodging resistance, while traits such as spike length, spikelet number, grain number, and grain weight underscored their yield potential. Higher BLUP values for TGW and GWS in the ICARDA lines highlight their suitability for breeding programs focused on improving grain size and yield. Overall, these ICARDA lines present valuable genetic resources for enhancing barley production, particularly in terms of yield potential, resilience, and grain quality. Future breeding efforts should capitalize on these traits to develop cultivars that address the challenges of climate change and contribute to more sustainable, productive cropping systems.

**Keywords:** *Hordeum vulgare* L., grain yield, yield-related traits, BLUPs

### Introduction

Winter barley (*Hordeum vulgare* L.) is one of the most important cereal crops cultivated worldwide, particularly in temperate regions. It is a versatile crop used for livestock feed, brewing, and human food, making it a crucial component of agricultural systems (El-Hashash et al., 2019). In Southeastern Bulgaria, barley has traditionally been a significant crop due to its adaptability to local conditions and its ability to provide stable yields even under less favorable environments. However, the region's continental climate, characterized by cold winters, drought, and fluctuating temperatures, presents significant challenges to winter barley production (Branzova, 2015). In this context, the selection of resilient barley genotypes is critical for maintaining and improving agricultural productivity.

The International Center for Agricultural Research in the Dry Areas (ICARDA) plays a pivotal role in developing barley lines that are bred for improved performance under diverse environmental stresses, particularly in arid and semi-arid regions (Ahmadi et al., 2016). ICARDA's breeding programs

focus on enhancing resistance to drought, frost, and diseases, while also improving yield and grain quality (Visioni, et al., 2023). The successful incorporation of ICARDA-developed lines into various barley breeding programs around the world underscores their value in advancing crop resilience and productivity in challenging climates (Jalata, 2012; Verma, 2017; Wallwork et al., 2022).

Given the climatic challenges faced in Southeastern Bulgaria, the introduction and evaluation of ICARDA's winter barley breeding lines offer a valuable opportunity to improve the region's barley production. Despite the potential of ICARDA breeding lines, little research has been conducted on their performance under Bulgarian conditions. The agro-ecological conditions in Southeastern Bulgaria, including soil types, precipitation patterns, and temperature extremes, differ from those in other regions where these lines have been tested. Therefore, it is essential to evaluate how well these lines adapt to the local environment, assess their agronomic and phenological traits, and determine their resistance to biotic and abiotic stresses.

The aim of this study was to evaluate the performance of winter barley breeding lines developed by the International Center for Agricultural Research in the Dry Areas (ICARDA) under the agro-ecological conditions of Southeastern Bulgaria.

**Materials and Methods**

The study included 19 winter barley breeding lines from ICARDA. Among these, five were 6-rowed lines: IBYT-W-14-24, IBON-W-14-30, IBON-W-14-59, IBON-W-14-70, and IBYT-W-16-7. The remaining 14 were 2-rowed lines: IBON-W-14-62, IBON-W-14-63, IBON-W-14-65, IBON-W-16-21, IBON-W-16-31, IBYT-W-16-27, IBYT-W-19-6, IBYT-W-19-7, IBYT-W-19-8, IBYT-W-19-14, IBYT-W-19-22, IBYT-W-19-28, IBYT-W-19-38, and IBYT-W-19-40. In addition, the study included four Bulgarian standard varieties: two 2-rowed varieties, Obzor and Emon, and two 6-rowed varieties, Veslets and Izgrev.

The study was conducted over two growing years, 2021/2022 and 2022/2023, at the experimental field of the Institute of Agriculture-Karnobat, Southeastern Bulgaria (42°39' N, 26°59' E). The soil of the experimental field was slightly acidic (pH 6.2) Pellic Vertisol.

The experiments were designed using a complete block with four replications on 10 m² plots, with a sowing rate of 450 germinated seeds per m². Standard technology for growing winter barley breeding materials at the Institute was employed.

The plant height (PH, cm), spike length (SL, cm), spikelet number per spike (SNS), grain number of per spike (GNS), and grain weight per spike (GSW, g) were measured on 20 randomly selected plants in each replication of each genotype. Lodging was rated on a scale 9-1, where 9 indicates a high level of resistance to lodging. Grain yield (GY, t ha⁻¹) and 1000-grain weight (TGW, g) were determined on a plot basis.

Data analysis and graph construction were carried out using R (version 4.3.0) within the RStudio integrated development environment. A two-way analysis of variance (ANOVA) was employed to detect significant differences among genotypes and growing seasons. Variance components, genetic parameters, and best linear unbiased prediction (BLUP) values for the winter barley genotypes were calculated using the 'metan' package (Olivoto and Lúcio, 2020).

### Results and Discussion

### Analysis of Variance, Heritability and Phenotypic Variation

The combined analysis of variance (Table 1) revealed a highly significant variation ($p < 0.001$) across genotypes, years, and their interaction (GxY) for the traits PH, SL, SNS, GNS, GWS, TGW, and GY. However, trait L showed no significant variation between growing seasons.

Table 1. Mean squares from combined analysis of variance for yield-related traits of 21 barley genotypes assessed for two growing seasons

| Traits | GEN | ENV | GEN x ENV | Residuals |
|--------|-----|-----|-----------|-----------|
| PH | 256.63* | 1099.32* | 194.30* | 1.79 |
| L | 3.68* | 0.05ns | 1.82* | 0.18 |
| SL | 4.00* | 51.43* | 1.72* | 0.10 |
| SNS | 3274.81* | 976.00* | 47.89* | 2.78 |
| GNS | 1874.73* | 1087.89* | 41.12* | 2.69 |
| GWS | 1.93* | 1.86* | 0.06* | 0.02 |
| TGW | 68.70* | 127.16* | 7.39* | 0.12 |
| GY | 5.04* | 35.57* | 3.15* | 0.08 |

* significant level at $p \leq 0.001$; ns- non-significant; PH - plant height, cm; L – lodging (score 9-1), SL - spike length, cm; SNS - spikelet number of per spike; GNS - grain number of per spike, GWS - grain weight per spike, g; TGW - 1000- grain weight, g; GY - grain yield, t ha⁻¹

The estimates of phenotypic variance (Vph) were lowest for L and highest for SNS (Table 2). High phenotypic variance often points to greater potential for selection, as more variability allows for

the identification of superior genotypes. Broad-sense heritability (H²) was moderate for L (0.29), PH (0.14), and GY (0.22), while the remaining traits exhibited high heritability, ranging from 0.36 for SL to 0.97 for SNS. The traits SNS, GNS, and GWS displayed low values for the coefficient of determination of interaction effects (GEIr²) that these traits are stable across environments, allowing for more consistent selection of genotypes without the need for extensive multienvironment testing. Heritability on a mean basis (h²mg) was low for PH, whereas all other traits demonstrated moderate to high h²mg values. Genotype-environment correlation (rge) was high for most of the traits studied. SNS and GNS exhibited the highest coefficients of variation for genotype (CVg). Additionally, the largest coefficients of relative variation (CV ratio) were observed for SNS (11.90) and GNS (9.26).

However, when considering that the population includes both 2-rowed and 6-rowed genotypes, these high CV ratios likely reflect the inherent structural differences between the two genotype groups.

Table 2. Estimation of variance components and genetic parameters for yield-related traits in winter barley genotypes

| Parameters | PH | L | SL | SNS | GNS | GWS | TGW | GY |
|---|---|---|---|---|---|---|---|---|
| $V_{ph}$ | 57.80 | 0.80 | 0.79 | 417.00 | 241.00 | 0.26 | 9.59 | 1.08 |
| $H^2$ | 0.14 | 0.29 | 0.36 | 0.97 | 0.95 | 0.91 | 0.80 | 0.22 |
| GEIr² | 0.83 | 0.52 | 0.51 | 0.03 | 0.04 | 0.04 | 0.19 | 0.71 |
| h²mg | 0.24 | 0.51 | 0.57 | 0.99 | 0.98 | 0.97 | 0.89 | 0.38 |
| Accuracy | 0.49 | 0.71 | 0.76 | 0.99 | 0.99 | 0.99 | 0.95 | 0.61 |
| rge | 0.96 | 0.74 | 0.81 | 0.80 | 0.78 | 0.42 | 0.94 | 0.91 |
| CVg | 2.71 | 6.15 | 6.64 | 49.60 | 42.40 | 29.30 | 6.24 | 8.28 |
| CVr | 1.32 | 4.94 | 3.90 | 4.17 | 4.57 | 7.29 | 0.75 | 4.72 |
| CV ratio | 2.05 | 1.25 | 1.70 | 11.90 | 9.26 | 4.03 | 8.35 | 1.76 |

$V_{ph}$ - phenotypic variance; $H^2$ - heritability in broad sense; GEIr2 - coefficient of determination of the interaction effects; $h^2_{gm}$ - heritability on the mean basis; Ac – accuracy of selection; $r_{ge}$ - genotype-environment correlation, CVg- genotypic coefficient of variation; CVr - residual coefficient of variation; CV ratio - ratio between genotypic and residual coefficient of variation; NSM – number of spikes per m²; PH - plant height, cm; L – lodging (score 9-1), SL - spike length, cm; SNS - spikelet number of per spike; GNS - grain number of per spike, GWS - grain weight per spike, g; TGW - 1000- grain weight, g; GY - grain yield, t ha⁻¹

In order to investigate the phenotypic variation of the studied set of ICARDA lines compared to the established Bulgarian varieties, the Best Linear Unbiased Predictions (BLUPs) for various traits were analyzed (Figure 1). The BLUPs provide a robust estimation of genotypic performance, which helps to discern the genetic potential of each line under the studied conditions (Piepho et al., 2008).

The standard variety Obzor exhibited a BLUP value for plant height (PH) approximately equal to the mean value, suggesting that it falls in the middle range among the tested genotypes.
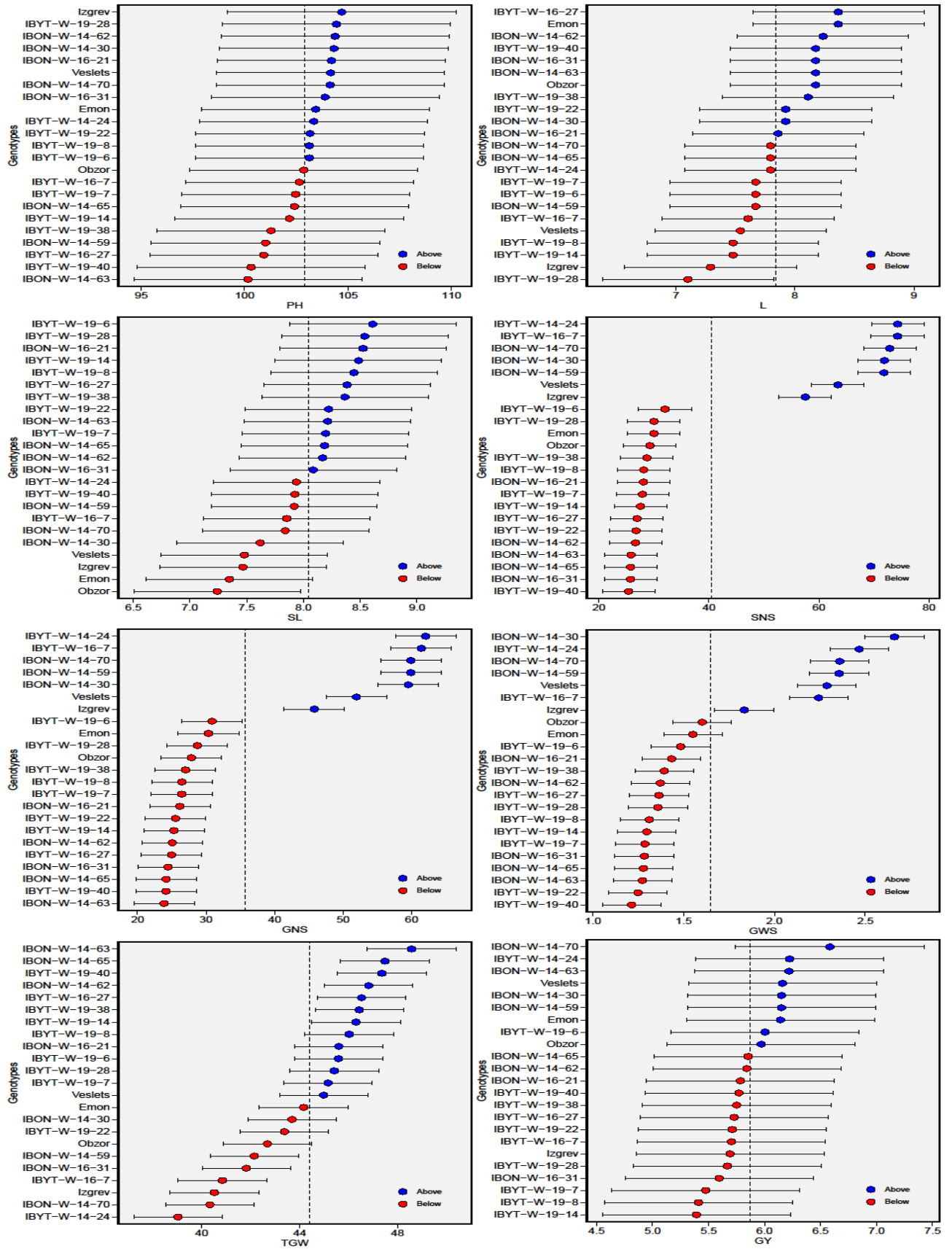
Figure 1. Best linear unbiased predictions (BLUPs) values of winter barley genotypes for plant height, cm (PH), lodging (L), spike length, cm (SL), spikelet number of per spike (SNS ); grain number of per spike (GNS); grain weight per spike, g (GWS ), 1000-grain weight, g (TGW), grain yield, t ha$^{-1}$ (GY)

In contrast, the other standard varieties demonstrated higher PH values, indicating their taller stature. Notably, nine ICARDA lines had lower PH than the overall mean, with the lines IBYT-W-19-40 and IBON-W-14-63 showing the lowest plant height. This reduction in height could be advantageous in terms of lodging resistance, especially under adverse weather conditions.

In terms of lodging resistance, the highest BLUP values were observed for the ICARDA line IBYT-W-16-27 and the Bulgarian variety Emon. Lodging resistance plays a crucial role in ensuring yield stability. Lines such as IBYT-W-16-27, which demonstrate superior lodging resistance compared to standard varieties, have the potential to deliver more consistent and stable yields across a wide range of environments.

All the studied ICARDA lines exhibited higher BLUP values for spike length (SL) when compared to the standard varieties.

The five studied 6-rowed ICARDA lines demonstrated higher BLUPs for both spikelet number per spike (SNS) and grain number per spike (GNS) compared to the 6-rowed standard varieties.

IBYT-W-19-6 and IBYT-W-19-28 exhibited the highest spikelet number per spike (SNS), with IBYT-W-19-6 also achieving the highest grain number per spike (GNS) among the 2-rowed lines.The increase in SNS and GNS among these lines suggests their potential for improved grain yield due to the higher grain-producing capacity of each spike. This trait is particularly beneficial for achieving higher yield under diverse environmental conditions.

Among the standard varieties, Veslets exhibited the highest BLUP value for grain weight per spike (GWS), a key yield component. However, four ICARDA lines (IBON-W-14-30, IBYT-W-14-24, IBON-W-14-70, and IBON-W-14-59) surpassed Veslets in GWS, indicating that these lines possess higher genetic potential for grain weight. This could translate to higher grain yield and enhanced productivity under appropriate environmental conditions.

Twelve ICARDA lines showed higher BLUP values for thousand grain weight (TGW) than the standard varieties, with IBON-W-14-63 having the highest value. TGW is a critical yield component that directly affects grain size and marketability. The significantly higher TGW in these lines suggests that they have the potential for superior grain size, which can be advantageous for both grain yield and quality traits.

In terms of overall grain yield (GY), the standard variety Veslets displayed the highest BLUP among the Bulgarian varieties. However, three ICARDA lines - IBON-W-14-70, IBYT-W-14-24, and IBON-W-14-63 exceeded Veslets in grain yield. This demonstrates the superior yield potential of these lines under the studied conditions. The higher GY observed in these ICARDA lines suggests that they could be promising candidates for inclusion in breeding programs aimed at improving yield.

### Conclusion

The observed phenotypic variation between the ICARDA lines and the Bulgarian standard varieties reflects the potential of these lines for improving key agronomic traits such as plant height, spike characteristics, and grain yield components. The shorter plant height in some ICARDA lines offers a promising avenue for enhancing lodging resistance, while traits such as spike length, spikelet number, grain number, and grain weight demonstrate the yield potential of these lines. The higher BLUPs observed in the ICARDA lines for traits like TGW and GWS suggest that these lines could be valuable for breeding programs aimed at improving grain size and yield. In conclusion, the ICARDA lines represent a valuable genetic resource for the improvement of barley cultivation, especially in terms of increasing yield potential, resilience, and grain quality.

### References

Jalata, Z. (2012). Evaluation of ICARDA Barley genotypes for yield stability and lodging resistance in southeastern Ethiopia highlands. Electronic Journal of Plant Breeding, 3(2), 722-732.

Verma, R. P. S. (2017). Mining the ICARDA germplasm collection for biotic and abiotic priority traits for Australia. 18th Australian Barley Technical Symposium, 3-6 September, 2017, Hobart, Tasmania, Australia

Wallwork, H., Butt, M., Grcic, M., & Garrard, T. (2022). The use of pathotype data for the selection and development of barley lines with useful resistance to scald. Plants, 11(19), 2501. http://dx.doi.org/10.3390/plants11192501

Branzova, P. (2015). Assess the economic imact of climate change on wheat, barley, maize and sunflower in Southeast Bulgaria. The Journal of Supercomputing, 13, 4-7. https://doi.org/10.15547/tjs.2015.s.01.002.

Visioni, A., Basile, B., Amri, A., Sanchez-Garcia, M., & Corrado, G. (2023). Advancing the conservation and utilization of barley genetic resources: Insights into germplasm management and breeding for sustainable agriculture. Plants, 12(18), 3186. http://dx.doi.org/10.3390/plants12183186

El-Hashash, E., & El-Absy, K. (2019). Barley (Hordeum vulgare L.) Breeding. Advances in Plant Breeding Strategies: Cereals. https://doi.org/10.1007/978-3-030-23108-8_1.

Ahmadi, J., Vaezi, B., & Pour-Aboughadareh, A. (2016). Analysis of variability, heritability, and interrelationships among grain yield and related characters in barley advanced lines. Genetika-belgrade, 48, 73-85. https://doi.org/10.2298/GENSR1601073A.

Olivoto, T., & Lúcio, A. D. C. (2020). metan: An R package for multi-environment trial analysis. Methods in Ecology and Evolution, 11(6), 783-789. http://dx.doi.org/10.1111/2041-210X.13384

Piepho, H., Möhring, J., Melchinger, A., & Büchse, A. (2008). BLUP for phenotypic selection in plant breeding and variety testing. Euphytica, 161, 209-228. https://doi.org/10.1007/s10681-007-9449-8.

# A Pepper Genotype Candidate for Geographical Indication Registration in the Selvi Region of Çanakkale: 'Selvi' Pepper

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## Abstract

The Çanakkale region hosts a variety of pepper genotypes due to its rich agricultural potential. Among these, the Kapya pepper is particularly prominent, with the Yenice region being the leading area for its production in Turkey. The geographically indicated pepper genotype 'Yenice Kırmızı Biberi' pepper is produced in significant quantities in the Yenice district. In addition, another notable pepper genotype in Çanakkale is the 'Selvi' (*Capsicum annuum* L.) pepper. This pepper is a candidate for geographical indication registration and is cultivated in substantial amounts in Selvi Village of Biga District. Known as 'Biga Selvi Yakan Biberi' this variety is a hot pepper that can be consumed fresh but is generally used for pickling. Selvi Village in Biga District is home to two pickled pepper enterprises, which play a significant role in producing pickles from 'Selvi' Pepper. Promoting a product through various initiatives contributes to its geographical indication registration. Such registration is an important step for marketing the product and enhancing its value. This study provides detailed information on the yield, pomological parameters and plant measurements for the important pepper genotype 'Selvi' pepper from Biga District in Çanakkale Province. The average fruit weight of 'Selvi' pepper was found as 1.73 g, and it was determined that it was a pepper genotype that was thinner and longer than the rosemary type pepper. The potential of 'Selvi' pepper is a crucial part of the agricultural identity of the region.

**Keywords:** 'Selvi' Biberi, geographical indication, pickled pepper

## Introduction

The Selvi pepper genotype, known as 'Biga Selvi Yakan Pepper,' is produced in high quantities in the Selvi province of the Biga district in Çanakkale.

The selvi pepper genotype has been cultivated by producers from their own seeds since 1980. It has been reported that this genotype yields approximately 2 tons per decare and has been harvested three times. Furthermore, selvi pepper is distributed to various regions, including Izmir, Gemlik, Gaziantep, and Bursa. Notably, when pickled, it can be preserved for extended periods and remains consumable for up to three years (Anonymous, 2016).

It is known that there are pickle processing factories at the main entrance of Selvi village. Selvi pepper has become a brand in the village. There are two pepper pickle businesses in Selvi village. These businesses have production and packaging facilities (Anonymous, 2023).

Geographical indication projects increase the value of products by increasing their recognition. Thus, significant contributions are made to the region in terms of agriculture. For this reason, geographical indication studies have been initiated (Anonymous, 2024) regarding the Selvi pepper.

In study (Düzyaman and Duman, 2005), yields of pickling pepper varieties biberiye 1 and biberiye 2 grown in the Izmir region were determined as 305.8 and 519.3 g/plant, respectively. Fruit weights were determined as 1.6 and 5.9 g, respectively; fruit lengths were determined as 5.9 and 9.4 cm, respectively; fruit diameters were determined as 0.8 and 1.4 cm, respectively; and fruit flesh thicknesses were determined as 0.1 and 0.16 cm, respectively.

Fırat et al. (2021) conducted hybridization breeding studies to develop sweet ornamental pepper varieties suitable for the pickle industry. In their study conducted on the developed pepper lines, the measurements were sorted from least to most as follows: fruit lengths (mm) 20 (BATEM Alpçelik) - 52.6 (Line 8), fruit diameters (mm) 9 (Line 8) - 13.1 (Line 9), fruit flesh thicknesses (mm) 1.5 (BATEM Alpçelik) - 2.5 (Line 9), fruit numbers (count) 263 (Line 9) - 287 (BATEM Alpçelik), fruit weights (g) 1.5 (BATEM Alpçelik) - 2.9 (Line 9), yield per plant (g) 427 (BATEM Alpçelik) - 759 (Line 9) and number of seeds per fruit (count) 24 (Line 11) - 45 (BATEM Alpçelik).

Mavi and Mavi (2015) examined the characteristics of 11 ornamental pepper genotypes grown in Hatay region in their study. In their study conducted on the pepper genotypes, the measurements were sorted from least to most as follows: plant lengths (cm) 14.3 – 77.3, fruit lengths (mm) 27.7 – 81, fruit diameters (mm) 7.3 – 42, number of seeds per fruit (count) 7 – 57.

Yaldız and Özgüven (2011) conducted a study on the adaptation of various ornamental pepper (*Capsicum* sp.) species and lines to the Çukurova region. The minimum fruit length recorded was 1.77 cm for *C. frutescens* 21, while the maximum fruit length was observed at 10.67 cm for *C. frutescens* 22. Additionally, the study identified a minimum fruit width of 0.27 cm for *C. frutescens* 33 and a maximum fruit width of 2.4 cm for *C. frutescens* 22. The findings also indicated that the minimum fresh yield was 41.6 kg/da for *C. frutescens* 43, whereas the maximum fresh yield reached 6427 kg/da for *C. frutescens* HC.

A geographical indication project is planned for the 'Selvi' pepper genotype, which is an important pickling pepper genotype in Selvi village, Biga district, Çanakkale province. In the scope of the study, it is aimed to make some plant and pomological measurements in order to have more information about the 'Selvi' pepper genotype. At the same time, it is among the aims of the study to provide more recognition of this pepper genotype and to contribute to the region.

**Materials and Methods**

'Selvi' pepper genotype (*Capsicum annuum* L.) was grown in Selvi village, Biga district, Çanakkale province in 2024 growing season. Seedlings planted with a distance of 0.33 meters within the row and 0.8 meter between the rows. The experiment was established in randomized plot design with 3 replications. 15 plants were used in each replication. 5 plants were selected from each replication and measurements were made.

Plant measurements of Selvi pepper (*Capsicum annuum* L.):

Plant Length (cm): The length of the above-ground part of the plant was determined by measuring.

Canopy Diameter (cm): It was determined by measuring the narrowest and widest diameter values of the plant crown and taking their averages.

Root Collar Diameter (mm): It was determined by measuring the plant root collar area with the help of a caliper.

Pomological parameters of Selvi pepper (*Capsicum annuum* L.):

Fruit Length (mm): It was determined with the help of a caliper, excluding the fruit stem.

Fruit Diameter (mm): It was measured from the widest part of the fruit with the help of a caliper.

Fruit Weight (g): Measured using precision scales, excluding the fruit stem.

Fruit Flesh Thickness (mm): The fruit was divided into 2 and measured with a caliper.

Number of Seeds in Fruit (number): It was determined by counting.

Length of Placenta in Fruit (mm): It was determined with the help of a caliper.

**Results and Discussion**

According to the information received from the producers, it is known that the average yield of 'Selvi' pepper is 2 tons/da. 'Selvi' pepper is usually harvested in 3 sessions.

Table 1. Plant measurements of Selvi pepper (*Capsicum annuum* L.)

| Plant Length (cm) | Canopy Diameter (cm) | Root Collar Diameter (mm) |
|---|---|---|
| 66.83 | 52 | 17.06 |

The plant length value of the 'Selvi' pepper genotype was determined as 66.83 cm, canopy diameter as 52 cm, root collar diameter as 17.06 cm. In a comparative study of 11 ornamental pepper

genotypes, it was found that only the MKÜ 86 genotype exhibited a greater plant height, measuring 77.3 cm, surpassing the height of the 'Selvi' genotype.

Table 2. Pomological parameters of Selvi pepper (*Capsicum annuum* L.)

| Fruit Length (mm) | Fruit Diameter (mm) | Fruit Weight (g) | Fruit Flesh Thickness (mm) | Number of Seeds in Fruit (number) | Length of Placenta in Fruit (mm) |
|---|---|---|---|---|---|
| 44,48 | 9,41 | 1,73 | 1,46 | 47,3 | 29,01 |

The fruit weight of the 'Selvi' pepper genotype was determined as 1.73 g. This value is similar to the fruit weight values (1.6 – 5.9 g) obtained from biberiye 1 and biberiye 2 pickling pepper varieties in the study (Düzyaman and Duman, 2005), respectively, and the fruit weight values (1.5 – 2.9 g) obtained from the pepper lines included in the study (Fırat et al., 2021).

It was observed that the fruit width values reported by Yaldız and Özgüven (2011) were lower than those in our study. The fruit width values in the study by Mavi and Mavi (2015) showed significant variation (7.3 - 42 mm). The fruit width value obtained in our study (9.41 mm) is similar to the study by Fırat et al. (2021) (9.0 - 13.1 mm). Additionally, it is close to the fruit width values (0.8 - 1.4 cm) of rosemary pepper varieties reported by Düzyaman and Duman (2005). This suggests that the 'Selvi' pepper genotype has a swollen fruit width despite being classified as a long, thin pepper genotype.

In a study by Düzyaman and Duman (2005), the fruit lengths of pickling pepper genotypes (Biberiye 1, Biberiye 2) ranged from 5.9 to 9.4 cm; in another study by Fırat et al. (2021), the fruit lengths of pepper lines ranged from 20 to 52.6 cm; in another study by Mavi and Mavi (2015), 11 ornamental pepper genotypes had fruit lengths ranging from 27.7 to 81 cm; and in a study by Yaldız and Özgüven (2011), the fruit lengths of various species and lines of ornamental peppers (Capsicum sp.) were found to range from 1.77 to 10.67 cm. The fruit length value of the 'Selvi' pepper genotype (44.48 cm) was similar to that of the study by Mavi and Mavi (2015).

The flesh thickness of the 'Selvi' pepper genotype was determined as 1.46 mm. It was observed that this value was between the flesh thickness values of biberiye 1 and biberiye 2 in the study (Düzyaman and Duman, 2005). The number of seeds per fruit of the 'Selvi' pepper genotype was determined as 47.3. It was observed that this value was between the seed count values (7-57) in the study (Mavi and Mavi, 2015). The placental length of the 'Selvi' pepper genotype was determined as 29.01 mm.

Table 3. Colour measurements of Selvi pepper (*Capsicum annuum* L.)

| Colour a (+a Red, -a Green) | Colour b (+b Yellow, -b Blue) | Colour L (Lightness) |
|---|---|---|
| -18.12 | 39.75 | 51.78 |

It is observed that the 'Selvi' pepper genotype has yellow (+39.75) and green (-18.12) color perceptions, however, the yellow color perception value is higher than the green color perception value.



Figure 1. 'Selvi' pepper genotype (*Capsicum annuum* L.)

**Conclusion**

The study established that the fruit structure of the 'Selvi' pepper genotype is longer and thinner compared to the rosemary-type peppers commonly used for pickling. Additionally, it was found that the fruits, while slender and elongated, are similar in length to pickling peppers and exhibit a slightly swollen morphology. The plant height was observed to be at a level that cannot be classified as short. Thus, it can be inferred that, as a pickling pepper genotype, it does not possess a small habitus. Furthermore, the 'Selvi' pepper genotype, identified as a significant raw material for two enterprises in the region, was determined to be highly suitable for geographical indication studies.

**Acknowledgements**

**References**

Anonymous. (2016). Biga`da Selvi Biberi hasadı tedirgin başladı. https://www.bigazete.com/2016/8/bigada-selvi-biberi-hasadi-tedirgin-basladi-h23480.html#google_vignette

Anonymous. (2023). Cumhuriyetin 100. Yılında Selvi Köyü. https://bigacarsambapostasi.com/cumhuriyetin-100-yilinda-selvi-koyu/

Anonymous. (2024). Biga'nın lezzeti 'Selvi Yakan Biberi' için coğrafi işaret yolculuğu başlıyor. https://www.biganinsesi.com/biganin-lezzeti-selvi-yakan-biberi-icin-cografi-isaret-yolculugu-basliyor

Fırat, C., Karataş, K., Arpacı, B. B., Mavi, K. (2021). Turşu sanayisine uygun tatlı süs biberi çeşitlerinin geliştirilmesine yönelik melezleme ıslahı çalışmaları. Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi, 26 (3), 679-691. https://doi.org/10.37908/mkutbd.961983

Düzyaman, E., Duman, İ. (2005). Sanayi kullanımına uygun bazı biber çeşitlerinin kalite ve verim özellikleri üzerinde karşılaştırmalı bir araştırma. Akademik Gıda Dergisi, 3 (2), 5-10.

Mavi, K., Mavi, F. (2015). Bazı süs biberi genotiplerinin bitki özellikleri ve tohum çıkış performansları. Dicle Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 4 (1), 31-35.

Yaldız, G., Özgüven, M. (2011). Farklı Süs Biberi (Capsicum Sp.) Tür ve hatlarının çukurova koşullarına adaptasyonu. YYÜ Tar Bil Derg, 21 (1), 1-11.

# From Vineyards to Global Markets: The Evolution and Trends, Opportunities and Threats of Grape and Wine Industries in Portugal and Türkiye

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## Abstract

The global grape and wine industry is a vital agricultural sector encompassing various applications such as table grapes, raisins, juice, and wine production. This paper addresses a gap in the literature by providing a comparative analysis of the evolution, trends, opportunities, and threats within the grape and wine industries of Portugal and Türkiye, two countries with rich viticultural histories and cultural ties but with distinct market dynamics and strategic approaches to grape utilization.

To ensure a robust comparative analysis, the study uses data from the Food and Agriculture Organization (FAO), the International Organization of Vine and Wine (OIV), and national statistical agencies and sectorial bodies, to examine the evolution and current trends in Portuguese and Turkish markets and their position in the global market. The findings highlight the distinct market trajectories: Portugal continues to consolidate its position as a major wine producer and exporter with established global markets, while Türkiye's market remains fragmented, with potential growth in both wine and non-wine segments, including domestic consumption and international trade, despite facing significant regulatory and socio-political challenges.

The strategic analysis identifies opportunities such as Portugal's capacity to further enhance its wine export strategies and Türkiye's potential to expand both domestic consumption and exports potential across various grape products. However, it also highlights threats, including increasing global competition and regulatory challenges in Portugal, alongside socio-political and regulatory barriers that could impede Türkiye's wine sector growth.

This paper contributes to the existing literature by providing a nuanced understanding of the distinct paths taken by Portugal and Türkiye, and strategic insights into their market positioning. The findings offer valuable implications for producers, marketers, and policymakers, emphasizing how these countries can leverage their unique strengths in grape production and address challenges to achieve sustainable growth in both wine and other grape-related rapidly evolving global markets.

**Keywords:** Grapes and wine production, International trade, Table grapes and wine consumption, Comparative market analysis

## Introduction

The global grape and wine industry is a cornerstone of agricultural and economic development, encompassing diverse applications such as table grapes, raisins, juice production, and winemaking. This industry plays a critical role in the global economy, contributing significantly to international trade and cultural heritage. Grapes, in their various forms, are not only essential for dietary consumption but also integral to multiple industrial processes. Understanding the dynamics and trends within these markets is

crucial for navigating their complexities and fostering sustainable growth (FAO, 2023a, 2023b, 2023c; OIV, 2023a, 2023b).

This study focuses on Portugal and Türkiye, two nations with rich viticultural histories but contrasting market dynamics and approaches to grape utilization. Portugal exemplifies an established, traditional wine producer with a robust export market and stable domestic consumption, positioning itself as a key player in the global wine industry (Rebelo & Baptista, 2024). In contrast, Türkiye represents a unique case of a predominantly non-wine-drinking culture, where grapes serve a broader range of applications, including table grapes and raisins, alongside a growing but smaller wine segment (Meininger's International, 2024). Analyzing these two nations provides valuable insights into how distinct cultural, economic, and regulatory contexts shape their positions in the global grape and wine markets.

The primary objective of this study is to examine the evolution and trends in the grape and wine industries of Portugal and Türkiye, identifying opportunities and threats within their respective markets. By leveraging data from authoritative sources such as the Food and Agriculture Organization (FAO), the International Organization of Vine and Wine (OIV), and national statistical agencies, the study seeks to provide a comprehensive comparative analysis of these countries' market dynamics. This includes exploring vineyard areas, grape production, trade flows, and *per capita* consumption to understand their global positioning (Akdemir, 2022; FAO, 2023a, 2023b, 2023c; GAIN, 2022, 2024; Guler et al., 2021; Soylemezoglu et al., 2016; TGDF, 2021; TUİK, 2024).

This study is guided by several key research questions aimed at understanding the dynamics of the grape and wine markets in Portugal and Türkiye. The primary research question focuses on how these markets have evolved over recent decades concerning vineyard area, grape production, and market segmentation, including wine, table grapes, and raisins. It also examines global trade and consumption patterns, identifying the key trends shaping these markets in both countries.

Secondary research questions delve deeper into specific aspects of these markets. They investigate the comparative differences and similarities between Portugal and Türkiye, particularly in terms of grape utilization. Another critical area of inquiry is the comparison of market structures and consumer preferences in both countries with global trends. Furthermore, the study explores how cultural,

religious, regulatory, and economic factors have influenced the development of grape and wine markets in Portugal and Türkiye, while anticipating future trends. It also examines the primary opportunities and threats facing the grape and wine industries in these countries and assesses how each can leverage or mitigate these in the context of global market dynamics. Lastly, the research seeks to determine how Portugal and Türkiye can optimize their strategies in grape production and other grape market segments to achieve sustainable growth and increase their global competitiveness.

The paper begins by providing a comprehensive analysis of the global grape and wine industry. It highlights major producers, consumption patterns, and emerging markets, setting the stage for understanding the broader context in which Portugal and Türkiye operate. Historical data is analyzed to trace the evolution of grape and wine production, exports, and consumption globally. This examination considers factors such as international trade policies, technological advancements, and shifts in consumer behavior that have shaped current trends (Soare et al., 2012). By situating Portugal and Türkiye within this global context, the study identifies their strategic market positioning, opportunities, and threats.

Subsequent sections focus on a detailed analysis of the grape and wine sectors in Portugal and Türkiye. Portugal's position in the global wine market is examined, with attention to challenges and opportunities, including the role of geographical indications and key industry players. Türkiye's grape and wine market are similarly analyzed, with a focus on domestic policies, cultural influences, and market structure. The comparative analysis highlights both commonalities and differences in the two countries' approaches to production, marketing, and consumption (Meininger's International, 2024; Rebelo & Baptista, 2024).

The discussion synthesizes findings from global, Portuguese, and Turkish contexts, providing insights into broader trends likely to shape the future of the wine industry. The paper concludes with strategic recommendations for producers, marketers, and policymakers, offering guidance on how to navigate the evolving market landscape. By providing a nuanced understanding of the global grape and wine markets, this study contributes valuable knowledge to literature, with specific implications for both markets.

**Literature review**

The global grape and wine markets have undergone significant transformations over centuries, reflecting historical, cultural, and economic shifts. Historically, the grape and wine industry was dominated by traditional Old World producers, such as France, Italy, and Spain, which continue to play a leading role in production and exports (Soare et al., 2012). However, the emergence of New World producers, including the United States, Australia, and Chile, and the rise of emergent markets like China and India, have altered the global landscape (Rebelo & Baptista, 2024). Globalization and technological advancements have facilitated these changes, enabling new producers to adopt innovative techniques and expand their market reach. The increased accessibility of global trade networks has also influenced consumption patterns, with growing demand for diverse wine varieties and sustainable production methods (OIV, 2023a, 2023b).

Global market trends reveal a diversification of production and consumption. While traditional producers maintain their dominance, regions like South America, South Africa, and Asia have shown remarkable growth. Technological innovations in viticulture and enology, coupled with international trade policies, have reshaped production and marketing strategies. Global consumer preferences have shifted towards organic and biodynamic wines, driven by environmental concerns and health awareness. These trends underscore the importance of understanding global market dynamics to contextualize the developments in Portugal and Türkiye (Meininger's International, 2024).

Portugal's grape and wine market is deeply rooted in its cultural and historical heritage. The country is globally renowned for its diverse wine portfolio, particularly fortified wines like Port and Madeira, alongside high-quality still wines. Key wine regions such as the Douro Valley, Alentejo, and Vinho Verde exemplify Portugal's regional strengths, benefiting from geographical indications that enhance their market value (Rebelo & Baptista, 2024). The market has evolved through investments in modernization and sustainability, with a growing focus on organic wine production. However, Portugal faces challenges from climate change, increased competition, and the need to diversify its export markets. Despite these challenges, the country remains a pivotal player in the global wine industry, with stable domestic consumption and a strong export orientation (Soare et al., 2012).

Türkiye's grape and wine market, on the other hand, offers a unique perspective within a predominantly non-wine-drinking cultural context. Grapes in Türkiye serve broader uses, including table grapes and raisins, which dominate the market alongside a smaller but growing wine segment. Türkiye's viticulture heritage spans millennia, yet modern wine production faces significant regulatory and socio-political challenges. The sector's growth is hindered by stringent advertising restrictions, high taxes, and limited domestic consumption (Meininger's International, 2024). Despite these barriers, Türkiye's native grape varieties, such as Narince and Kalecik Karasi, and the increasing quality of boutique wineries present opportunities for niche market growth. The country's strategic geographical position and rich viticultural history provide a foundation for future expansion, particularly in export markets (Rebelo & Baptista, 2024).

Existing comparative studies in grape and wine markets highlight the diversity in production methods, consumption patterns, and market dynamics across regions. Comparative analyses often focus on the economic and cultural factors that shape market evolution, providing strategic insights into global competitiveness. Studies comparing Old World and New World producers emphasize the role of tradition *versus* innovation, while emergent markets showcase the impact of globalization and shifting consumer preferences (OIV, 2023a, 2023b; Soare et al., 2012).

The theoretical framework underpinning this study integrates economic and agricultural theories relevant to grape market analysis. Business and marketing theories provide a lens to understand market segmentation, strategic positioning, and consumer behavior within the industry. Market dynamics are influenced by economic factors such as production costs, trade policies, and consumer income levels. Furthermore, the evolution of consumer preferences highlights the increasing demand for sustainability, quality, and innovation in grape and wine products. These theoretical insights offer a robust foundation for analyzing the comparative trajectories of Portugal and Türkiye's grape and wine industries (Meininger's International, 2024).

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**Methodology**

This study employs a robust methodological framework to explore the evolution and dynamics of the grape and wine markets in Portugal and Türkiye. It integrates statistical data from multiple authoritative sources, analytical techniques, and a SWOT analysis to provide a comprehensive understanding of these markets within the global context.

The data used in this study were collected from globally recognized organizations such as the Food and Agriculture Organization (FAO) and the International Organization of Vine and Wine (OIV), alongside national statistical agencies like the Instituto Nacional de Estatística (INE - National Institute of Statistics) in Portugal and Turkish Statistical Institute in Türkiye. The FAO provided essential data on global grape production and utilization, including metrics for wine, table grapes, and raisins, while

the OIV offered insights into international wine market trends and trade flows. National sources contributed granular data on regional production, export patterns, and consumption trends. This diverse set of data sources ensures the reliability and relevance of the study's findings (Akdemir, 2022; FAO, 2023a, 2023b, 2023c; GAIN, 2022, 2024; Guler et al., 2021; OIV, 2023a, 2023b; Soylemezoglu et al., 2016; TGDF, 2021; TUİK, 2024).

The analytical approach combines comparative analysis, time-series analysis, and market trend analysis. Comparative analysis was used to identify similarities and differences between the Portuguese and Turkish grape and wine markets, focusing on vineyard area, grape production, and market segmentation. Time-series analysis enabled the identification of trends and patterns over the past two decades, while market trend analysis provided insights into emerging opportunities and threats within these industries. To complement these techniques, a SWOT analysis was conducted to systematically evaluate the strengths, weaknesses, opportunities, and threats associated with the grape and wine markets in both countries (Meininger's International, 2024; Rebelo & Baptista, 2024) .

The criteria for selecting Portugal and Türkiye as case studies were grounded in their distinct positions within the global grape and wine markets. Portugal represents an established Old-World producer with a strong export orientation and a rich viticultural tradition. In contrast, Türkiye offers a unique perspective as a country with a predominantly non-wine-drinking culture, yet significant grape production for diverse applications, including table grapes and raisins. These contrasting profiles provide a valuable comparative framework to understand the diverse strategies and challenges within the global grape and wine markets (OIV, 2023a, 2023b; Soare et al., 2012).

The scope of this study encompasses an analysis of the evolution and current dynamics of the grape and wine industries in Portugal and Türkiye, with a particular focus on production, utilization, trade flows, and market trends. However, several limitations should be acknowledged. Data constraints, including the availability and comparability of historical statistics, posed challenges in aligning metrics across sources. Additionally, cultural and regulatory nuances may have influenced the interpretation of some data points. Despite these limitations, the study provides a comprehensive framework to analyze the strategic positioning of these two markets within the global context (Akdemir, 2022; GAIN, 2022,

2024; Guler et al., 2021; Meininger's International, 2024; Soylemezoglu et al., 2016; TGDF, 2021; TUİK, 2024).

**Results**

The results of this study provide an in-depth analysis of the global grape and wine markets, focusing on Portugal and Türkiye's market dynamics, as well as a comparative perspective to identify strategic opportunities and risks. The findings highlight global production trends, key players, and emerging markets, alongside detailed insights into the evolution of grape utilization and wine production in Portugal and Türkiye.

The global grape and wine markets exhibit diverse trends in production, consumption, and trade, as seen in figures below (figures 1, 2 and 3). Statistical data from the FAO and OIV indicate that vineyard areas worldwide have shown a slight decline in recent years, yet production remains stable due to technological advancements and improved agricultural practices. Grapes serve multiple purposes, including wine production, table consumption, and raisin production. The leading wine-producing countries remain France, Italy, and Spain, while emerging markets such as China and South Africa are gaining prominence (OIV, 2023a, 2023b). Technological innovations, such as precision viticulture and sustainable practices, have played a significant role in shaping production trends.

International trade policies and tariffs significantly impact market dynamics. The reduction of trade barriers through agreements such as the EU's free trade policies has facilitated market access for key players, while emerging markets face challenges from protectionist measures. Innovations in logistics and marketing, including e-commerce platforms, have further expanded market reach (Meininger's International, 2024).

Figure 1. Global Grape production (OIV, 2023a)
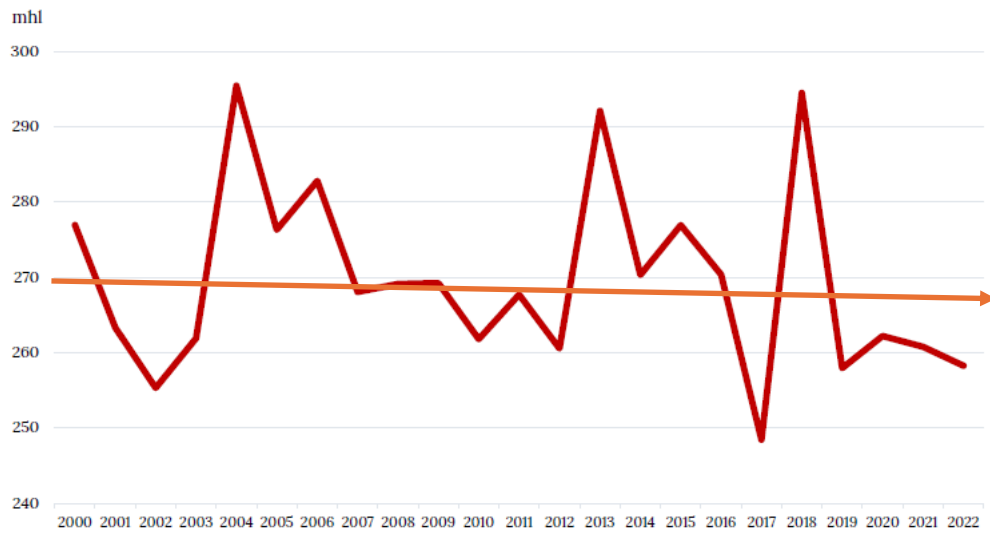


Figure 2. Global Wine production (OIV, 2023a)
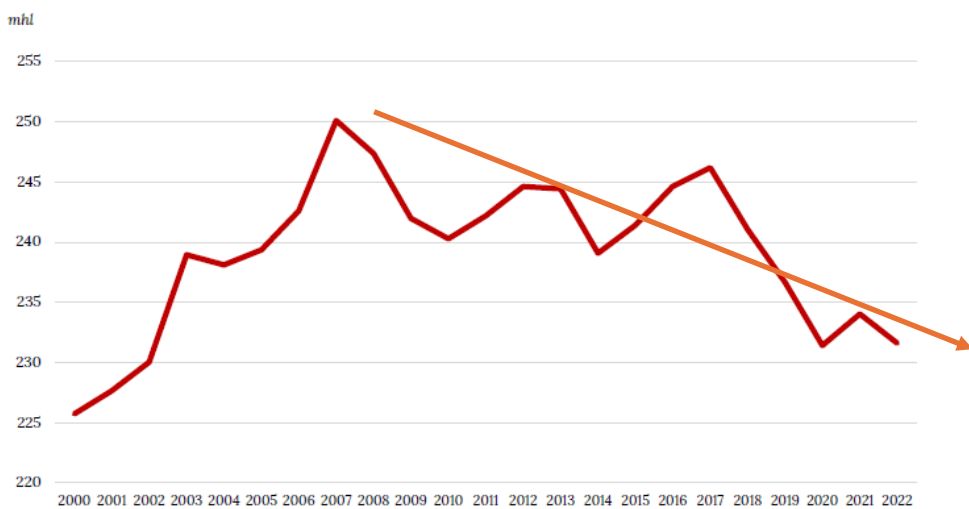


Figure 3. Global Wine consumption (OIV, 2023a)

Portugal's grape and wine market has evolved significantly, reflecting a blend of tradition and innovation. The country's viticulture is deeply rooted in history, with the Douro Valley and Alentejo regions standing out as key contributors to its global reputation. Vineyard areas in Portugal have remained stable, focusing on high-quality grape varieties predominantly used for wine production. Portuguese wines, including Port and Madeira, have strong market positions, bolstered by geographical indications (Rebelo & Baptista, 2024).



Figure 4. Vineyard Distribution and Key Wine Regions in Portugal (IVV, 2023)

Wine production and exports play a crucial role in Portugal's economy. The country's export-oriented strategies have allowed it to maintain a competitive edge in international markets. However, climate change poses a challenge to consistent production. *Per capita* wine consumption in Portugal remains one of the highest globally, emphasizing the cultural significance of wine (Soare et al., 2012). Türkiye's grape and wine market presents a contrasting narrative. With a predominantly non-wine-drinking culture, Türkiye's grape industry is heavily oriented toward table grapes and raisins, although wine production has shown modest growth. Native grape varieties such as Narince and Kalecik Karasi highlight the potential for niche markets. Regulatory and socio-political challenges, including advertising restrictions and high taxes, have limited market expansion (Meininger's International, 2024).
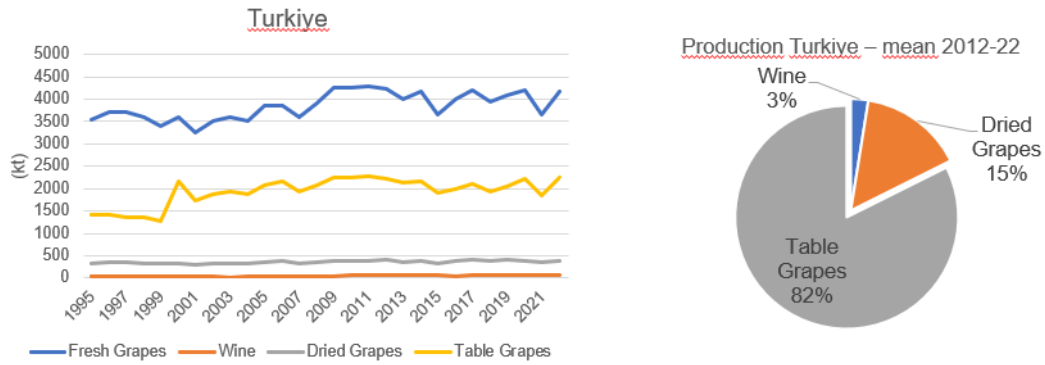
Figure 5. Grape Production by Use in Türkiye (OIV, 2023a)

Despite these barriers, Türkiye's geographical position and viticultural history present opportunities for growth, particularly in export markets. *Per capita* wine consumption remains low, reflecting cultural and economic constraints. However, non-wine grape segments continue to dominate, with raisins being a major export product (Akdemir, 2022; GAIN, 2022, 2024; Guler et al., 2021; Soylemezoglu et al., 2016; TGDF, 2021; TUİK, 2024).

The comparative analysis reveals stark differences and notable similarities between Portugal and Türkiye. While Portugal excels in wine production and exports, Türkiye's strength lies in its diverse grape applications. Regulatory and economic factors significantly shape both markets. For example, Portugal benefits from EU trade agreements, while Türkiye faces challenges from its regulatory environment.

Portugal's opportunities lie in expanding its export markets and investing in sustainable practices, while Türkiye could diversify its grape products and enhance its wine market through targeted strategies. However, both countries face threats from climate change and global competition. For Portugal, maintaining its market position requires navigating these challenges effectively. For Türkiye, socio-political factors and potential oversupply in non-wine grape segments present significant obstacles.
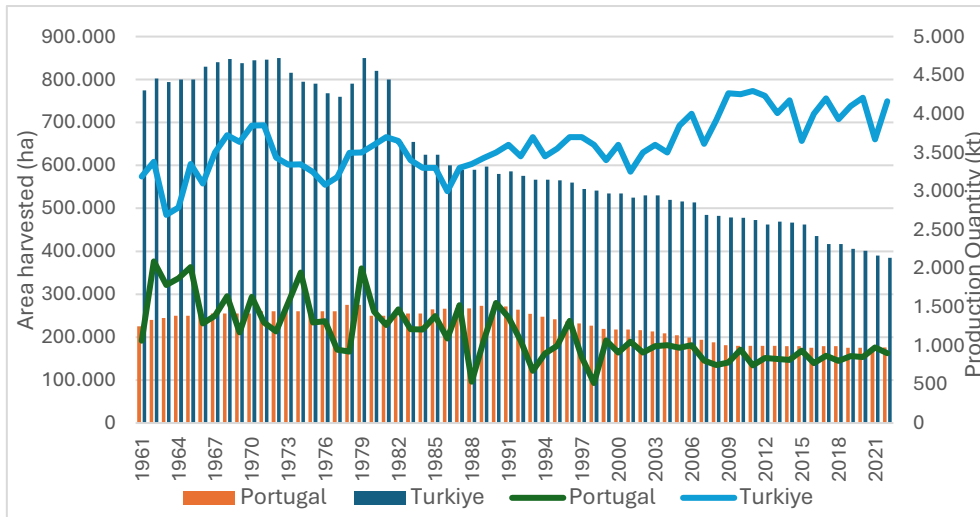
Figure 6. Comparative Analysis of Portugal and Türkiye's Area and Grape production 1961-2021 (FAO, 2023)
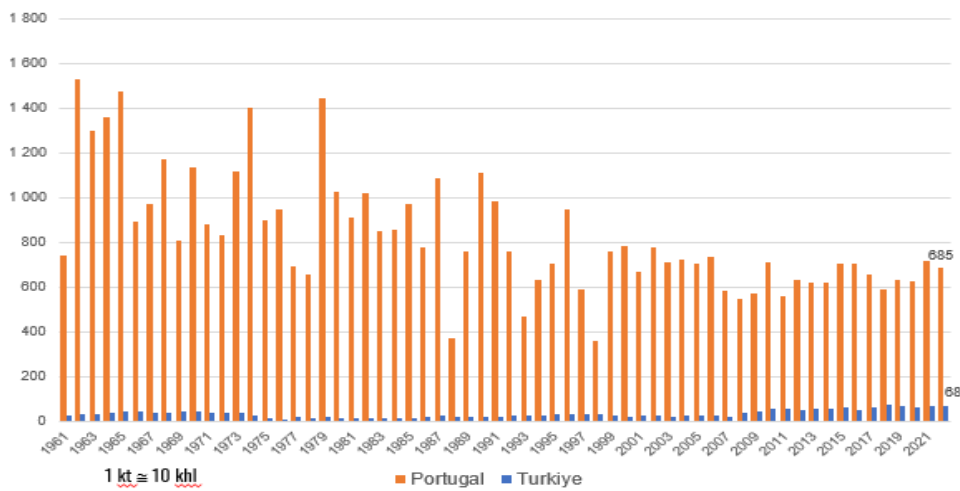


Figure 7. Comparative Analysis of Portugal and Türkiye's Wine production 1961-2021 (FAO, 2023)
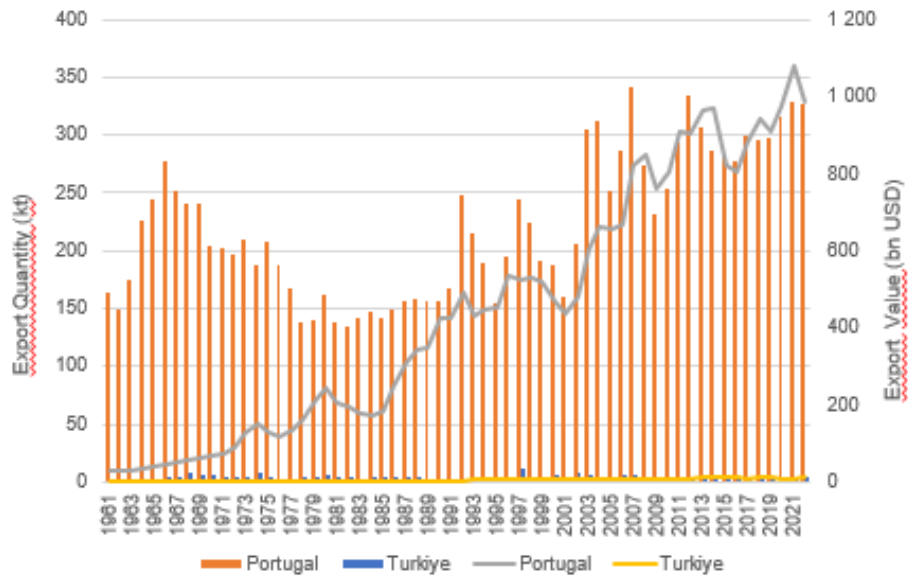
Figure 8. Comparative Analysis of Portugal and Türkiye's Wine exports 1961-2021 (FAO, 2023)

The strategic market positioning of both countries emphasizes leveraging their unique strengths. Portugal's focus on high-quality wines with geographical indications positions it well in premium markets. Türkiye's potential lies in capitalizing on its native grape varieties and expanding its presence in international markets, as seen in both SWOT analysis below:
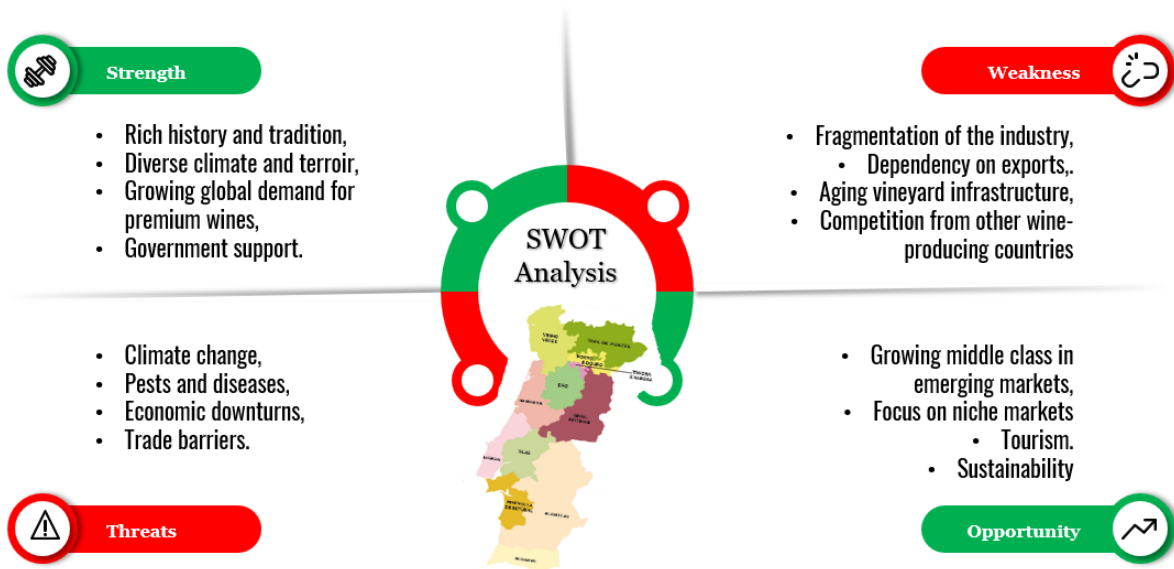


Figure 9. SWOT analysis for Portugal concerning wine industry
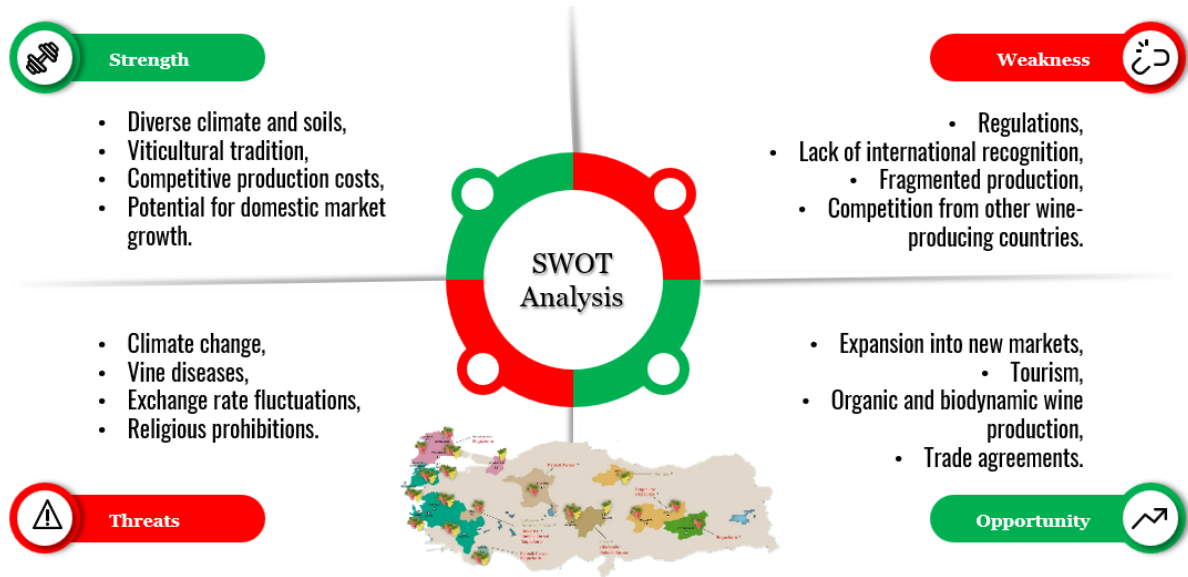
Figure 10. SWOT analysis for Türkiye concerning wine industry

In conclusion, this study highlights the evolving dynamics of the global grape and wine markets, situating Portugal and Türkiye within this context. The findings underscore the need for strategic interventions by stakeholders to address challenges and capitalize on emerging opportunities.

**Conclusions**

This research has provided a comprehensive analysis of the global grape and wine markets, with a specific focus on Portugal and Türkiye. It has highlighted the dual role of grapes as a cornerstone for both wine production and other market segments, such as table grapes and raisins. The findings emphasize the contrasting trajectories of Portugal and Türkiye within these industries, shaped by their historical, cultural, and regulatory contexts.

The global grape market remains a dynamic landscape, with approximately 80 million tons of fresh grapes produced annually. Türkiye ranks as the 6th largest producer globally, contributing significantly to the dried and table grape segments. In contrast, Portugal, ranked 19th, primarily channels its grape production into wine, positioning itself as the 10th largest wine producer worldwide (OIV, 2023a, 2023b). The disparity in grape utilization reflects their divergent market strategies: Portugal adds value through wine exports and premium branding, while Türkiye focuses on the volume and diversity of grape products.

For policymakers and industry stakeholders, several recommendations arise from this study. In Portugal, efforts should focus on diversifying export markets, mitigating the impacts of climate change on viticulture, and continuing investments in sustainable and organic wine production. The preservation and promotion of geographical indications, such as those associated with the Douro and Alentejo regions, are crucial for maintaining competitiveness in premium markets. In Türkiye, stakeholders should capitalize on the country's strength in table and dried grape segments while fostering niche markets for native wine varieties. Addressing regulatory and socio-political barriers will be pivotal in unlocking the potential of the Turkish wine industry (Meininger's International, 2024; Rebelo & Baptista, 2024).

Future research should delve deeper into the non-wine uses of grapes, exploring their economic impact and potential for innovation. For example, studies on consumer behavior toward dried and table grapes in emerging markets could provide actionable insights. Additionally, research on business and marketing strategies tailored to the unique strengths of each country's grape products can enhance their global positioning. There is also a need to examine the interplay between cultural and regulatory factors and their influence on market dynamics, particularly in non-traditional wine-consuming nations like Türkiye.

In summary, Portugal and Türkiye represent two contrasting yet complementary profiles in the global grape and wine markets. Portugal's strength lies in its wine production and export strategies, while Türkiye excels in leveraging the diversity of grape products. Both nations face unique challenges and opportunities, but their ability to adapt and innovate will determine their future trajectories. By integrating strategic recommendations and addressing identified gaps, stakeholders in both countries can ensure sustainable growth and competitiveness in the rapidly evolving global market.

**References**

Akdemir, U. (2022). Regional Economics of Viticulture in Türkiye in the Period 1970-2021. Tekirdag Viticulture Research Institute. https://doi.org/10.52001/vis.2022.11.55.71

FAO. (2023a). Portugal (Selected Indicators - Countries) https://www.fao.org/faostat/en/#country/174

FAO. (2023b). Trade / Crops and livestock products https://www.fao.org/faostat/en/#data/TCL

FAO. (2023c). Türkiye (Selected Indicators - Countries) https://www.fao.org/faostat/en/#country/223

GAIN. (2022). Türkiye: Raisin Annual. https://fas.usda.gov/data/Türkiye-raisin-annual-7

GAIN. (2024). Turkiye Raisins Update (Global Agricultural Information Network, Issue. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Turkiye%20 Raisins%20Update%20_Ankara_Turkiye_TU2024-0031.pdf

Guler, D., Saner, G., Şengül, Z., & Saner, C. (2021). Wine Grape Production in Türkiye, Evaluation of Developments in the Wine Sector, and Forecasts. https://www.researchgate.net/publication/357082074_Wine_Grape_Production_in_Türkiye_Evaluation _of_Developments_in_the_Wine_Sector_and_Forecasts

IVV. (2023). Vinho/Regiões. Instituto da Vinha e do Vinho. https://www.ivv.gov.pt/np4/regioes/

Meininger's International. (2024). A Snapshot of Türkiye's Wine Market. https://www.meiningers-international.com/wine/insights-markets/snapshot-Türkiyes-wine-market

OIV. (2023a). Annual Assessment of the World Vine and Wine Sector in 2022. https://www.oiv.int/sites/default/files/documents/OIV_Annual_Assessment-2023.pdf

OIV. (2023b). State of the World Vine and Wine Sector in 2023. https://www.oiv.int/sites/default/files/documents/OIV_State_of_the_world_Vine_and_Wine_sector_in_ 2022_2.pdf

Rebelo, J., & Baptista, A. (2024). Potential market failures in the Portuguese wine industry. Ciencia E Tecnica Vitivinicola, 39(1), 1-13. https://doi.org/10.1051/ctv/20243901001

Soare, E., Cofas, E., & Bălan, A. (2012). Research on the Wine Market in the European Union. Lucrări Ştiinţifice, XV(2), 155-.

Soylemezoglu, G., Atak, A., Boz, Y., Ünal, A., & Sağlam, M. (2016). Viticulture in Türkiye (2016). Chronica Horticulturae, 56, 27-31.

TGDF. (2021). Towards Alcoholic Beverage Sector 2023: Its Evaluation In terms os Agriculture and Foreign Trade Ecosystem. https://www.tgdf.org.tr/wp-content/uploads/2022/01/TGDF-towards-2023-alcoholic-beverage-sector.pdf

TUİK. (2024). Agricultural Production Statistics www.tuik.gov.tr

# Strategic Analysis of Olive and Olive Oil Markets Dynamics: Comparison of Evolution and Trends in Portugal and Türkiye and their Position in Global Context

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## Abstract

The olive and olive oil industry plays a pivotal role in global agriculture and food markets, undergoing significant transformations due to shifts in production, consumption, and trade dynamics. This study provides a comparative analysis of the olive and olive oil markets in Portugal and Türkiye, countries with distinct production and consumption patterns, addressing a gap in the literature. Using data from the Food and Agriculture Organization (FAO), the International Olive Council (IOC), and national statistics, the research employs descriptive statistics and trend analysis to examine production, trade flows, consumption habits, and the impact of geographical indications (PGI, PDO).

The findings reveal substantial shifts in global olive and olive oil markets influenced by climate change, consumer preferences, and international trade policies. While Portugal focuses on high-quality olive oil production and exports, Türkiye is a major producer of table olives and olive oil, driven primarily by domestic consumption with growing export ambitions. The study highlights opportunities for regional market differentiation and strategic adaptation to global trends, alongside threats such as climate vulnerability and market volatility.

These insights are crucial for policymakers, producers, and consumers, offering strategic recommendations to capitalize on opportunities and mitigate risks. The research emphasizes the importance of future studies on climate change, consumer behavior, and technological advancements to support sustainable development and market competitiveness.

**Keywords:** Comparative Market Analysis, World Olive and Olive Oil Market, Portuguese and Turkish Olive and Olive Oil Industry, PDO and PGI regions

## Introduction

The olive and olive oil industry stands as a cornerstone of global agriculture, particularly within the Mediterranean region, where it intertwines with cultural heritage, dietary habits, and economic development. Over recent decades, this industry has faced significant transformations driven by shifts

in production practices, evolving consumer preferences, and global trade policies (FranceAgriMer, 2023; Tok, Çobanoğlu, & Tunalıoğlu, 2023). Among the key players in this sector, Portugal and Türkiye present compelling case studies due to their distinct production and consumption dynamics, as well as their unique roles within the global market.

Portugal has established itself as a leader in the production of high-quality olive oil, underpinned by strong export-oriented strategies and certifications such as Protected Geographical Indication (PGI) and Protected Designation of Origin (PDO) (AGRO.GES, 2022). In contrast, Türkiye boasts a dual specialization in table olives and olive oil, characterized by a domestic consumption-driven market alongside burgeoning export ambitions (Kadakoğlu & Karli, 2023; Yurt, Kota, & Jarmai, 2019). These contrasting profiles offer a robust framework for comparative analysis, shedding light on the opportunities and threats faced by each country.

This study seeks to address critical gaps in the literature by analyzing the evolution, production, consumption, and trade dynamics of the olive and olive oil markets in Portugal and Türkiye. Using data from the Food and Agriculture Organization (FAO), International Olive Council (IOC), and national statistics, this research employs descriptive statistics and trend analysis to examine key performance indicators such as production quantities, trade flows, and *per capita* consumption (IOC, 2016; Balkan & Meral, 2017). Additionally, the study explores the role of geographic indications in enhancing market competitiveness and promoting sustainability (Tok et al., 2023).

The findings aim to provide actionable insights for stakeholders, including policymakers, producers, and consumers, enabling them to capitalize on emerging opportunities while mitigating risks such as climate change and market volatility. By situating Portugal and Türkiye within the global context, this research contributes to a deeper understanding of the dynamics shaping the olive and olive oil industry and offers strategic recommendations for fostering sustainable growth.

**Literature Review**

**Global Olive and Olive Oil Market Trends**

The global olive and olive oil market is a key component of agricultural trade, shaped by historical and emerging trends in production, consumption, and trade. The Mediterranean region accounts for over 90% of the world's olive oil production, with Spain, Italy, and Greece dominating global output. Recent studies emphasize that globalization, consumer health trends, and climate impacts have significantly reshaped market dynamics. For instance, the rising popularity of the Mediterranean diet has spurred global demand for olive oil, particularly in non-traditional markets such as the United States and Asia (FranceAgriMer, 2023).

Climate change and its effects on olive cultivation are among the most pressing challenges for industry. The increasing frequency of extreme weather events has disrupted production cycles, particularly in rainfed olive-growing areas. Studies highlight that irrigation and modern production techniques are mitigating some of these impacts, particularly in the European Union (European Commission, 2023). Moreover, advancements in technology, such as precision agriculture and automated harvesting, are contributing to efficiency gains and improved quality standards (Kadakoğlu & Karli, 2023).

The influence of international trade policies and economic factors cannot be overlooked. Trade agreements, tariffs, and subsidies directly affect the competitiveness of olive oil exporters. For example, Türkiye's olive oil exports have faced challenges due to inconsistent trade policies and competition from EU producers (Çukur, Demirbaş, & Gölge, 2017). Meanwhile, certifications such as Protected Geographical Indication (PGI) and Protected Designation of Origin (PDO) have become critical for enhancing product differentiation and securing market niches.

**The Olive and Olive Oil Markets in Portugal and Türkiye**

Portugal and Türkiye represent distinct but complementary profiles within the global olive and olive oil markets. Portugal's olive oil sector is characterized by high-quality production and a strong export orientation. Its Alentejo region accounts for most of the national production, leveraging modern irrigation systems and state-of-the-art processing facilities (AGRO.GES, 2022). Portuguese olive oil has gained international recognition for its quality, bolstered by PDO certifications and strategic marketing campaigns.

Conversely, Türkiye is a dual powerhouse in table olives and olive oil. With the world's fifth-largest olive-growing area, Türkiye has seen a steady increase in production, supported by government subsidies and investments in modern processing technologies (Yurt et al., 2019). However, the Turkish market is predominantly domestic, with only a fraction of its production being exported. Studies emphasize the need for Türkiye to improve its branding and marketing strategies to enhance its global competitiveness (Sönmüş & Aslan, 2021).

Despite extensive research on these individual markets, comparative analyses remain scarce. There is limited literature that directly compares the production methods, consumption habits, and trade policies of Portugal and Türkiye. This gap underscores the importance of this study in providing a comprehensive, data-driven comparison.

### Role of PGI and PDO Regions in Market Differentiation

PGI and PDO certifications play a pivotal role in differentiating high-quality olive oil in the global market. These designations protect regional specialties and enhance consumer trust by ensuring product authenticity and traceability. In Portugal, PDO-certified olive oils such as those from Trás-os-Montes and Alentejo have gained international acclaim, significantly boosting exports (AGRO.GES, 2022).

Türkiye has also leveraged geographical indications for its table olive varieties, such as "Akhisar Domat" and "Gemlik", which are well-regarded for their unique characteristics. However, the use of PDO and PGI certifications in Turkish olive oil remains underdeveloped compared to European producers (Tok et al., 2023). Increasing the adoption of these certifications could improve Türkiye's market positioning and competitiveness.

### Key Gaps in Comparative Analyses of Portugal and Türkiye

Existing literature on the olive and olive oil markets predominantly focuses on individual countries or global trends, leaving a critical gap in comparative studies. For example, research has extensively analyzed the competitiveness of Turkish olive oil (Türkekul et al., 2010) and the sustainability of Portuguese olive groves (AGRO.GES, 2022), but few studies have attempted to compare these markets within a unified framework.

This gap is particularly significant given the complementary roles that Portugal and Türkiye could play in the global market. By combining Portugal's emphasis on high-quality, branded exports with Türkiye's volume-driven production strategy, stakeholders could identify synergies and address shared challenges, such as climate change and market volatility. This study addresses these gaps by providing a detailed quantitative analysis of production trends, trade flows, and market dynamics, offering actionable insights for policymakers and industry leaders.

## Methodology

### Data Sources

This study relies on data from reputable and comprehensive sources, including the Food and Agriculture Organization (FAO), the International Olive Council (IOC), and national statistics from Portugal and Türkiye. These sources provide extensive datasets on production volumes, trade flows, consumption patterns, and the economic importance of olives and olive oil.

The FAO offers global agricultural datasets, including time-series on olive cultivation and trade, which are crucial for trend analysis (FranceAgriMer, 2023). The IOC provides detailed insights into olive oil quality, market trends, and geographical indicators, as seen in the IOC's 2019 report (IOC, 2019). Country-specific data are gathered from statistical offices such as the Instituto Nacional de Estatística (INE) in Portugal and the Turkish Statistical Institute (TurkStat), which deliver granular data on regional production and consumption dynamics.

### Analytical Techniques

To examine the data, the study employs descriptive statistics and trend analysis: descriptive statistics summarizes data using measures such as averages, percentages, and distributions, enabling direct comparison between Portugal and Türkiye on metrics such as production efficiency and trade balances. These summaries provide a clear understanding of market behaviors across key variables; and trend analysis, to identify patterns and shifts in market behavior over time, employing historical data to project future trends. For example, production and trade trends from 2010 to 2022 are analyzed to discern the effects of technological advancements and climatic changes (Balkan & Meral, 2017).

**Variables**

The analysis emphasizes key variables essential for understanding the dynamics of the olive and olive oil markets and the competitive positioning of Portugal and Türkiye within a global context. These variables include annual production volumes of olives and olive oil, which provide insights into production capacities, as well as trade metrics such as the volume and economic value of imports and exports, shedding light on trade balances and market positioning. Additionally, domestic consumption patterns in both countries are examined through *per capita* consumption data, offering a detailed understanding of internal demand structures. The significance of Protected Geographical Indications (PGI) and Protected Designations of Origin (PDO) is also analyzed, highlighting their role in enhancing market value and product differentiation, as emphasized by Tok et al. (2023). These factors contribute to identifying trends, opportunities, and challenges that shape the market landscape and inform strategic decision-making.

**Comparative Framework for Analyzing Market Structures**

The comparison of market structures between Portugal and Türkiye is conducted across four key dimensions. First, production efficiency is evaluated by examining agricultural practices, yield rates, and technological advancements, providing insights into the productivity and sustainability of each country's olive and olive oil industries. Second, the analysis considers market size and trade balances, focusing on trade flows and the balance between imports and exports to assess overall market strength and the emphasis on domestic consumption versus export orientation. Third, the study investigates the internal *versus* external market focus, exploring the relative importance of domestic demand compared to export-driven strategies to better understand each country's market positioning. Lastly, global positioning is analyzed by situating findings within broader international market trends, utilizing frameworks such as SWOT analysis to identify the strengths, weaknesses, opportunities, and threats faced by both countries in the global context.

**Criteria for Selecting Portugal and Türkiye as Case Studies**

Portugal and Türkiye were chosen due to their prominent roles in the olive and olive oil sectors and their contrasting market characteristics. Portugal's emphasis on high-quality production and export

orientation contrasts with Türkiye's volume-driven production and domestic consumption focus. These differences provide a robust framework for comparative analysis, particularly in addressing shared challenges such as climate change and trade barriers (Kadakoğlu & Karli, 2023).

**Scope and Limitations**

This study examines the olive and olive oil markets in Portugal and Türkiye from 2010 to 2022, with a particular focus on production, trade, and consumption dynamics. However, certain limitations must be acknowledged. Data constraints arise from variability in the granularity and availability of information across sources, particularly for smaller production regions. Additionally, the methodological approach is limited by the absence of econometric modeling, which confines the analysis to descriptive and trend-based insights, reducing its predictive accuracy. Despite these limitations, the study offers valuable comparative insights, equipping stakeholders with the necessary information to inform market strategies and guide policy development.

**Results and Discussion**

**Evolution of the Global Olive and Olive Oil Markets**

The global olive and olive oil markets have undergone significant transformations over the last few decades. Spain remains the dominant global producer, contributing over 50% of the world's olive oil, followed by Italy, Greece, and Türkiye. The global demand for premium olive oil has surged, driven by health trends emphasizing the benefits of the Mediterranean diet (FranceAgriMer, 2023). This has catalyzed market growth in emerging regions such as North America and Asia.

Trade policies and tariffs have played a crucial role in shaping market dynamics. For instance, the EU's subsidies for olive oil production have given European producers a competitive edge over non-EU countries like Türkiye (Çukur, Demirbaş, & Gölge, 2017). Furthermore, technological innovations such as precision agriculture and advanced irrigation systems have enhanced production efficiency and quality (Kadakoğlu & Karli, 2023).

**Comparative Analysis of Portugal and Türkiye Within the Global Market**

Portugal and Türkiye occupy unique positions in the global olive and olive oil markets. Portugal focuses on high-quality, PDO-certified olive oils, positioning itself as a premium exporter. Conversely,

Türkiye is a significant producer of both table olives and olive oil, with a market driven largely by domestic consumption but growing export ambitions (Tok et al., 2023).
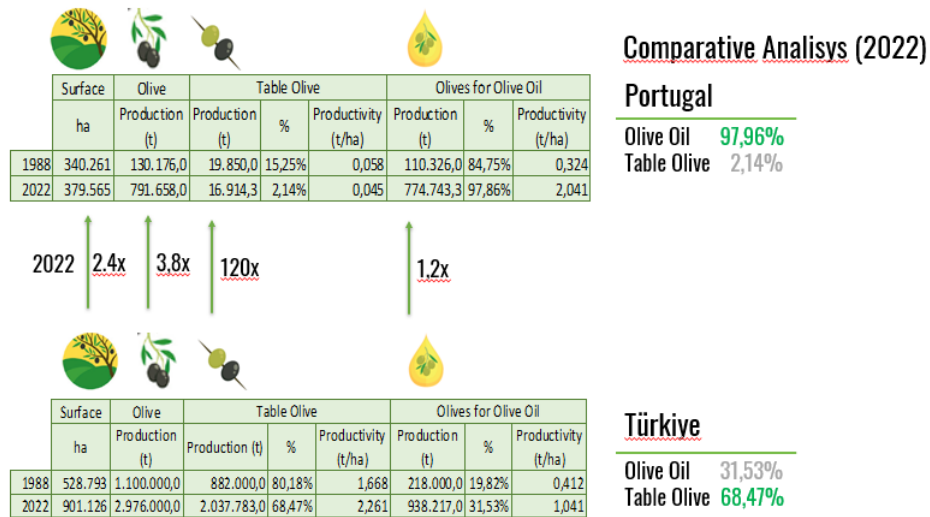


Figure 1. Comparative Analysis - Portugal and Türkiye

**Portugal's Production Trends in Olives and Olive Oil**

Portugal has steadily increased its olive oil production, with the Alentejo region accounting for nearly 75% of national output. This growth is attributed to advancements in irrigation and processing technology, as well as government incentives promoting modern agricultural practices (AGRO.GES, 2022). PDO certifications, such as those for Trás-os-Montes olive oil, play a critical role in maintaining high production standards.
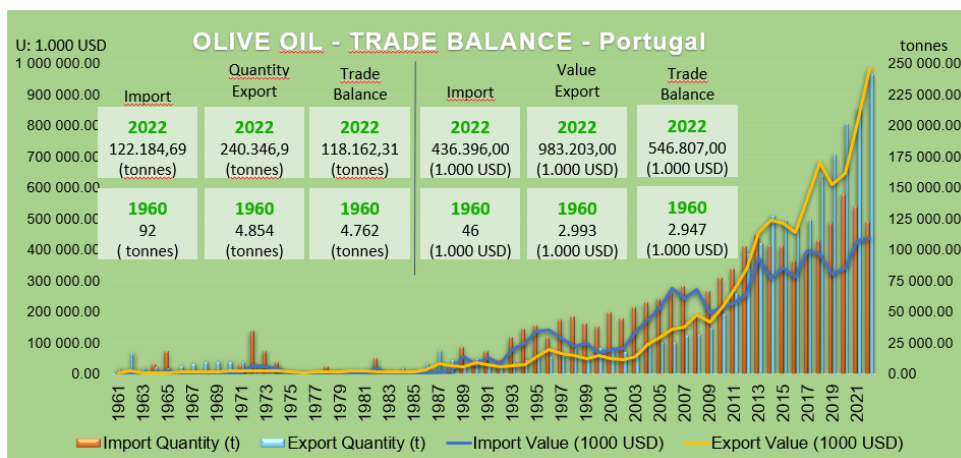


Figure 2. Trade balance of Olive Oil in Portugal from 1961 to 2021

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Portugal's olive oil exports are concentrated in Europe and North America, with Spain and Italy as its primary trade partners. Exports represent a significant portion of their market strategy, with high-quality products commanding premium prices (FranceAgriMer, 2023). Domestic olive oil consumption in Portugal has remained stable, with increasing demand for organic and artisanal products. Internationally, Portuguese olive oil is highly regarded for its quality, driven by strategic branding and marketing efforts (AGRO.GES, 2022).
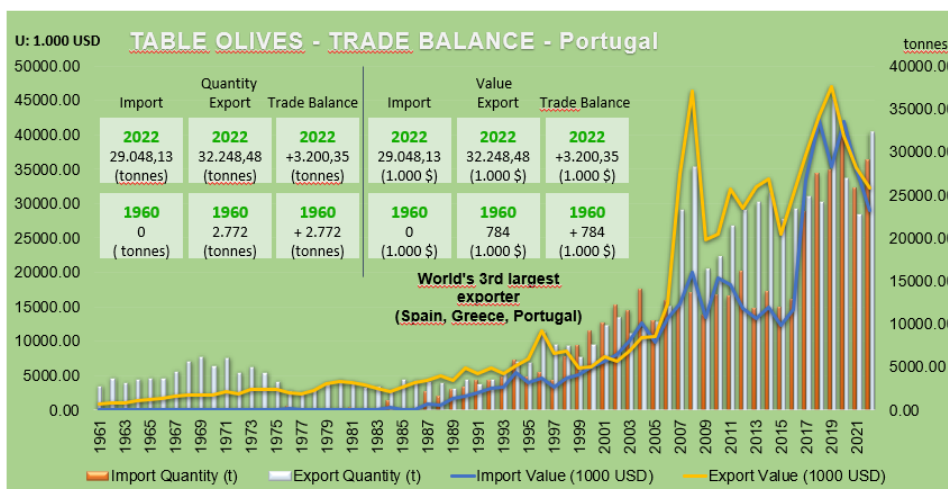


Figure 3. Trade balance of Table Olives in Portugal from 1961 to 2021

**Türkiye's Production Trends in Olives and Olive Oil**

Türkiye is the fifth-largest olive oil producer globally, with production concentrated in regions such as Aegean and Marmara. The country is also a leading producer of table olives, with varieties such as Gemlik and Akhisar Domat gaining recognition for their quality (Tok et al., 2023). Government policies, including subsidies and technical support, have significantly boosted production levels (Kadakoğlu & Karli, 2023).
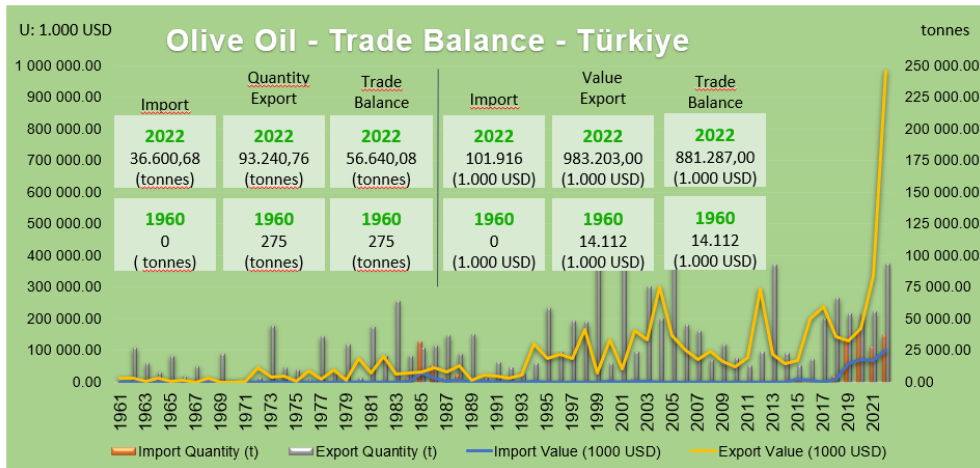
Figure 4. Trade balance of Olive Oil in Türkiye from 1961 to 2021

Türkiye's primary export markets for olive oil include Europe, the Middle East, and Asia. However, challenges such as quality control and market access barriers hinder its ability to compete with EU producers. Despite these obstacles, Türkiye's export volume has grown steadily over the past decade (Çukur et al., 2017). Olive oil and table olives are staples in Turkish cuisine, with domestic consumption surpassing exports. However, *per capita* olive oil consumption is growing as consumers shift towards healthier dietary habits (Yurt et al., 2019).
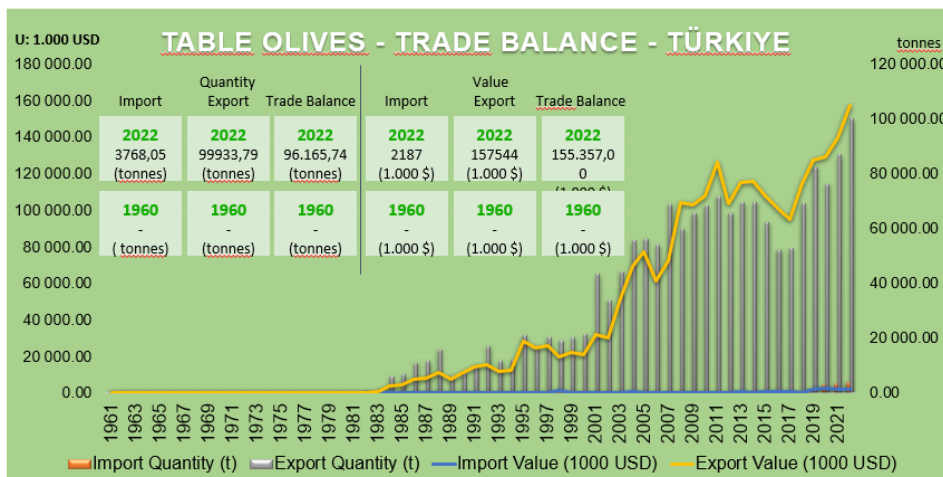


Figure 5. Trade balance of Table Olives in Türkiye from 1961 to 2021

**Comparative Analysis: Key Differences in Production Methods, Consumption Habits, and Trade Dynamics**

The olive oil industries in Portugal and Türkiye exhibit notable differences in production methods and market structures. Portugal prioritizes mechanization and quality, leveraging its Protected

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Designation of Origin (PDO) regions to secure a premium position in the global market. This approach ensures consistency in quality and supports the country's focus on high-value exports. In contrast, Türkiye's production is characterized by its high volume, largely driven by traditional agricultural practices and bolstered by government support. This production model highlights Türkiye's emphasis on quantity over premium positioning, reflecting a different strategic focus (Balkan & Meral, 2017).
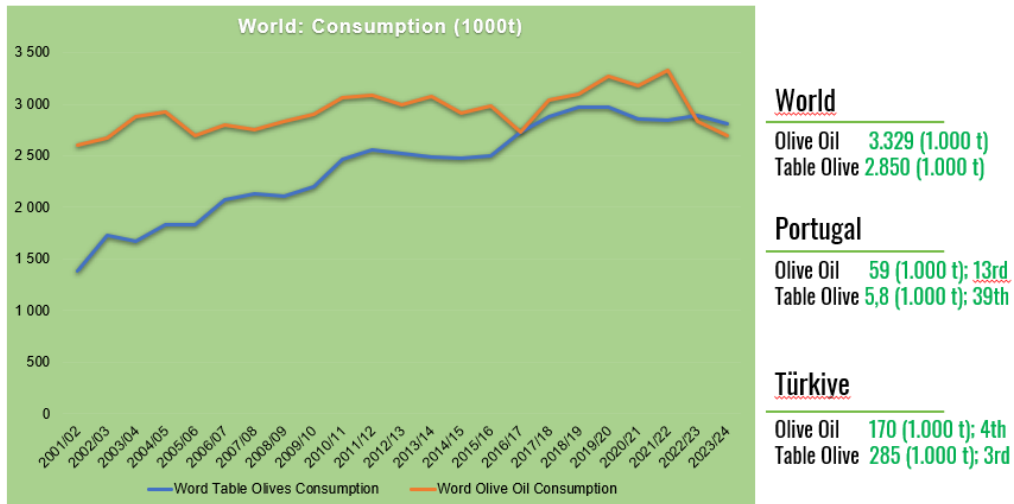


Figure 6. World consumption of Olive Oil and Table Olives from 2001 to 2024

Domestic consumption trends further underscore these differences. In Portugal, there is a strong preference for artisanal and organic olive oil products, aligning with consumer shifts toward sustainability and health-conscious choices. By contrast, Türkiye's domestic market is dominated by table olives and traditional olive oil products, reflecting a deep integration of these items into its culinary traditions. Türkiye also reports higher per capita consumption, indicative of the staple role olive oil plays in Turkish diets (AGRO.GES, 2022).

When examining trade dynamics and global positioning, the strategies of the two countries diverge. Portugal has established itself as an export-oriented producer, leveraging its reputation for high-quality olive oil to access premium international markets. In comparison, Türkiye's export ambitions are still developing. While Türkiye has the potential to grow its presence in global markets, it remains an emerging competitor. Both countries face significant competition from dominant producers such as Spain and Italy, but they could enhance their positions through strategic branding and the expanded use

of quality certifications. These efforts would help differentiate their products and increase competitiveness in high-value markets (Tok et al., 2023).

**Conclusion**

This study highlights the distinct dynamics of Portugal and Türkiye's olive and olive oil markets, emphasizing both their unique strengths and shared challenges. Portugal's market is characterized by its focus on high-quality olive oil production, leveraging Protected Geographical Indication (PGI) and Protected Designation of Origin (PDO) certifications to secure a competitive edge in premium export markets. Conversely, Türkiye is a dual powerhouse in olive oil and table olive production, driven largely by domestic consumption but increasingly focused on expanding its global footprint (AGRO.GES, 2022; Tok et al., 2023).

Key differences include production methods, market structures, and trade orientations. Portugal's reliance on mechanization and high standards contrasts with Türkiye's more traditional methods and volume-oriented approach. Both countries, however, face common challenges such as climate change, market volatility, and competition from dominant players like Spain and Italy.

**Strategic Recommendations and Implications for Policymakers and Market Stakeholders**

Policymakers in both Portugal and Türkiye should prioritize supporting sustainable growth by investing in adaptive agricultural practices to mitigate the impacts of climate change. This entails promoting water-efficient irrigation systems and incentivizing sustainable farming methods, as emphasized by recent studies (FranceAgriMer, 2023). For Portugal, enhancing Protected Designation of Origin (PDO) certifications remains crucial to maintaining its premium market position. On the other hand, Türkiye should expand its application of quality certifications to improve market perception and access high-value markets. Furthermore, trade policies require attention from policymakers in both nations. Negotiating favorable trade agreements, particularly those that address tariffs and non-tariff barriers, is essential to facilitate exports. Türkiye, in particular, must address quality control issues to align with European Union standards (Çukur, Demirbaş, & Gölge, 2017).

Producers in both countries should focus on improving efficiency and quality in olive oil production. Portuguese producers can achieve this by leveraging advanced mechanization and adopting sustainable practices, thereby enhancing both efficiency and product quality. Turkish producers, meanwhile, should embrace innovative technologies to increase production efficiency while preserving traditional methods that contribute to the authenticity of their products. In addition, strategies to counteract the impacts of climate change are critical. These strategies include diversifying crop varieties and investing in climate-resilient technologies to ensure long-term sustainability.

Exporters and traders should focus on diversifying markets to capitalize on growing demand for premium olive oil in emerging markets across Asia and North America. Türkiye, in particular, should leverage its production scale to target mid-tier markets alongside premium segments, thus maximizing its export potential (Kadakoğlu & Karli, 2023). Branding and marketing efforts are equally essential. Portugal's success in premium branding provides a model for Türkiye, which should focus on leveraging geographical indications to enhance product differentiation and improve competitiveness in the global market.

### Strategic recommendations for stakeholders

In the olive oil sector, recommendations should be tailored to address the unique strengths and challenges of each country. Portuguese stakeholders are encouraged to enhance branding efforts for olive oils with Protected Designation of Origin (PDO) certifications. By targeting health-conscious consumers in high-income markets, they can capitalize on the premium positioning of their products. Turkish stakeholders, on the other hand, should focus on developing integrated marketing strategies that emphasize ongoing quality improvements and the cultural authenticity of their olive oil. This approach will enable Türkiye to establish a stronger presence in competitive export markets (Tok et al., 2023).

### Future research

Future research should focus on several critical areas to further advance the understanding of the olive and olive oil markets. First, studies should examine the long-term effects of climate change on olive yield and quality in Mediterranean regions. Scenario analyses would be particularly valuable in identifying adaptive strategies for producers in both Portugal and Türkiye, ensuring resilience against

environmental challenges. Second, research should investigate the role of precision agriculture and digital technologies in enhancing production efficiency and sustainability. Understanding how these innovations can be effectively implemented in the olive oil sectors of both countries could significantly improve their competitiveness. Lastly, future studies should explore evolving consumer preferences, particularly how the increasing emphasis on sustainability and health influences purchasing behaviors. Special attention should be given to the growing demand for organic and premium olive oil.

This study has provided a comprehensive understanding of the olive and olive oil markets in Portugal and Türkiye, offering actionable insights to support stakeholders in navigating the complexities of the evolving global market.

### References

AGRO.GES. (2022). Sustentabilidade dos olivais em Portugal: Desafios e respostas. Princípia Editora.

Balkan, B. A., & Meral, S. (2017). Olive oil industry dynamics: The case of Turkey. In Proceedings of the 35th International Conference of the System Dynamics Society. Cambridge, MA, USA. https://doi.org/10.17660/ActaHortic.2018.1199.32

Çukur, F., Demirbaş, N., & Gölge, E. (2017). International competitiveness of the Turkish olive oil sector. Selçuk Journal of Agriculture and Food Sciences, 31(3), 162–168. https://doi.org/10.15316/SJAFS.2017.50

European Commission. (2023). Market situation in the olive oil and table olives sectors. Committee for the Common Organisation of the Agricultural Markets.

FranceAgriMer. (2023). Marché de l'huile d'olive: Monde, Europe, France. FranceAgriMer Publications.

International Olive Council. (2016). Olivae No. 123: Special focus issue on Turkey. IOC Official Journal.

International Olive Council. (2019). 60th Anniversary Report: Imprinting the future. IOC Official Journal.

Kadakoğlu, B., & Karli, B. (2023). Turkish olive oil: How can its global competitiveness be increased? Scientific Papers Series Management Economic Engineering in Agriculture and Rural Development. https://doi.org/10.1234/5.2023.7890

Sönmüş, A., & Aslan, M. H. (2021). Comparative advantage of Turkish olive oil in global markets: An empirical analysis. Turkish Journal of Agriculture - Food Science and Technology, 9(6), 1114–1119. https://doi.org/10.24925/turjaf.v9i6.1114-1119.4320

Tok, N., Çobanoğlu, F., & Tunalıoğlu, R. (2023). The link between geographic indication, sustainability, and multifunctionality: The case of table olive groves in Western Turkey. Erwerbs-Obstbau, 65(6), 851–859. https://doi.org/10.1007/s10341-023-00814-9

Türkekul, B., Günden, C., Abay, C., & Miran, B. (2010). The competitiveness of Turkish olive oil on the world market. Journal of Food, Agriculture & Environment, 8(2), 68–73. https://doi.org/10.1234/4.2010.1621

Yurt, O., Kota, L., & Jarmai, K. (2019). Analysis and optimization of an olive oil supply chain: A case from Turkey. Roehampton Business School Working Papers. https://doi.org/10.13140/RG.2.2.12345.67890

# Relationship between Agriculture and Tourism in Sustainable Development: Çanakkale Case

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## Abstract

Agriculture and Tourism sectors, have complementary and supportive features. People, who live and work in metropolises and cities, desire to get away from their routines and experience diffirent activities and environment. More and more tourists have started to prefer tourism types which take place in countryside, which are intertwined with the agricultural sector and rural life. With the development of tourism activities in rural areas, the demand for agricultural and animal products increases, business and employment opportunities related to tourism are provided. Income increase and new business and employment opportunities created by tourism activities in rural areas prevent migration to cities and even encourage reverse migration.

Canakkale has many values that combine agriculture and tourism with its unique geographical location between the Aegean and Marmara regions, climate, nature, soil structure, vegetation and sea. Canakkale is also extremely rich in terms of animal and agricultural products and dishes for gastronomy tourism, which is gaining importance day by day. Canakkale has many animal and agricultural products, which have geographical indication. These products contribute to the development of agriculture and tourism with their originality, brand value, demand and recognition. However; increasing number and capacity of mining activities, thermal power plants and wind power plants in Canakkale, have negative impacts on sustainable development of agriculture and tourism. Similarly, misuse of eco-tourism incentives damages agricultural areas and causes the local population to abandon agriculture and migrate to cities.

This conceptual study is based on literature and observations made within the scope of different projects. In the first part of the study, the relationship between rural areas, agriculture and tourism is examined. In the second part, the role of agricultural and animal products in the development of tourism is emphasized. In the third part, the threats faced by the agricultural and tourism sectors in Canakkale are examined. In the last part, some suggestions are tried to be developed for sustainable agriculture and tourism development.

**Keywords:** Agriculture and Tourism, Canakkale Agriculture, Canakkale Tourism, Rural Development, Sustainable Development

## Introduction

The relationship between agriculture and tourism sectors are multifaceted and complex. When the tourism and agriculture sectors interact, both synergies and competition arise. It ranges from conflict between the two sectors, arising from competition for land, water, energy, labor and capital, to joint development in which both sectors mutually benefit from each other (Telfer and Wall, 1996:635; Torres and Momsen, 2011; Gálvez Nogales, Puntsagdavaa, Casari, & Bennett, 2023). Many studies emphasize the competition between agriculture and tourism for land, labor and capital resources. For example; In Bozcaada, one of the important tourist destinations of Çanakkale, the local people are abandoning their traditional livelihoods such as viticulture and fishing and are switching to the tourism sector of managing guesthouses, hotels, restaurants and cafes. However; the most important tourism values of Bozcaada are the gastronomic richness provided by viticulture and fishing. A similar contradiction is also observed in regions where tourism has become popular such as Gökçeada, Assos, Yeşilyurt and Adatepe.

On the other hand, due to technological developments, degredation and decreasing of agricultural lands, decrease in agricultural incomes, and desire for better living opportunities, agricultural employment is decreasing and migration from rural areas to big cities increases day by day. If it is planned and managed in sustainable manner, agriculture and Tourism sectors, have complementary and supportive features. Nowdays, tourist demand trends are changing from the classical mass tourism approach based on the passive sea-sand-sun trilogy to a tourism approach where tourists are more participatory and wish to know and experience foreign cultures and lives. Many different types of tourism are experienced in countryside such as, Rural tourism, Farm tourism, Harvest tourism, Hunting tourism, Plateau tourism, Api tourism, Gastronomy tourism, Nature and Hiking tourism, Viticulture and Wine tourism, Festival tourism, Horse riding, Fishing which are close relationship with agriculture and tourism sectors. Sustainable Tourism makes significant contributions to the development of rural areas and the development and diversification of agricultural sector.

### Relationship between Agriculture and Tourism

Agriculture is one of the oldest and most fundamental sectors of the global economy, while tourism is one of the newest and most rapidly expanding. As agriculture remains an important source of income for many rural people around the world, tourism has become one of the world's largest and fastest-growing industry. The tourism industry has become an important economic development strategy for both industrialized and developing countries. Recent researches show that tourism and agriculture relationships tend to be multifaceted, destination-specific, and highly complex. The potential for creating synergistic partnerships between tourism and agriculture is widely recognized by development planners, policy makers, and academics. However, understanding, planning, and implementing the benefits of this synergy is much more difficult than one might expect. In the face of current challenges such as climate change, pandemics, regional wars, increasing unemployment, rising food prices, and global financial crisis, the linkages between agriculture and tourism could provide the basis for new solutions in many countries. However, there are a number of challenges to increased cooperation between the tourism and agriculture sectors. One of the prerequisites is a better understanding of the

processes of rural reconstruction and agricultural transformation and their relationship with sustainable tourism development (Telfer and Wall, 1996:636; Torres and Momsen 2011:1).

Agricultural tourism is seen as a vital option for promoting and developing social, cultural and economic relations between local people and national and international visitors, balancing the economic decline in rural areas, increasing rural employment opportunities, preventing migration and improving the quality of life (Fischer, 2019: 544). In agricultural tourism interactions and transactions between locals and tourists can take various formats as shown in Table 1.

Table 1: The in-country transaction interface between farmers and tourists

| **Farmers – Tourists Transactions** | | | |
|---|---|---|---|
| Indirect Transactions (no personal contact) | Indirect Transactions (Personal contact between farmers and tourists) | | |
| Food, etc. Deliveries -Directly to tourism industry (e.g. fruit, vegetables, eggs, -Via food processing industry (e.g. diary products, meat, fish, cheese | Events / Markets -Product sales -Service sales music, dances, festivals etc. | Farm / village visits -Product sales -Service sales Catering, sightseeing, workshops, harvest, education and training | Farm / village stays -Product sales -Service sales Accomodation, catering, sightseing, workshops, harvest, education and training |

Source: Fischer (2009:546)

**Agricultural Tourism (Agritourism)**

Agritourism can be defined as a form of tourism in which tourists and visitors plan their trips in rural, in whole or in part, to undertake activities related to agriculture, including enjoying an agricultural setting. UN Tourism defines Rural Tourism as "a type of tourism activity in which the visitor's experience is related to a wide range of products generally linked to nature-based activities, agriculture, rural lifestyle / culture, angling and sightseeing" (UN Tourism, 2024). Agriculture provides the backdrop for three forms of tourism in rural settings: agritourism, agricultural heritage tourism, and community-based tourism (Telfer & Wall, 1996). The lines between these three types of experiences are intertwined and often blurred. Their defining characteristics can be combined into hybrid experiences (Gálvez Nogales, Puntsagdavaa, Casari, & Bennett, 2023:84).

**Table 2: Potential benefits of developing agricultural tourism**

**Economic Benefits**
• Direct income generation and diversification for farmers and local communities
• Opportunity to market agricultural and animal products directly to tourists
• Creation of employment and entrepreneurship opportunities in rural communities
• Reduction of poverty by creating direct and indirect employment in local communities
• Increased local incomes by increasing the number of tourists and the duration of overnight stays
• Contribution to the development of the region by increasing infrastructure and superstructure investments
• Use of increased incomes for the development of the region, encouraging social participation
• Sustainable income increase resulting from diversification of income sources

**Social Benefits**
• Reducing migration to cities and ensuring that young people stay in the region
• Empowering women and young people in rural communities;
• Strengthening rural-urban ties through social and cultural activities
• Improving communication and interaction through events such as youth camps, harvest days and local festivals
• Providing incentives to preserve and revitalize cultural, food and agricultural heritage
• Prioritizing local organic food and protecting and promoting local biodiversity
• Strengthening the community through the active participation of local community members
• Strengthening social capital and team spirit

**Environmental Benefits**
• Protection and improvement of the environment, biodiversity and natural resources that are critical to attracting tourists
• Improved environmental management
• Transition to organic farming methods
• Increased awareness of the environmental functions and responsibilities of farmers
• Relief of pressure on natural resources associated with intensive farming practices through income generation from tourism activities

Source Gálvez Nogales, E., Puntsagdavaa, A., Casari, G. & Bennett, A. (2023:112)

Agricultural and rural tourism activities are not held only farms or villages. There are different types of tourism that are getting more and more popular year by year, new tourism activities and types are added every year,  and are intertwined with the agricultural sector and rural life. Rural tourism encompasses different activities. Rural tourism is a type of tourism activity in which the visitor's experience is associated with a wide range of products, usually linked to nature-based activities such as agriculture, rural lifestyle/culture, ecotourism, hiking, climbing, horse riding, adventure, hunting, angling, and sightseeing. Rural tourism activities take place in natural and rural areas where population density is low, agriculture and forestry dominate, and traditional social structures and lifestyles are maintained (UNWTO Glossary, 2018). Accommodation in agritourism can be provided in sections reserved for guests in a family farm or village house, in separate buildings converted into guesthouses, in tree houses or in a campsite. Among all agritourism activities, the accommodation segment is

expected to grow rapidly. Potential economic, social and environmental benefits of agricultural – rural tourism can be shown as in Table 2.

**Gastronomy and agricultural tourism relationship**

Local gastronomic values are becoming increasingly important in tourists' destination choices. Agricultural and animal products specific to the region, food and beverages produced from these products, and production methods constitute a part of the cultural and social capital of that region. Local food and beverage heritage, "the creation and/or revitalization of cultural identity is an important element that encourages tourism and enriches the tourism experience" (Bircha and Memery 2020:54).

There is increasing evidence that tourists are consciously seeking food experiences. Many tourists travel for reasons such as reconnecting with nature, resilience to globalization, the search for freshness, taste and authenticity, support for local producers, environmental concerns, discovering new tastes. Developing food experiences for tourism has many advantages. It can diversify local economies and contribute to regional attractiveness, thus strengthening all aspects of the economy. It can also sustain the local environment and cultural heritage, strengthen local identities and sense of community. Finally, it can create backward linkages, reduce economic leakage by promoting agriculture and local food production, industry and auxiliary services (UNIDO - United Nations Industrial Development Organization, 2017:9; Bircha and Memery 2020:54).

The relationship between food and tourism forms the basis of creative and cultural industries, the importance of which is only beginning to be understood. At the same time, tourism has become part of the cultural or symbolic economy. Locally authentic food and beverage experiences can be used for destination branding and marketing. Food is often a gateway to local culture. It can bring tourists and locals together in a shared cultural experience. Food and beverage can be linked to local traditions, customs, landscapes and food production systems to provide engaging and authentic experiences for tourists. Food experiences can directly support local cultural development by providing the cultural capital needed to create and sustain cultural production and consumption (UNIDO, 2017:10)

Gastronomy has a particularly important role in the development of tourism services. Local businesses and agriculture can receive a significant share of this income. It has also been suggested that integrating food experiences into sustainable tourism development in rural and outlying areas can help

alleviate poverty. Gastronomy tourism is also important as an economic development strategy, encouraging tourists to spend more and stay longer in the destination (OECD, 2012:9). The ratio of food and beverage expenditures in total tourist expenditures is 25 percent according to the research of the WFTA - World Food and Travel Association (2020), 26.7 percent according to the research of TCMB - Central Bank of the Republic of Türkiye experts (Erkılıç and Şenoğlu, 2019), and around 30 percent according to the figures of the OECD (2012).

Çanakkale is basically an agricultural city. Thanks to its unique geographical location between the Mediterranean and Marmara regions and Anatolia and Thrace, its suitable climate, nature, soil structure, vegetation, and the surrounding Aegean and Marmara seas, it has a wide variety of productive agricultural and animal production opportunities. In addition to the diversity of agricultural and animal production, the population structure consisting of people from different cultures and ethnic origins has revealed rich gastronomic values and food and beverage culture.

In general, Ezine Cheese, Bayramiç Apple, Bayramiç White, Bozcaada Çavuş Grape, Yenice Red Pepper, Geyikli Olive Oil, Bayramiç Tahini Halva, Bayramiç Olive Oil, Lapseki Peach, Biga Cheese Dessert, Biga Rice, Çanakkale Tomato, Işıkeli Chickpea Coffee, Gelibolu Cheese Halva are among the products with geographical indication (Çanakkale Valiliği, 2024; Çanakkale Ticaret Borsası, 2024). Geographically indicated products contribute to the development of agriculture and tourism with the originality, brand value, demand and awareness they add to animal and agricultural products.
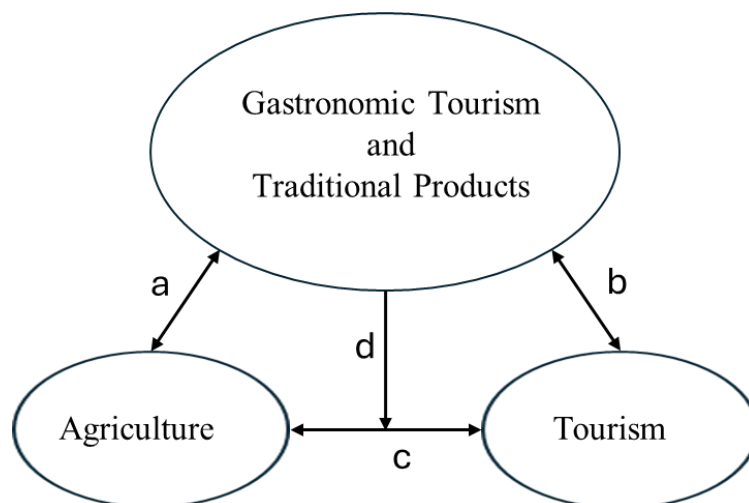


Figure 1: The role of the local gastronomy in the triomial relationship between Agriculture – Gastronomy – Tourism
Source: (Di-Clemente and others, 2020:6)

As can be seen in the figure 1, local gastronomic values play an important role in agriculture-tourism-gastronomy relationship:

a – Local producers and farmers supply traditional and regional products to hotels, restaurants and other food and beverage businesses in the destination.

b – Diversification, tourist image, new products, especially the supply of gastronomic services and products to consumers interested in local culinary cultures

c – Complex intersectoral relationships achieved through business diversification and commercial cooperation.

d – The strengthening effect of gastronomic tourism in cooperation between agriculture and tourism sectors

Gastronomic tourism mediates local producers and service providers in the development of regional identities, increasing environmental awareness and preserving traditional lifestyles. Local gastronomic tourism is a growing phenomenon in the tourism industry, with a special emphasis on experiencing authentic and traditional local foods (Birchae and Memery 2020:53).

**Obstacles to Sustainable Agriculture and Tourism in Çanakkale**

Although Çanakkale, today's agricultural city and tourism destination in the future, is seen to have a competitive advantage in national and international tourism markets, it is faced with some facts that can negatively affect sustainable agriculture and tourism efforts. The most important of these are intensive mineral exploration and extraction activities, the establishment of thermal power plants largely based on imported coal, the promotion of wind power plants above their carrying capacity and their uncontrolled activities, the opening of agricultural and historical regions to construction under the name of ecotourism, water, soil and air pollution (Boz and Özkan, 2024:301).

Table 3: Coal-fired thermal power plants in Çanakkale

| Name of the plant | Location | Power supply | Capacity (MW) |
|---|---|---|---|
| In operation | | | |
| Çanakkale Çan | Çan | Lignite coal (local) | 320 |
| Çanakkale Çan 2 | Çan | Lignite coal (local) | 330 |
| Cenal | Biga | Imported coal | 1.320 |
| Biga | Biga | Imported coal | 405 |
| Biga 2 | Biga | Imported coal | 1.200 |
| Under construction | | | |
| Karaburun TES | Biga | Imported coal | 1.320 |
| Karaburun TES | Lapseki | Imported coal | 1.260 |

Source: TKİK – Türkiye Kömür İşletmeleri Kurumu (2021).

Coal-fired thermal power plants in Çanakkale run mostly imported coal as shown in table 3. According to the study of the TEMA Foundation, mining licenses have been granted for 79 percent of the total acreage of Çanakkale province (Tema Foundation, 2022).
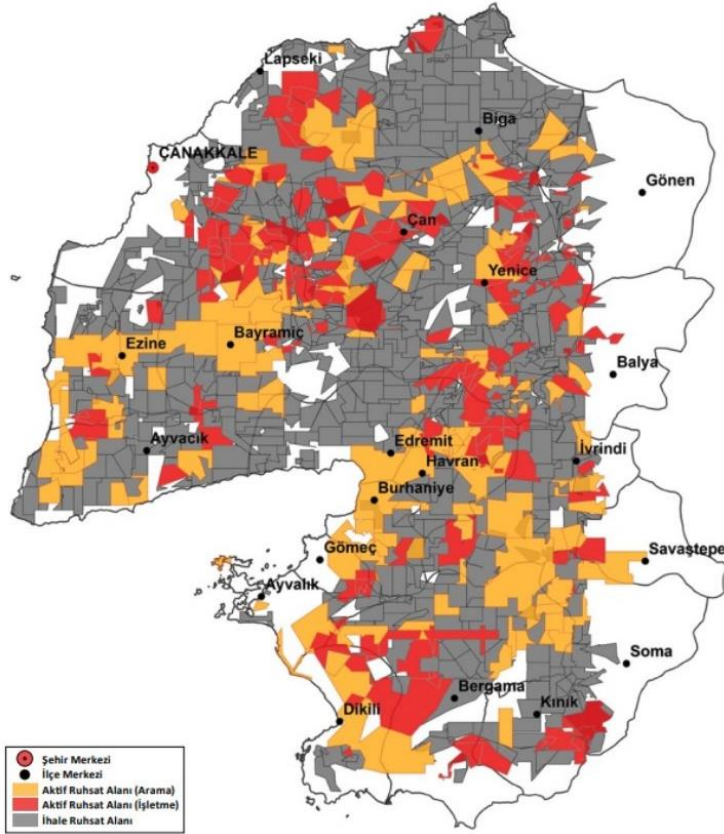
Figure 2: Tender and active (exploration and operation) license areas in the Ida Mountains region
Source: Cumhuriyet (2024).

Hundred thousands of trees are being cut on Ida Mountains for mining activities, and millions are also planned to be cut. (Figure 3)



Figure 3: Tree cutting in Ida Mountains for Mining Activities
Source: Birgün (2024).

Tablo 4. Wind Power Plants in Operation in Çanakkale

| Plant name | District | Power (MWe) |
|---|---|---|
| Saros RES | Gelibolu | 138 MW |
| Üçpınar RES | Lapseki | 99 MW |
| Çamseki RES | Ezine | 63 MW |
| İÇDAŞ Biga RES | Biga | 60 MW |
| İntepe Anemon RES | Merkez | 56 MW |
| Maslaktepe RES | Gelibolu | 52 MW |
| Gazi 9 RES | Bayramiç | 51 MW |
| Hasanoba RES | Merkez | 51 MW |
| Koru Rüzgar Santrali | Lapseki | 50 MW |
| Yeniköy RES | Gelibolu | 48 MW |
| Gülpınar RES | Merkez | 35 MW |
| Gelibolu RES | | 30 MW |
| Çanakkale Rüzgar Santrali | Ezine | 30 MW |
| Sares Rüzgar Santrali | | 28 MW |
| Kocalar RES | Merkez | 26 MW |
| Ayes Yeniköy RES | Gelibolu | 15 MW |
| Burgaz Rüzgar Santrali | Gelibolu | 15 MW |
| Bozcaada RES | Bozcaada | 10 MW |
| Ilgardere RES | Ayvacık | 10 MW |
| Ayvacık Seyit Onbaşı RES | Ayvacık | 9,00 MW |
| Ayvacık Gelibolu RES | Ayvacık | 8,75 MW |
| G RES | Gelibolu | 5,00 MW |
| Çahan RES | Gökçeada | 0,90 MW |
| Gökçe RES | Gökçeada | 0,90 MW |
| Kıvam Gıda Ezine RES | Ezine | 0,50 MW |
| **Total** | **25 WPPs** | **891 MWe** |

**Source:** Enerji Atlası (2023).

Wind power plants are promoted as renewable energy sources. However, the damage that WPPs cause to the environment, living spaces and life is slowly beginning to be understood. As in other regions of Turkey, in Çanakkale, the (WPP) wind power plant turbines with increasing capacities are being installed in pastures, agricultural areas, forests , near to historical and touristic areas, very close to living areas, their negative effects increase (Boz and Özkan, 2024:306). As of 2020, wind power plants in operation, under construction, and those with preliminary license permits in Çanakkale are as shown in Tables 4 and 5.

As can be seen from Table 5, RES construction continues to increase in Çanakkale. The negative effects of these investments, which greatly exceed the carrying capacity, will be noticeable in the coming years. Çanakkale's installed power plant capacity is 4,743 MWe. Approximately 27,412 GWh of electricity is produced annually with 43 power plants in Çanakkale. This production amount is 6.91 times the electricity consumption of Çanakkale.

Tablo 5. Wind Power Plants Under Construction and Under Pre-Licensing in Çanakkale

| Plant name | District | Power (MWe) |
|---|---|---|
| Wind Power Plants Under Construction | | |
| Yeşil RES | Ezine | 3,00 MW |
| Tezyaparlar RES | Çan | 2,00 MW |
| Gelibolu 1 ve 2 Lisanssız RES | Lâpseki | 1,80 MW |
| Nilüfer Belediyesi RES | Lâpseki | 0,90 MW |
| Kumburun RES | Ezine | 0,81 MW |
| BHT Rüzgar Santrali | Lâpseki | 0,80 MW |
| Lapseki Belediyesi Rüzgar Santrali | Lâpseki | 0,50 MW |
| **Total** | **7 WPPs** | **9,81 Mwe2** |
| **Wind Power Plants Under Pre-Licensing** | | |
| Köseler RES | Yenice | 71 MW |
| Ihlamur RES | | 60 MW |
| Ayça RES | Bayramiç | 40 MW |
| Güneyli RES | Lâpseki | 32 MW |
| Selin 4 RES | Bayramiç | 10 MW |
| Yeldeğirmeni RES | Bayramiç | 5,00 MW |
| Keremres RES | Yenice | 3,80 MW |
| **Total** | **7 WPPs** | **222 MWe** |

**Source:** Enerji Atlası (2023).

The issue of ecotourism in Çanakkale remains on the agenda. Ecotourism projects, which are promoted to support rural development, are unfortunately largely used for purposes other than intended (Figure 4). In the last ten years, 252 ecotourism files have passed through the Provincial Assembly, while 48 ecotourism files have been accepted in the last three months. With the 252 ecotourism files accepted, nine million square meters of forest and agricultural land have been opened to construction development. It is known that the number of facilities suitable for the real ecotourism change granted to support rural development is only around 7-8. It is known that all the remaining files are aimed at building luxury villas or creating profits through cheaply purchased lands (Aynalı Pazar, 2024:1).

Figure 4: Construction in agricultural and forest areas under the name of eco-tourism
Source: İşte Çanakkale (2024).

**Conclusion**

It is envisaged that the most realistic and rational method is to follow a sustainable development policy that is based on improving the welfare and living standards of the local people and that protects and develops the cultural values, natural beauties and historical riches of the region (Boz, 2019). It is thought that agriculture and agriculture-based industry, can develop together with the tourism sector in Çanakkale and each one can support the other and create synergy in the sustainable development of Çanakkale.

Çanakkale has unique resources in terms of agriculture and tourism with its natural and historical riches, fertile soils, suitable climate and geographical location. However; the environment is being destroyed to a great extent due to the thermal power plants based on imported coal, wind power plants that are promoted in an uncontrolled manner, the number and capacity of which have increased rapidly in recent years, intensive mineral exploration and extraction activities, and ecotourism incentives used for purposes other than their intended purpose. It can be thought that Çanakkale's underground is rich in gold, silver, copper and zinc. However; it should not be forgotten that Çanakkale's above-ground natural, archaeological, cultural and historical values are also diamonds waiting to be processed.

## References

Aynalı Pazar (2024). Ekoturizm adı altında 9 milyon m2 arazi İmara açıldı. 12 Mayıs 2024. Year 21 No 1086 p.1

Bircha, D., and Memery, J. (2020). Tourists, Local Food and the İntention-Behaviour Gap. Journal of *Hospitality and Tourism Management*, (43), 53–61.

Birgün (2024). Kazdağları'nda binlerce ağaç daha tehlike altında: Maden şirketi 10 kat büyümek istiyor! https://www.birgun.net/haber/kazdaglarinda-binlerce-agac-daha-tehlike-altinda-maden-sirketi-10-kat-buyumek-istiyor-512850 (01.12.2024).

Boz, M. (2019). Turizm Destinasyonunun Rekabet Avantajı Sağlayabilmesinde Doğal ve Tarihi Çevrenin Önemi: Çanakkale Örneği. *Türk Turizm Araştırmaları Dergisi*, 3(2), 146-158.

Boz, M., and Özkan, Ç. (2024). Kültürel Ve Doğal Zenginliklerin Korunması ve Çanakkale Turizmi (Eds.) M. Boz, Ş. Aydın, and D. Eren, *Çanakkale ve Turizm*. Detay Yayıncılık, Ankara.

Cumhuriyet (2024). Ege'nin altına dinamit. https://www.cumhuriyet.com.tr/cevre/egenin-altina-dinamit-2180885 (01.12.2024).

Çanakkale Ticaret Borsası (2024). Gelibolu Peynir Helvası Coğrafi İşaret Aldı. https://www.ctb.org.tr/T%C3%BCmHaberler/tabid/21096/articleType/ArticleView/articleId/65120/ ELIBOLU-PEYNIR-HELVASI-COGRAFI-ISARET-ALDI.aspx (04.12.2024).

Çanakkale Valiliği (2024). Coğrafi İşaret Tescilli Ürünler. Coğrafi İşaret Tescilli Ürünler. http://www.canakkale.gov.tr/cografi-isaret-tescilli-urunler. (04.12.2024).

Di-Clemente,E , Hernández-Mogollón, J. M., and López-Guzmán, T. (2020). Culinary Tourism as An Effective Strategy for a Profitable Cooperation between Agriculture and Tourism Social Sciences. 9, (25). doi:10.3390/socsci9030025

Enerji Atlası (2023). Çanakkale Rüzgar Santralleri https://www.enerjiatlasi.com/ruzgar-enerjisi-haritasi/canakkale (04.11.2024).

Erkılıç, S., and Şenoğlu, D. (2019). How Do Tourists Spend Their Money? https://tcmbblog.org/wps/wcm/connect/blog/en/main+menu/analyses/howtouristsspends#:~:text=Highlights%20of%20the%20breakdown%20of,spending%20item%20(Chart%204) (05.12.2024).

Fischer, C. (2019). Agriculture and Tourism Sector Linkages: Global Relevance and Local Evidence for the Case of South Tyrol. Open Agriculture. (4), 544-553.

Gálvez Nogales, E., Puntsagdavaa, A., Casari, G. & Bennett, A. (2023). Linking Agriculture and Tourism to Strengthen Agrifood Systems in Asia and the Pacific. Bangkok, FAO. https://doi.org/10.4060/cc7124en

İşte Çanakkale (2024). "Ekoturizm Projeleri İmar Rantına Dönüştü". https://www.istecanakkalegazetesi.com/haber/57627-ekoturizm-projeleri-imar-rantina-donustu (03.12.2024).

OECD (The Organisation for Economic Co-operation and Development) (2012). Food and the Tourism Experience: The OECD-Korea Workshop, OECD Studies on Tourism, OECD Publishing. http://dx.doi.org/10.1787/9789264171923-en.

Telfer, D. J. and Wall, G. (1996). Linkages Between Tourism and Food Production . Annals of Tourism Research, Vol. 23, No. 3, pp. 635-653.

Tema Foundation (2022). Türkiye Maden Ruhsatlarının Tehdidi Altında: 24 İlde 20 Bine Yakın Maden Ruhsatı. https://www.tema.org.tr/basin-odasi/basin-bultenleri/turkiye-maden-ruhsatlarinin-tehdidi-altinda (14.10.2024).

Torres, R. M. and Momsen, J. H. (2011). Tourism and Agriculture New Geographies Of Consumption, Production And Rural Restructuring. Edited by R. M. Torres and J. H. Momsen. Routledge. Abingdon, Oxon. ISBN: 978–0–415–58429–6 (hbk) ISBN: 978–0–203–83440–4 (ebk)

TKIK (Türkiye Kömür İşletmeleri Kurumu (2921). Türkiye Kömür İşletmeleri Kurumu 2020 Kömür Sektör Raporu (Linyit). Ankara

UN Tourism (2024). Rural Tourism. https://www.unwto.org/rural-tourism (08.12.2024).

UNIDO (United Nations Industrial Development Organization) (2017). Agro-Food, Tourism and Creative Industries an Integrated Cluster Approach. Inclusive and Sustainable Industrial Development Report.

UNWTO (2008). Glossary of Tourism Terms. https://www.unwto.org/glossary-tourism-terms

WFTA (World Food Travel Association) (2020). The Economic Impact of Food Tourism. https://www.worldfoodtravel.org/news-the-economic-impact-of-food-tourism

# International Balkan Agriculture Congress

# Electronic System For Automated Control of Greenhouse Irrigation

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## Abstract

Agriculture is one of mankind's oldest and most important industries. The climatic challenges we are facing require the development of new concepts for precision and smart agriculture using digital technologies to control and manage its processes. Irrigation is one of the key processes for ensuring sustainably high yields of agricultural produce. Drip irrigation is the most efficient system for delivering water and nutrients directly to the root zone of the plant. Selecting the right amount and the right timing of application ensures that each plant receives the optimum moisture for its development. The development of an automated, self-powered irrigation system based on sensors, microprocessor control, block information and block signalling will provide a solution to facilitate farmers when the presence of a human in the field or greenhouse is not mandatory.

A microprocessor-based system with autonomous power supply has been designed that can be used for automatic greenhouse irrigation. It consists of a controller based on the ATmega328P chip, input primary converters, modules and actuators. The microprocessor generates control signals to the power electronics, which in turn generate pulses to the actuators. The output signals generated by the controller are based on the input data received from the system sensors. The multiple input sensors and the feedback from some actuators enable the system to obtain accurate and precise information, reliability and certainty of the processed results, thus achieving quality control and management of the set process.

**Keywords:** Microprocessor-based electronic system, automatic control, greenhouse irrigation

## Introduction

Setting up an automatic drip irrigation control system in a greenhouse requires the provision of a reliable water source and a tank in which to store the water required for the process. This requires the use of a hydrophore pump that will be switched on and off when necessary to maintain an optimum water volume in the tank. It is envisaged that the temperature of the water will be heated to optimize the temperature performance at different process standards of the task. The system will use sensors to monitor the water level in the tank, sensors to measure the irrigation water temperature and sensors to measure the soil moisture. The control processor will control the tank fill pump, the tank emptying valve, and the tank water heater. A unit for visualization of process parameters and measurement results, as well as an alarm unit in the event of an undesired event or emergency are provided. The system shall have an autonomous power supply to ensure the energy needs of the individual units and elements as well as the reliable operation of the control unit itself.

**Materials and Methods**

For the needs of the designed system, it is necessary to select a tank with a suitable capacity, a hydrophore pump with a certain power and flow rate, a heater for heating the water for irrigation and the type of autonomous power supply. From the analyses carried out, a 1 000 liter tank, a 900 W pump, a 2 kW water tank heater and an autonomous power supply based on RES with photovoltaic panels were selected for the drip irrigation needs. From the calculations, a power supply of about 4kW is needed. A 5 kW diesel generator is proposed for back-up power supply.

The structural diagram of the electronic system is shown on Figure 1. It consists of main control unit based on Arduino Uno microprocessor system, three measuring units for water level, soil moisture and temperature of irrigation water and three actuators for tank filling pump, tank water heater and tank emptying valve. The system is equipped with alarm and information blocks together with autonomous power supply
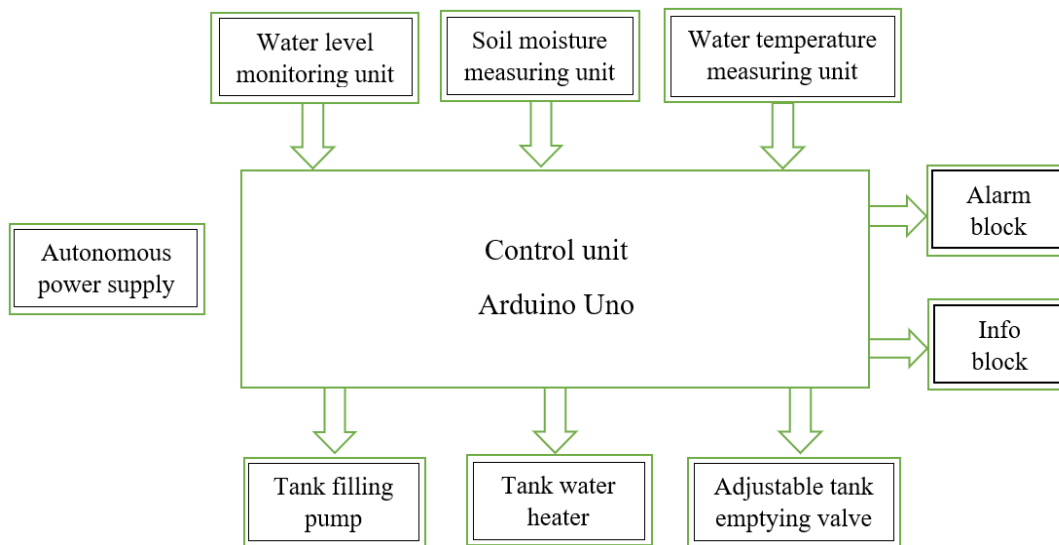


Figure 1. Structural diagram of the electronic system for automated control

The parameter levels to be monitored are set by the process specification for the selected irrigation process. The monitored process parameters are displayed on the indication in the informational block. Critical levels are set for the most important parameters to monitor: soil moisture, water level and temperature in the tank. Reaching them activates the inclusion of alarm signals (light and sound) in the alarm unit.

**Results and Discussion**

An algorithm for working of the system for automated control of greenhouse irrigation based on the proposed structure diagram is shown on Figure 2.
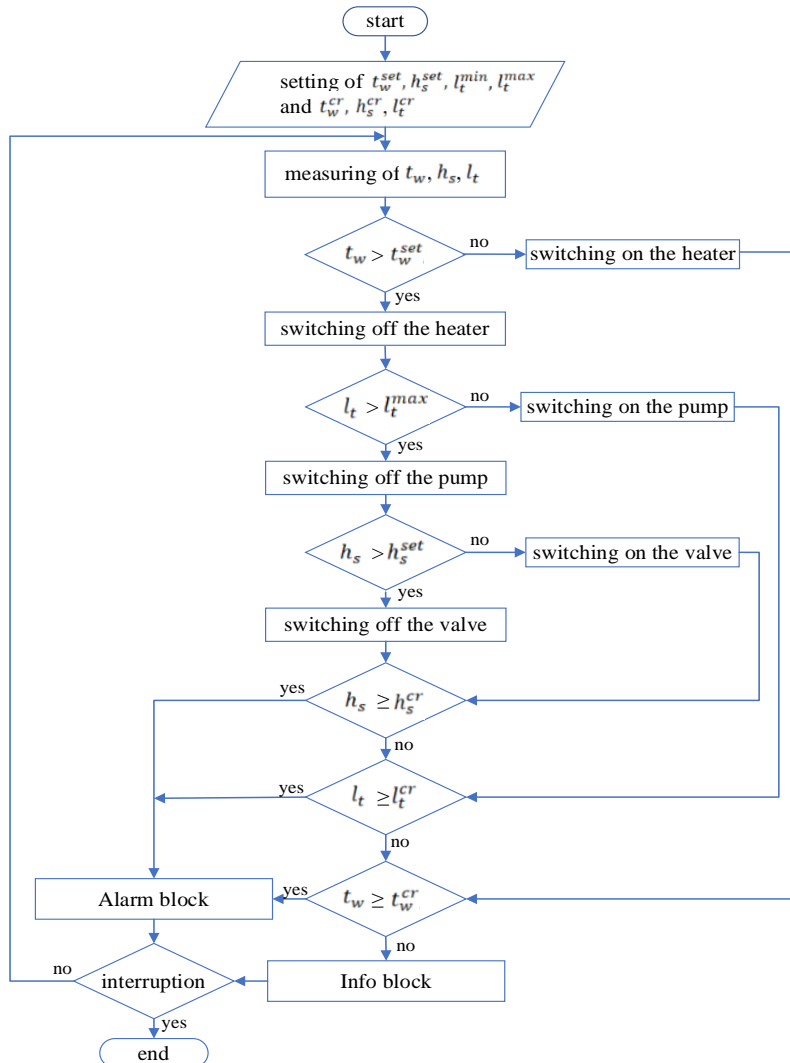


Figure 2. Algorithm for working of the electronic system for automated control of greenhouse irrigation

The process begins with setting the nominal values of the monitored process parameters and their critical values. Measuring their current values, the program controls switching on and off the corresponding actuators and displays the appropriate informational data. When a critical mode is presented, the corresponding alarm is activated (sound or light). The program works in a cyclic mode until an occurrence of interruption breaks the process.

The designed principle electrical circuit of the control unit is shown as a schematic diagram on Figure 3.
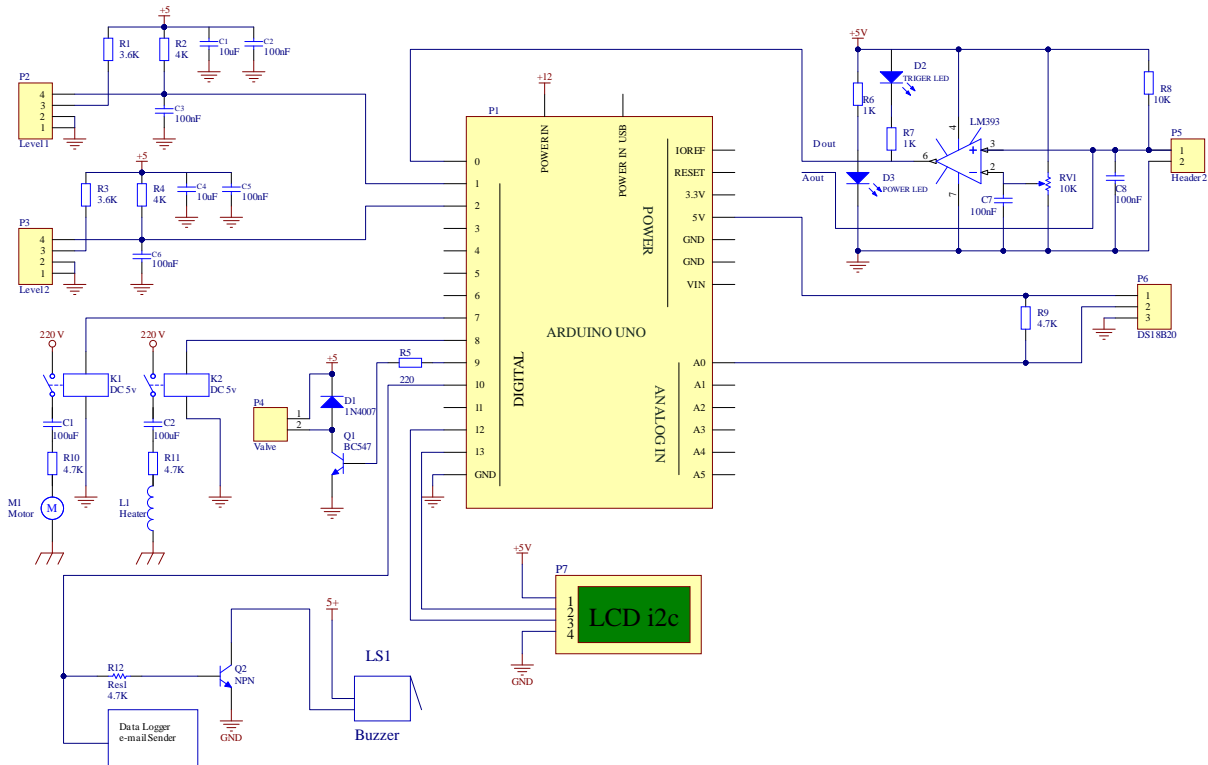
Figure 3. Schematic diagram of the electronic system for automated control

To monitor the water levels a signal is fed from probe 1 (plug P2) to digital input D1 of microprocessor P1 for measuring water level 1 and from probe 2 (plug P3) to D2 for measuring water level 2. Two FS IR02 liquid level sensors are used. The water temperature monitoring unit DS18B20 is fed to analogue input A0 and a signal is fed to D3 to obtain soil moisture information (plug P5) by the digital output of FC-28 module. D9 signals an electromagnetic valve (plug P4) to empty the soil irrigation water from the tank. D8 signals an electromagnetic relay K2, which controls the heater, that will heat the water in the tank. D7 signals an electromagnetic relay K1, which controls the pump, that fills the tank with water.

**Conclusion**

In this study is presented the design and development of an electronic system for automated control of greenhouse irrigation.

The structural diagram, algorithm of the electronic module and the circuit diagram of the control unit are presented and explained.

The use of such a system eliminates the risk of over-watering or soil dryness, ensuring better yields and better quality production.

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The system is designed to work in hard-to-reach areas and can be developed with readily available items on the market.

**References**

Gamal, Yomna & Soltan, Ahmed & Said, Lobna & Madian, Hazem & Radwan, Ahmed. (2023). Smart Irrigation Systems: Overview. IEEE Access. PP. 1-1. 10.1109/ACCESS.2023.3251655.

Malbog, Mon Arjay & Susa, Julie & S. Alon D.Eng, Alvin & Casuat, Cherry & Nicolas-Mindoro, Jennalyn. (2020). A Fuzzy Rule-Based Approach for Automatic Irrigation System through Controlled Soil Moisture Measurement. International Journal of Advanced Trends in Computer Science and Engineering. 9. 2332-2337. 10.30534/ijatcse/2020/216922020.

Norris, Donald. (2015). The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi, and BeagleBone Black. 1st ed. New York: McGraw-Hill Education. https://www.accessengineeringlibrary.com/content/book/9780071835206

Nwazor, Nkolika & Odiushovwi, Peter & Onalaja, Lukman. (2019). Design of an Automatic Irrigation System. European Journal of Engineering and Technology Research. 4. 97-99. 10.24018/ejeng.2019.4.3.1190.

Щерева Красимира. (2016). Микроелектроника, Академично издателство „Русенски университет", ISBN 978-954-712-700-5

https://domoticzfaq.ru/samyy-malen-kiy-displey-dlya-arduino/

https://erelement.com/arduino-uno

https://www.electronicshub.org/interfacing-soil-moisture-sensor-with-arduino/

https://www.uio.no/studier/emner/matnat/ifi/IN1060/v21/arduino/arduino-projects-book.pdf

**Abstracts**

# The Effects of Limited Irrigation Applicatıons and Training Systems on Plant Development of Pitaya

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## Abstract

Knowledge of crop phenology, particularly for important commodity crops, is vital to ensure stable food systems. Crop phenology is largely affected by temperature, which is a key factor for the timing of biological processes and the development of plants. Thus, monitoring climatic conditions of crop growth allows better understanding of crop development and proper adjustment of management practices during the growth stages. In the present study, growth of durum wheat (*Triticum durum*) was monitored in the province of northern Evros from November 2020 until July 2021 using meteorological data that were collected from the local station of the National Observatory of Athens, Greece. In addition, all stages of the biological cycle (from germination to ripening) were photographed with a Nikon D3500 digital camera. Based on the meteorological data collected, the growing degree-days (GDDs) for each growth stage were calculated, firstly, with the average method as the most common method of calculation and, secondly, with the modified average method. Additionally, four different upper and lower value approaches were applied to each method, resulting in eight scenarios. The growing season lasted 222 calendar days. The vegetative stage (germination to tillering) accumulated the highest values of GDDs. The analysis with the two different ways of calculating the total GDDs where the same limits were used led to the conclusion that the modified average method tended to accumulate higher values of GDDs than the average method. The accumulation of GDDs was correlated with the growth stage of wheat plants according to Zadok's scale.

**Keywords:** Pitaya, limited irrigation, training systems, plant development

# The Effects of Different Priming Techniques with Seaweed Extract on Seedling Quality and Performance of Lettuce

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## Abstract

Climate change is causing significant changes and challenges in the global economy, particularly in the agricultural sector. Horticultural production is highly sensitive to climate change, with rising temperatures, erratic rainfall and extreme weather events reducing productivity and negatively affecting product quality. The main consequences of this situation are reduced production and yields, fluctuations in product prices and economic losses. To mitigate these adverse effects and support sustainable agricultural practices, the adoption of new production techniques and modern biotechnology methods is crucial. These techniques include the development of climate-resilient crop varieties, greenhouse and controlled environment agriculture, drip irrigation and water-saving techniques, digital agriculture and precision farming technologies. Climate-resilient crop varieties offer significant benefits to growers because they are more resilient to extreme conditions. Greenhouse and controlled environment agriculture optimises growing conditions, increasing productivity and reducing seasonal dependency. Drip irrigation systems use water more efficiently, while digital and precision farming techniques optimise production processes. Modern biotechnology is revolutionising agriculture. Genetic engineering, particularly CRISPR-Cas9 technology, is enabling the development of climate-resilient and high-yielding crop varieties. Tissue culture facilitates the propagation of disease-free and genetically homogeneous plants, while biofertilisation techniques enhance nutrient uptake and resilience to stress. Precision genomic selection allows the identification of more efficient and resilient plant varieties. This study uniquely highlights innovative production techniques and biotechnological methods that can mitigate the economic challenges of climate change in agriculture. It synthesises existing literature to identify effective strategies for enhancing sustainability and resilience, and discusses how to support sustainable agricultural practices and reduce economic losses for producers.

**Keywords:** *Ascophyllum nodosum*, *lactuca sativa* l. var. crispa, *lactuca sativa* l. var. longifolia, mean germination time normal germination rate

# Biotechnology-Supported Vegetable Breeding

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## Abstract

The primary objective of breeding studies is to develop new varieties that can adapt to changing and challenging global conditions and meet the demands of consumers and producers in Turkey and around the world. Despite the use of classical breeding methods in the development of new varieties to enhance crucial agronomic traits in numerous species, the outputs yielded by classical breeding methods alone are inadequate to meet the escalating demand for solutions to challenges such as rising food demand, constraints in soil and water resources, and the impact of diseases and pests. These limitations are primarily attributed to the prolonged and labor-intensive nature of the process, as well as economic considerations. The most significant addition to traditional breeding methods in recent years has been the incorporation of biotechnological techniques. The biotechnological methods employed primarily encompass plant tissue cultures, molecular applications, and gene editing technologies. The application of biotechnological methods in the production of hybrid varieties has the potential to surpass local varieties in terms of yield, quality, standardization, and resistance to stress conditions. The integration of these methods has the additional benefit of reducing the time and labor required for production, while also facilitating the achievement of more reliable results in a shorter time frame. This study will examine the applications of plant tissue cultures and molecular marker-based selection biotechnological methods in the breeding of resistant varieties in different vegetable species, including tomato, pepper, eggplant, and watermelon, at the United Genetics Turkey Seed Company, a leading seed and seedling producer in Turkey.

**Keywords:** Breeding, biotechnology, plant tissue culture, molecular markers

# Determination of the Effects of Cover Crops Application on Some Soil Properties and Yield, Phenological and Pomological Characteristics on Sweet Cherry Orchards

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## Abstract

Cover crops applications, something weeds, hosting beneficial insect populations, increasing the amount of organic matter in the soil, deactivating the use of herbicides, soil pH regulation, increasing capillary root activities in fruit trees, utilising of micronutrients at a higher level, maintaining soil moisture and reducing soil temperature are among the most important effects.Cover crop applications, also known as vivid mulch, have positive effects on yield and quality, especially in orchards of perennial fruit species. This study, conducted in 2024, was carried out to determine the effects of cover crop application on some soil properties, yield, phenological traits and pomological traits of sweet cherry trees. A seed mixture of cover crop seeds belonging to 9 different species was sown in the row spacing consisting of 2 different rootstocks and 3 varieties determined in the trial plot in Anadolu Etap Tahirova commercial orchards in Gönen District of Balıkesir Province and following the germination of the seeds, examinations were carried out to determine the phenological development performance under orchard conditions, counts were made to determine fruit yield, fruit samples were taken and pomological analyzes were carried out. According to the results of the study; fruit weight, fruit length, fruit width, fruit firmness, fruit index, cherry pit weight, cherry pit width, cherry pit length, fruit flesh ratio, fruit fruit stem length, fruit stem thickness, fruit peel color, total soluble solid content, fruit yield per tree, soil temperature values were determined to be statistically different in the trees where cover crop applications were applied to the control group. It was observed that especially the cover crop application had a certain effect on fruit weight and fruit yield parameters to the control group.Trees in the area where cover crops were applied had 15.6% higher fruit yield. Whereas the average fruit weight was 9.86 g in the control plot, the average fruit weight was 11.40 g in the area where the cover crop was applied.It was concluded that cover crop application had positive effects on physical and phenological traits of fruits in cherries.

**Keywords:** Prunus avium, quality, maxma 14, adara, soil temperature

# Integrated Pest Management (IPM) in Vineyards in Canakkale

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## Abstract

IPM studies which aim to keep pesticide use in minimum level, to highlight environment friendly practice and human health were firstly conducted in 1970s in Turkey parallel to the world. A lot of research proposals and activities were implemented for increasing environment friendly practices. Technical information and support were presented for awareness of farmers. The first and the most considerable principle of Integrated Pest Management (IPM) in vineyards is to use the best available practices, especially scouting, to prevent pests from reaching established damage thresholds. Another principle of IPM is to monitor of pests and information about the biology of pests to design pest resistant cropping systems. Best practices are defined by criteria that include effectiveness, cost, convenience and risk to human health and the environment. Viticulture is one of the important agricultural activities in Canakkale. Integrated pest management (IPM) in vineyards was begun in Canakkale in 2010. This has led to the use of forecasting systems according to grape moth (i (*Lobesia botrana* (Den. & Schiff, 1775) (Lepidoptera; Tortricidae)')  and downy mildew (*Plasmopara viticola*) of the main harmful organisms of the grapevines of the Canakkale. It was carried out in 447 decares of land in the Central, Bozcaada, Gokceada, Bayramic and Eceabat districts by 30 producers (in 64 vineyards).

**Keywords:** Grapevine, integrate, disease, pest

# Investigation of Insecticidal Activity of Different Microbial Fertilisers on Diamondback Moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) Under Laboratory Conditions

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## Abstract

The diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) is one of the most destructive plant pests of the Brassicaceae family in worldwide. Frequently used synthetic insecticides leads to the development of resistant populations of the diamondback moth to various insecticides, with adverse effects on humans and the environment. Microbial fertilisers contain beneficial microorganisms that promote plant growth and increase soil fertility. Some microbial fertilisers may contain entomopathogenic fungi, bacteria or viruses that have a direct lethal effect on insects. The aim of the study was to determine the inseksitidal effect of GBF-41 (*Bacillus mojavensis*) and RC-72 (*Bacillius subtilis*) microbial fertilisers on different larval developmental stages and pupal weights of diamondback moth. Diamondback moth larvae reared as colonies on natural hosts in the laboratory were used in this study. Microbial bacteria solutions were incubated at 28°C at 150 rpm for 3 hours. Blotting papers were placed on the bottom of a 9 cm petri dish then 3x5 cm discs were cut from broccoli leaves then 100 µl of microbial fertiliser was transferred by a micropipette and distrubuted on the leaf with no gap. The larvae having I, II, III and IV instars were starved for 3 hours then 20 larvae were transferred to each petri dish. Treatments were carried out as each petri dish as a replication having 3 replication. Distilled water was used as control. Trials were checked daily and immobilised larvae were recorded as dead. The data obtained were analysed by LSD test using SAS software. Survival curves were generated by Kaplan Meier test using SigmaPlot statistical software. The difference between microbial bacteria solutions was compared by Long-Rank test. There was no statistical difference between the mortality of I, II and III. instars. Larval mortality in IV. instar was $13.33\pm1.15$ and $6.00\pm1.00$ in RC-72 and GBF-41 microbial fertilisers, respectively. Pupal weights were recorded as $2.61\pm1.98$ mg, $5.68\pm0.51$ mg and $6.20\pm0.65$ mg in RC-72, GBF-41 and control, respectively. The difference between the survival rates of IV. instars in RC-72 and GBF-41 microbial fertilisers was significant (Log-Rank test; Chi-square= 6.949; df=1, P<0.01). In conclusion, tested microbial agents used as an alternative to the sustainable and environmentally friendly control of diamondback moth could be an effective method on larval mortality, pupal weights and survival rates of the pest.

**Keywords:** *Plutella xylostella*, diamondback moth, microbial fertiliser, lethal effect, larval mortality

# Evaluation of Potent Essential Oils and Their Major Components for Their Antifungal Properties in Vitro

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## Abstract

Essential oils (EOs) are natural hydrophobic compounds, which are highly complex, typically comprising 20 to 60 constituents, with two or three main components making up 20% to 95% of their composition, alongside other minor constituents. Research has firmly established the potent antifungal properties of EOs and their primary components. To assess their efficacy, one EO, Nutmeg oil, and seven main components, including safrole, toscanol, safraleine, cinnamaldehyde, carvacrol, carvone, and thymol, were tested against four economically significant fungal pathogens (*Alternaria solani, Fusarium graminearum, Rhizoctonia solani,* and *Sclerotiorum sclerotiorum*), one oomycete pathogen (Phytium ultimum). In vitro studies were conducted to evaluate the inhibitory effects of these selected EOs and major components on fungal growth, determine the Minimum Inhibition Concentration (MIC), Minimum Fungicidal Concentration (MFC) of the compounds, and investigate their impact on spore production and germination of F. graminearum. Among the tested components, carvacrol, carvone, cinnamaldehyde, safraleine, and thymol exhibited significant growth inhibition of the pathogens. The in vitro screening revealed varying efficacy of the main EO components against fungal pathogens, depending on the tested components, their concentrations, and the testing pathogens. Cinnamaldehyde, carvacrol, and thymol demonstrated the strongest growth inhibition against both fungal pathogens and oomycete, with MIC, MFC, concentrations ranging from 0.25 mg/mL to 5 mg/mL. These components also inhibited spore production and germination at relatively low concentrations. Carvacrol and thymol were found to be the most effective in inhibiting sporulation, while cinnamaldehyde was the most potent in suppressing spore germination. The testing of major EO components in vitro establishes a foundation for discovering novel alternative biocides for controlling fungal diseases.

**Keywords:** Essential oils, major components, fungal pathogens, MIC, MFC

# Effect of Infrared Radiation Load on Energy Parameters in Persimmon Drying

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## Abstract

Persimmon is an increasingly popular fruit that is slowly spreading worldwide due to its high productivity, rich nutritional content and commercial quality. Considering the limited availability of fresh fruits and vegetables throughout the year, different methods are utilised to ensure continuous consumption throughout the year. Drying is an intensive energy use process, one of the most preferred preservation methods. Studies show that approximately 12% of the total energy in food processing industries is consumed in the drying process and drying can reach 60-70% of the total cost. If the necessary conditions are not met in different drying methods, high energy consumption and increased production costs occur. For this reason; different methods should be used in order to reduce the negative effects of electricity and fossil fuels, which are the energy consumption sources of dryers. In this direction, infrared drying technology is an ideal energy source with many advantages such as shorter drying time, lower energy consumption, better thermal efficiency, heat transfer feature, direct penetration into the product and low operating cost. For this purpose, the effect of the infrared drying method on drying kinetics (DT and Deff) and energy consumption direction (SMER, MER and SEC) in drying persimmon was investigated in this study. Experiments were carried out at infrared medium wavelength, three different infrared radiation intensities (IP) (1037, 1210 and 1407 W m-2) and three different air velocities (Av) (1.0, 1.5 and 2.0 m s-1). The results showed that drying time (DT) 93-162 min, specific energy consumption (SEC) 8.95-15.72 Mj/kg, specific moisture removal rate (SMER) 0.064-0.112 kg/Mj, moisture removal rate (MER) 0.98-2.09 kg/h.m2 and effective diffusion coefficient (Deff) 3.85 10-8- 8.15 10-8 m2/s. At constant IP values, drying times and specific energy consumption values increased with increasing air velocity. On the other hand, SMER, MER and Deff values decreased. Negative and positive correlations between the properties were analysed. Strong negative correlations were determined between Deff -DT and SMER-SEC with r:-0.97 and -0.98, respectively. Strong negative correlations were determined between MER-SMER and SEC-DT with r:0.93 and 0.89, respectively. When all parameters were considered, it was determined that the recommended drying condition, i.e. the optimum point, for drying persimmon with infrared energy was 1407 W m-2 IP' and 1 m/s.

**Keywords:** Persimmon, infrared drying, energy consumption

# The Effect of Strip Tillage Method Applied in Cotton Cultivation in Ceyhan Plain on Yield

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## Abstract

Considering the food security of the increasing world population, it is extremely important to create sustainable agricultural production systems that will reduce greenhouse gas emissions, are resistant to and sensitive to climate change, prevent erosion, and protect the soil. In the strip tillage method, which is one of the conservation tillage methods, 30%-40% of the field surface is allowed to be tilled in a strip form before planting for seed bed preparation. The soil between seed planting rows are left no-tilled, covered with stubble. The research was carried out in a trial field in the Ceyhan Plain of the Çukurova Region between 2023-2024. In the research, the conventional tillage method (CT) and the strip tillage (ST) methods were compared in terms of cotton yield. Field trials were arranged with 4 replicates. The cotton variety used in the research was Ceyhan 520 and its thousand-grain weight was 105 g. As a result of the research, with an average yield of 427,5 kg/da, higher cotton yield was obtained than conventional soil tillage, and the strip tillage yield were an average of 417,5 kg/da. When the conventional tillage and strip tillage methods were compared, no statistically significant difference was found in terms of the cotton yield ($P<0.05$). Therefore, since the yield results of the two methods are close to each other, it is recommended to prefer the strip tillage method, which is a conservation and sustainable method, as an alternative to conventional tillage.

**Keywords:** Strip tillage, conservation tillage, sustainable agriculture, cotton

# Web-Based Environmental Monitoring System Design and Dust Concentration Modeling for Dairy Barns

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## Abstract

The majority of dairy cattle operations in Türkiye (approximately 99%) are small family enterprises. In almost all of these businesses, air conditioning systems are either inadequate or not used at all. This is largely due to the fact that farmers have insufficient information about the environmental demands of animals and their inadequate economic situation. Temperature and humidity are often the first environmental conditions that come to mind. However, another parameter that needs to be taken into consideration for the health of the animals in the barn and the workers inside, but is generally not taken into account, is the indoor dust concentration. This study focuses on the development and testing of a low-cost, easy-to-use prototype device for monitoring dust concentrations, temperature, and humidity in dairy cattle barns. The prototype integrates Arduino technology with temperature/humidity and dust sensors, facilitating real-time data transmission to a web-based system via a GSM module. The device was evaluated in a typical small-scale dairy operation in Türkiye, with testing confirming its ability to effectively monitor environmental conditions and calculate the Temperature Humidity Index (THI). Utilizing multiple regression and artificial neural network algorithms, the study analyzed the relationship between dust concentrations and environmental factors, revealing significant correlations. The findings suggest that both analytical approaches are effective for predicting dust levels based on temperature and humidity. The prototype represents a cost-effective solution for improving livestock environment management in small family farms, enhancing both animal welfare and productivity.

**Keywords:** Dust monitoring, dairy cattle, arduino, temperature humidity index

# International Balkan Agriculture Congress

# From Vineyards to Global Markets: The Evolution and Trends, Opportunities and Threats of Grape and Wine Industries in Portugal and Türkiye

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## Abstract

The global grape and wine industry is a vital agricultural sector encompassing various applications such as table grapes, raisins, juice, and wine production. This paper addresses a gap in the literature by providing a comparative analysis of the evolution, trends, opportunities, and threats within the grape and wine industries of Portugal and Turkey, two countries with rich viticultural histories and cultural ties but with distinct market dynamics and strategic approaches to grape utilization. Portugal is renowned for its wine production, relying heavily on exports and stable domestic consumption, positioning it as a key player in the global wine industry. In contrast, Turkiye, with its deep historical ties to viticulture, exhibits a more diverse use of grapes, including significant production of table grapes and raisins, alongside a smaller but growing segment for wine production. To ensure a robust comparative analysis, the study uses data from the Food and Agriculture Organization (FAO), the International Organisation of Vine and Wine (OIV), and national statistical agencies and sectorial bodies, to examine the evolution and current trends in Portuguese and Turkish markets and their position in the global market. Key metrics analyzed include vineyard area, grape production, wine production, trade flows (imports and exports), and per capita consumption. The findings highlight the distinct market trajectories: Portugal continues to consolidate its position as a major wine producer and exporter with established global markets, while Turkey's market remains fragmented, with potential growth in both wine and non-wine segments, including domestic consumption and international trade, despite facing significant regulatory and socio-political challenges. The strategic analysis identifies opportunities such as Portugal's capacity to further enhance its wine export strategies and Turkey's potential to expand both domestic consumption and export potential across various grape products. However, it also highlights threats, including increasing global competition and regulatory challenges in Portugal, alongside socio-political and regulatory barriers that could impede Turkey's wine sector growth. This paper contributes to the existing literature by providing a nuanced understanding of the global grape and wine market's evolution, highlighting the distinct paths taken by Portugal and Turkey, and provides strategic insights into their market positioning within those industries. The findings offer valuable implications for producers, marketers, and policymakers, emphasizing how these countries can leverage their unique strengths in grape production and address challenges to achieve sustainable growth in both wine and other grape-related in rapidly evolving global markets.

**Keywords:** Grapes and wine production, international trade, table grapes and wine consuption, comparative market analysis

# Strategic Analysis of Olive and Olive Oil Markets Dynamics: Comparation of Evolution and Trends in Portugal and Türkiye and Their Position in Global Context

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## Abstract

The olive and olive oil industry plays a significant role in global agriculture and food markets, experiencing significant transformations driven by changes in production, consumption, and trade dynamics. However, comparative studies that focus on key players like Portugal and Turkiye- countries with distinct production and consumption patterns, remain sparse. This study addresses this gap making a comprehensive analysis of olive and olive oil markets in Portugal and Turkiye, examining evolution, consumption habits, production, trade flows, opportunities, and threats, while situating these findings within a global context.Utilizing data from the Food and Agriculture Organization, the International Olive Council, and national statistics, this research employs descriptive statistics and trend analysis to compare the olive and olive markets structures and dynamics both between the two countries and in comparison to global trends, using key metrics such as production quantity, import and export values, consumption per capita, and the significance of Protected Geographical Indication (PGI) and Protected Designation of Origin (PDO) regions. This analysis allowed to identify opportunities and threats in each market.The results reveal that the global olive and olive oil markets have undergone substantial shifts, shaped by varying production methods, climate changes, consumer preferences, and international trade / economic policies and markets regulation. Additionally, the analysis reveals that while both countries have seen growth in the olive and olive oil sectors, their market dynamics differ significantly: Portugal's market is characterized by its focus on high-quality olive oil production and strong export orientation, whereas Turkey is a dominant producer of both table olives and olive oil, with a market driven largely by domestic consumption but with increasing export ambitions.The study also identifies key opportunities, such as the potential for market regional differentiation and strategic adaptation to global trends, as well as threats, including climate change vulnerability and market volatility.In conclusion, these findings contribute to identify key trends, assess market performance, and explore potential future scenarios to understand the dynamics of the olive and olive oil market, which is crucial for policymakers, producers, and consumers. This knowledge brings valuable insights into the evolving dynamics of the olive and olive oil markets in Portugal and Turkey, offering strategic recommendations for stakeholders to capitalize on opportunities and mitigate potential risks. Furthermore, the research underscores the need for future studies to examine factors such as climate change, consumer preferences, and technological advancements to support sustainable development and enhance market competitiveness.

**Keywords:** Comparative market analysis, world olive and olive oil market, Portuguese and Turkish olive and olive oil industry, pgi and pdo regions

# Relationship Between Agriculture and Tourism in Sustainable Development: Çanakkale Case

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## Abstract

The agriculture and tourism sectors have complementary and supportive features. Nowadays, tourist demands are changing from the classical mass tourism approach based on the passive sea-sand-sun trilogy to a tourism approach where tourists are more participatory and wish to experience foreign cultures and lives. People, who live and work in metropolises and cities, desire to get away from their routines and experience different activities and environments. More and more tourists have started to prefer tourism types such as rural tourism, farm tourism, harvest tourism, hunting tourism, plateau tourism, api tourism, gastronomy tourism, nature and hiking tourism, viticulture and wine tourism, and festival tourism, which are intertwined with the agricultural sector and rural life. Sustainable tourism makes significant contributions to the development of rural areas and diversification of the agricultural sector. With the development of tourism activities in rural areas, the demand for agricultural and animal products increases, and business and employment opportunities related to tourism are provided. Tourism activities in rural areas not only increase income but also create new business and employment opportunities, thereby preventing migration to cities and even encouraging reverse migration. Canakkale has many values that combine agriculture and tourism with its unique geographical location between the Aegean and Marmara regions, climate, nature, soil structure, vegetation, and sea. Canakkale is also extremely rich in terms of animal and agricultural products, and dishes for gastronomy tourism, which is gaining importance day by day. Canakkale has many animal and agricultural products, which have geographical indications. These products contribute to the development of agriculture and tourism with their originality, brand value, demand, and recognition. However; the increasing number and capacity of mining activities, thermal power plants, and wind power plants in Canakkale, have negative impacts on sustainable development of agriculture and tourism. Similarly, misuse of eco-tourism incentives damages agricultural areas and causes the local population to abandon agriculture and migrate to cities. This conceptual study is based on literature and observations made within the scope of different projects. In the first part of the study, the relationship between rural areas, agriculture, and tourism is examined. In the second part, the role of agricultural and animal products in the development of Canakkale tourism is emphasized. In the third part, the threats faced by the agricultural and tourism sectors in Canakkale are examined. In the last part, some suggestions are tried to be developed for sustainable agriculture and tourism development.

**Keywords:** Agriculture and tourism, Çanakkale agriculture, Çanakkale tourism, rural development, sustainable development

# Spatial and Economic Analysis of Agricultural Land Changes using NASA-Black Marble and Sentinel Data in Türkiye

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## Abstract

Identification of agricultural areas using night light imagery has gained great importance in recent years. In addition to optical imagery, night light imagery from satellites also helps us to identify changes in Land Use and Land Cover (LULC). In this study, in order to monitor agricultural land changes and to investigate the feasibility of a fast and cost-effective alternative, night light data from NASA's Black Marble satellite were used to determine the changes in different periods. Konya, Antalya, İzmir, Şanlıurfa, and Mersin provinces in Türkiye, which contribute the most to the Gross Domestic Product (GDP) in agriculture, forestry, and fisheries sectors, were determined as the study area. The spatial changes of agricultural lands are analyzed seasonally and annually for the time period from 2016 to 2022. In addition, for the same periods, the relationship between changes in night lights and GDP and changes in LULC were revealed. Konya province has grown by 211773,46 ha of rural residence + agricultural land in the period from 2016 to 2022. Within the same dates and same LULC areas, there was an increase in night lights by 52% ($0,086669$ nW•cm$^{-2}$•sr$^{-1}$). A regression analysis was performed between night lights affecting rural residence + agricultural areas and GDP with R$^2$ of 0,88. For future studies, the importance of wider use of Black Marble data in agricultural and economic planning is emphasized, and it is suggested that these data can be an important tool to better analyze the long-term effects of agricultural policies.

**Keywords:** Agriculture, LULC, nighttime light

# Determination of Sustainable Photovoltaic (Pv) Energy Plant Areas Using Analytical Hierarchical Process (Ahp): The Case of Ezine/Ayvacik District

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## Abstract

The growing population and economic developments have significantly increased the demand for energy. The limited availability and harmful effects of fossil fuels have incereased interest in renewable energy sources. Among these sources, solar energy systems (SES) are considered one of the most efficient methods for producing without emitting carbon dioxide. The use of SES for agricultural purposes has become widespread in recent years.This study aimed to assess the potential use of SES for supplying energy required for processes such as extracting and transporting groundwater in agricultural areas. The research was carried out in Ezine and Ayvacık districts of the Çanakkale province, Türkiye. Suitable areas for the installation of SES photovoltaic panels (FP) were identified using Geographic Information Systems (GIS) based on an Analytical Hierarchical Process (AHP).In addition to geographical features, United Nations International Standards Organization (UN-ISO) and UN Sustainability criterian were taken into consideration to  determine  suitable locations, whereby suitable areas for FP installation in Ayvacık and Ezine districts were mapped based on the selected criteria, 700 hectares of suitable areas for FP installation in the Ayvacık and Ezine districts were mapped, taking restricted areas into consideration. The accuracy and feasibility of the analysis results were evaluated in the GIS environment by comparing them with the panels previously installed in the region.

**Keywords:** Analytical hierarchical process, renewable energy, solar panel

# Analyses of Land Use-Land Cover Changes and Land Price Around Refugee Camps

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## Abstract

Refugee camps in host countries are observed to bring about significant environmental and socioeconomic changes. Long-term observations around these camps reveal notable changes in Land Use and Land Cover (LULC). This study aims to investigate LULC changes within 1 km, 5 km, and 10 km radius around refugee camps with populations exceeding 20,000 in southeastern Türkiye. Using Sentinel-2 satellite images and random forest algorithms on the Google Earth Engine (GEE) platform, the analysis provides a detailed representation of these LULC changes. The findings show a decrease in agricultural areas and an expansion of settlement areas within the 10 km radius. Within the 1 km radius, in Region Akçakale refugee camp, an increase in settlement areas was observed between 2016 and 2020, but this growth slowed down between 2020 and 2024. This is attributed to the recent relocation or closure of camp sites in this area. In Region Elbeyli refugee camp, settlement areas increased by 2 ha after 2016 and have remained stable since, while in Regions Ceylanpınar-1 refugee camp and Ceylanpınar-2, settlement areas have fluctuated due to the shifting locations of the camps, leading to an increase in Ceylanpınar-1 and a decrease in Ceylanpınar-2. In the 5 km radius, agricultural areas decreased by an average of 150 ha, while settlement areas expanded by approximately 75 ha. The decline in agricultural land is linked to falling land prices, which in turn is associated with the reduction in available agricultural areas in the region. These changes provide critical data that should be considered in the planning processes of local authorities. The study serves as an important foundation for understanding the environmental and socioeconomic impacts of LULC changes around refugee camps, as well as their effects on real estate prices. Furthermore, this study is related to previous research in the literature on LULC changes, ecosystem effects, and the impacts of refugee camps on local socioeconomic structures. Following these results, the effects of other refugee camps in the region will also be comprehensively examined, and these findings will be expanded. Furthermore, more comprehensive data on land transformations around refugee camps and their impacts on the real estate market will be analyzed.

**Keywords:** Google Earth Engine, land price, land use change, refugee camps, sentinel-2

# Determination of Suitable Eco-Tourism Areas Using GIS-Based Analytical Hierarchy Process (AHP) in Çanakkale Province

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## Abstract

In recent years, the concept of ecotourism has come to the forefront due to the biodiversity conservation, the awareness of sustainability, and the increasing demand for nature. Therefore, the aim of study is to identify areas suitable for ecotourism in Çanakkale by using Geographic Information Systems (GIS) and Analytic Hierarchy Process (AHP), which is one of the most preferred Multiple-Criteria Decision Analysis (MCDA) methods. In order to determine the areas suitable for ecotourism, 13 criteria were used, and restricted areas were selected based on the literature review and expert opinions. The criteria used in the research are namely, topographic analysis, climate, geology, vegetation and accessibility. The restricted areas are protected areas, forest and pasture boundaries, agricultural basins and areas subject to special laws. The importance scores of the pairwise comparisons of the criteria were scored according to the 1-9 scale. Restricted areas were later combined with areas unsuitable for ecotourism. Accordingly, it was found that 64.95% of the study area is not suitable for ecotourism, 20.26% of the study area is moderately suitable, and 14.77% is highly suitable for ecotourism. The methods and outputs of this study can serve as a preliminary model for ecotourism planning in similar study areas.

**Keywords:** Analytical hierarchy process (AHP), Çanakkale ecotourism, gis, land use

# Analyzing Agricultural Land Price Prediction Using Linear Regression and XGBoost Machine Learning Algorithms: A Case Study of Çanakkale

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## Abstract

Agricultural lands, in addition to being areas of growing economic value as agricultural production spaces, are also long-term assets with investment potential in today's world. In recent years, fluctuations in economic indicators such as the euro, dollar, and gold, along with increasing demand for investment, have influenced the changes in agricultural land prices. The sustainable management of agricultural lands and ensuring price stability are closely related to the United Nations Sustainable Development Goals (SDGs), specifically SDGs 11 and 15 'Sustainable Cities and Communities' and " Life on land".  In this context, minimizing price fluctuations in agricultural lands and accurately predicting prices to support sustainable development is important for both investors and landowners. Overall, the Linear Regression (LR) model is considered one of the traditional price prediction methods that is effective. However, more reliable results can be obtained from powerful deep learning models like the Extreme Gradient Boosting (XGBoost) algorithm, which has shown superior predictive performance. This study aims to predict the prices of agricultural lands in the central neighborhoods of Çanakkale by comparing the LR and XGBoost algorithms, along with the daily fluctuations in economic indicators such as the dollar, gold, and euro. The results showed that XGBoost (r2 = 0.66) has an advantage in terms of the coefficient of determination values compared to LR (r2 = 0.01).  Accurate land price estimation of agricultural lands will help to control land price volatility. Furthermore, it will assist farmers and investors in making informed decisions for a sustainable agricultural economy.

**Keywords:** Agricultural land, linear regression, price predict, SDG-11, XGBoost

# A Novel Compound Functioning As a Stimulator and Signaling Molecule: Colloidal Silver in Response to Drought Stress in Olive Fruit

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## Abstract

The use of colloidal silver is increasing due to its potential antimicrobial activity and its properties to stimulate and signal pathways that enhance plant defense mechanisms. Colloidal silver can be used to activate these defense mechanisms through the synthesis and production of reactive oxygen species (ROS). The nanoscale dimensions and intrinsic properties of colloidal silver expand its applicability in controlled environments such as greenhouses and agricultural fields. Due to its minimal application volume, this compound can be used in agricultural areas in an environmentally friendly manner. It is suggested that colloidal silver may represent a promising agent with triggering effects for crop species exposed to both abiotic and biotic stress, given that it accelerates the activation of plant defense systems with remarkable efficiency. In this study, Germioo, a chemical containing colloidal silver (1.5 ppm colloidal silver) at a volume of 500 ml/ha was applied in 4 different periods: olive bud stage, pre-flowering, post-flowering, and fruit scattering size. Fruit physical parameters (diameter, weight) and fruit chemical contents (K, Na, NO3, EC) were analyzed. Fruit diameter increased by 86% compared to the untreated group. Fruit weight increased by 176% compared to the untreated group. In terms of fruit chemical content, potassium content in the treated area was 22% less than the control. Fruit nitrate content was 20% higher than the control. Fruit sodium value was 62% lower than the control and fruit electrical conductivity measurement was 25% less than the control. There was a visual value difference in the fruits. The positive contribution of this application to olive trees growing in arid regions was observed. It was emphasized that this situation increased the signaling mechanism of colloidal silver element in the plant and increased metabolic activities improved root development and took more water and mineral substances from the soil.

**Keywords:** Nanomaterials, olive, drought, stress, colloidal silver

# Efficient Double Haploid Production by Anther Culture in Different Chickpea (*Cicer arietinum* L.) Genotypes

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## Abstract

The goal of this study was to optimize anther culture methods using cold pre-treatments (0, 4, and 7 days at +4 °C) and different forms of media containing various combinations and concentrations of auxin/cytokine for 15 different chickpea genotypes. The research results showed that the cold pre-treatment had a positive influence on callus development and better embryogenic callus development of the intended type was achieved in the cold pre-treatment applied for 4 days in all genotypes.The development of the best embryonic callus formation from the gemmule was obtained from donor plants and attained in the medium EDM 2, the highest mature embryonic callus was achieved in EMM 2, and the highest shoot regeneration from the embryonic callus was detected in PRM 3. There were significant differences between the genotypes in terms of embryonic callus and shoot formation. The best embryonic callus was obtained in population F2 8, matured embryonic callus was obtained in F2 1, and the highest shoot formation was obtained in F2 1. As a result of this, shoot regeneration was attained from embryonic callus and the ploidy levels of the shoots were specified. Rooting experiments were conducted in media that included several auxin types and concentrations, and after rooting they were transferred to sterile soil.

**Keywords:** Chickpea population, breeding, anther culture, double haploid technology

# Effects of Different Maturity Periods on Berry Quality and Biochemical Properties in Müşküle Grape Variety (*V. vinifera* L.)

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## Abstract

This research was conducted in the 'Table Grape Varieties Application and Research Vineyard' located in the 'ÇOMÜ Dardanos Campus, Faculty of Agriculture, Plant Production Research and Application Unit'in 2020 and 2021. The aim of the research was to determine the effects of different maturity periods on berry quality and biochemical properties of the Müşküle grape variety. In this context, berries were taken for a total of 6 weeks in once a week starting from harvest maturity (23.10.2020 and 13.10.2021). In the collected berries; berry width (mm berry$^{-1}$), berry length (mm berry$^{-1}$), berry weight (g berry$^{-1}$), berry size index, skin thickness (mm berry$^{-1}$), berry skin color (L, Chroma and Hue), TSS (%), pH, acidity (%), maturity index, total phenolic substance amount (mg GAE 100 ml$^{-1}$) and total tannin amount (mg kg$^{-1}$) were determined. According to the two-year findings; no significant change was detected between weeks in berry width, berry length and pH values. Berry weight followed a slightly fluctuating course but reached the highest value in the 6th week (4.35 g berry$^{-1}$), and skin thickness decreased from 0.250 mm berry$^{-1}$ to 0.180 and 0.160 mm berry$^{-1}$ in the 6th and 5th weeks. As the weeks progressed, the berries had a more yellowish, vivid and bright skin color in terms of L, Chroma and Hue values due to maturation. The TSS value increased by approximately 0.50% in the 6th week compared to the first weeks, the acidity value gradually decreased as the weeks progressed, and the maturity index gradually increased from 51 to 56. Although fluctuations were observed in the total phenolic and tannin amounts between weeks, the lowest values were determined in the 6th week (3.41 mg GAE 100 ml$^{-1}$ and 0.621 mg kg$^{-1}$, respectively). As a result; In the Müşküle grape variety, no collapse–rot damage occurred in the grapes kept on the vines for 6 weeks from harvest maturity, it was observed that the berry maturity progressed quite slowly and the quality was preserved. It is thought that the Müşküle grape variety can find buyers at a higher price by keeping it on the vines for up to 8 weeks from harvest maturity, without losing quality in the years when there is no frost event in the conditions of Çanakkale province.

**Keywords:** Phenolic compound, quality, müşküle, maturity, *V. vinifera* L

# Superfruit Aronia [*Aronia melanocarpa* (Michaux) Elliot]: Intersectoral Utilization Potential

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## Abstract

Aronia (*Aronia melanocarpa*) is a fruit that has gained prominence in recent years, particularly in the fields of health and nutrition, and is also referred to as a superfruit. The high antioxidant content of Aronia, along with its rich vitamin and mineral composition, provides extensive application opportunities across various sectors. In the agricultural sector, Aronia plants are known for their cold climate resistance and low cultural maintenance requirements. These characteristics make Aronia an ideal plant, especially in rural areas and regions with low agricultural productivity. Additionally, Aronia plants offer environmental benefits such as soil erosion protection and ecosystem services. In the food industry, the nutritional and health benefits of Aronia have made it a popular ingredient in various food products. Aronia berries are used in products such as fruit juice, jams, marmalades, and frozen fruit, as well as in the formulation of dietary supplements and sports drinks. This diversity highlights the versatile application of Aronia in the food industry. In the cosmetic sector, Aronia extracts are favored for their anti-aging and skin health-improving properties in skincare products. The antioxidant properties of Aronia can slow down the aging process of the skin and support overall skin health. In the pharmaceutical sector, the antioxidant and anti-inflammatory properties of Aronia enhance its potential for use in herbal medicine formulations. The health benefits of Aronia offer potential contributions to the treatment of various diseases and create a field for pharmaceutical research. The aim of this study is to detail the various applications and potentials of Aronia in the agriculture, food, cosmetic, and pharmaceutical sectors, examining the fruit's multifaceted benefits and applications from a comprehensive perspective.

**Keywords: A**ntioxidant, agricultural technologies, food processing, cosmetic applications, pharmaceutical research

# Comparison of Chemical Properties of Olive Oils Obtained from Central District and Eceabat District

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## Abstract

Olive is an evergreen plant belonging to the Oleaceae family. The scientific name of olive belonging to the genus Olea is *Olea europaea*. Olive, whose homeland is Anatolia, grows in many ecologies of Turkey and finds the opportunity to be cultivated in a wide area. Oil, which is the main product of olives, is generally between 15%-30% depending on the olive variety. Olive oil obtained from olives by physical means contains high amounts of monounsaturated fatty acid oleic acid. The fact that the dominant fatty acid is oleic acid provides olive oil with high oxidative resistance and high resistance to abiotic conditions. However, this part, consisting mainly of triglycerides esterified with fatty acids, constitutes about 98% of olive oil. The other components are called unsaponifiable substances and constitute 2% olive oil. In this study, the effect of location difference on the chemical properties of olive oils obtained from Edremit (Ayvalık) olive variety fruits harvested at the same maturity period (variegated maturity) and grown under the same cultural care conditions in the Central and Eceabat districts of Çanakkale province was investigated. Within the scope of the study, total phenol content (mg/kg GAE), free fatty acidity (%Oleic acid), peroxide number (meq O2/kg oil), iodine number (Wijs), UV (232 nm, 270 nm and Delta K) and fatty acids methyl esters (FAME) analyses were performed. According to the data obtained, statistically significant differences were found in polyphenols, free acidity, K232, and some fatty acids between the two regions. It was determined that olive oil from both locations was extra virgin olive oil.

**Keywords:** Polyphenol, extra virgin olive oil, acidity, Ayvalık, Eceabat olive oil

# Evaluation of Elasmobranch Bycatch in the Waters Surrounding Gökçeada Island, Northern Aegean Sea

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## Abstract

Demersal sharks and rays are frequently caught as bycatch in bottom-trawl fisheries, where they are often discarded back into the water, injured or dead. This poses a significant problem, as many of these species are already vulnerable or endangered. In recent years, concerns have been increasing regarding the impact of these fisheries on elasmobranch populations, leading to efforts aimed at gaining a better understanding of these impacts. Specifically, there is a need for more detailed information on the composition of elasmobranch assemblages in different fisheries, including those around Gökçeada in the northern Aegean Sea. To address this, a total of 2,682 sharks and 345 rays (representing 21 species from 13 families) were collected from commercial bottom trawl vessels operating near Gökçeada, northern Aegean Sea, Turkey, between February 2019 and February 2020. The species studied included the lesser spotted dogfish (*Scyliorhinus canicula*), nursehound (*Scyliorhinus stellaris*), blackmouth catshark (*Galeus melastomus*), velvet belly (*Etmopterus spinax*), and picked dogfish (*Squalus acanthias*). Among batoids, species such as the thornback ray (*Raja clavata*), brown ray (*Raja miraletus*), and longnosed skate (*Dipturus oxyrinchus*) were recorded. Other species, which were less commonly caught and numbered fewer than 10 individuals, included the smooth-hound (*Mustelus mustelus*), starry smooth-hound (*Mustelus asterias*), bluntnose sixgill shark (*Hexanchus griseus*), gulper shark (*Centrophorus granulosus*), angular roughshark (*Oxynotus centrina*), common stingray (*Dasyatis pastinaca*), spiny butterfly ray (*Gymnura altavela*), cuckoo ray (*Leucoraja naevus*), common eagle ray (*Myliobatis aquila*), bullray (*Aetomylaeus bovinus*), white skate (*Rostroraja alba*), marbled electric ray (*Torpedo marmorata*), and electric ray (*Tetronarce nobiliana*). This study contributes scientifically to the regulation of commercial and small-scale fishing by comparing the reproductive timing and size at first maturity of some cartilaginous fish species with the rates of fishing bans and non-target catches.

**Keywords:** Elasmobranch, bilycatch, northern aegean sea, conservation

# Determination of Fresh Food Preferences of *Tenebrio molitor* Larvae

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## Abstract

*Tenebrio molitor* has been intensively used as an alternative protein source in recent years. In previous studies, it has been reported that they feed selectively according to their own needs. In order to provide the water needs of mealworms, which are usually fed with grains, foods such as potatoes, apples and carrots are usually offered. However, it is not known whether they only satisfied their water needs with these foods and what their preferences are among these foods. In line with this issue, a total of 400 Tenebrio molitor larvae were used in this study. Larvae were divided into 8 equal groups into cups containing wheat bran. Larvae were subjected to a choice test every 2 weeks until the pupal stage. During this period, no application was made to supply their water needs. Potato, apple, cucumber, carrot, pumpkin and water gel were used as fresh food in the test phase. The larvae in the test box were released for 10 minutes and at the end of the test period, the larvae on each food were collected and counted. In the statistical analysis, food groups, test days and their interactions were included in the model for food preference. Analysis of variance method was used in the analysis and TUKEY test was used for post-hoc analysis. As a result of the findings, a significant preference for potato and apple was observed over the weeks. At the same time, the preference for gel decreased over the weeks. As a result of this study, it was observed that mealworm larvae prefer foods high in carbohydrates. It was determined that mealworm larvae do not only meet their water needs from the offered foods, but also the nutritional content of the offered foods plays an important role in their choices.

**Keywords:** Self-Selection, tenebrio, edible insects, mealworm, insect breeding

# Identification of Phenotypes for Selection in Honeybee Breeding Programs:

# Beekeeper Preference Tests

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## Abstract

The organization and implementation of honeybee breeding is more difficult than other livestock species, as their biology is quite different. Nevertheless, efforts in this direction have reached the stage of implementing honeybee breeding programs. Biological and technical factors and the economic importance of these phenotypes are important when determining the phenotypes that are subject to selection in animal breeding. In addition, the question of which animals the breeders want to work with is neglected when determining the selection criteria. In this study, beekeeper colony trait preferences were defined for breeding purposes. For this purpose, two preference methods were developed and presented to 88 beekeepers. In one method, virtual colonies with 8 trait combinations, each with two high and two low values, were created and presented to the beekeepers for preference in the form of 9 different paired colony comparisons. In the other method, 6 combinations with high and low values and two traits each were again preferred by the beekeepers in pairs. The generalized estimating equations method with repeated measures was used to analyze preferences between traits. The preference tests focused on honey yield (BV), hygienic behavior (HD), docility (S) and Varroa resistance (VD). In the first method, the preference between traits was found to be significant (P<0.0001). Accordingly, the probability of preferring BV to HD is 48% lower, the probability of preferring BV to S is 68% lower and the probability of preferring BV to VD is 36% lower. The probability of preferring HD to S is 39% lower, while the probability of preferring HD to VD is 43% higher. Beekeepers are 2.34 times more likely to prefer S to VD. For the other method, a statistically significant difference was found between the preferences (P=0.0017). Accordingly, the probability of preferring BV instead of HD is 27%, 44% instead of S and 58% instead of VD. The probability of preferring HD instead of S is 24% lower and 43% lower than for VD. The probability of preferring S instead of WD is 25% lower. Although it is the main source of income, honey yield is less preferred than other traits. On the other hand, methods influence preferences. This difference is probably because of traits that were not included in the preference method for colonies in this work.

**Keywords**: Choice test, honey, hygenic behaviour, docility, varroa resistance

# A Case Study on the Zootechnical Evaluation of Traditional Dairy Sheep Farms in Çanakkale Based on the Animal-Oriented Approach

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## Abstract

The Production System Of Traditional Sheep Farms In Çanakkale Can Be Described As Relatively Low-Input. These Farms Based On Natural Pastures. In This Study A Method Was Developed And Tested That Is Based On The Evaluation Criteria Of Animal Welfare. Forty Traditional Sheep Farms In Çanakkale Province Were Randomly Selected. Adult Ewe Mortality And Frequency Of Disease Incidence (HU) Were Reported By The Breeder, While Flock Temperament (SM) And Some Behavioral Traits (DB) Were Observed During Farm Visits. These Groups Of Traits Were Compared By The Canonical Correlation Method. In Addition, The Linear Effects Of These Traits On Adult Sheep Mortality Rates Were Analyzed Using The Stepwise Regression Method. The Canonical Correlation Coefficients Between HU And SM Were $0.78\pm0.063$ (P=0.5667), Between HU And DM $0.76\pm0.069$ (P=0.0597) And Between SM And DM $0.84\pm0.771$ (P=0.2937). Frequency Of Respiratory Diseases, "Interest", "Curiosity", "Restlessness", "Feeding Behavior", "Proportion Of Animals With Anormal Breathing". And "Coughing Frequency" Have Positive Significant Linear Effects, While The Trait "Satisfied" Had A Negative Significant Linear Effect (P≤0.0424). On The Other Hand, The Effects Of Lameness Frequency (P=0.0751), Agalactia Frequency (P=0.0646) And "Indifferent" (P=0.0554) Also Tended To Be Significant. Although The Canonical Correlation Coefficients For The Holistic Relationships Between The Evaluation Criteria Groups Are High, It Does Not Seem Possible To Evaluate The Relationships Other Than The Value Between HU And WL In A Meaningful And Clear Way. Although The Traits Caring And Curiosity Used To Measure Flock Temperament Have A Positive Significance, It Is Quite Interesting That Their Relationship With Adult Mortality Rate Is Positive. This Suggests That Flocks With This Temperament Are More Prone To Accidents Or Are More Easily Attacked By Predators Due To This Character. Mortality Is Expected To Be Higher In Flocks Classified As Restless. In Flocks That Are Frequently Fed During The Resting Phase, It Can Be Assumed That The Feed Is Not Evenly Distributed, And That Feeding Is Inadequate. Irregular Breathing And Coughing May Indicate Respiratory Disease Or The Presence Of Internal Parasites. A Herd With An "Unsatisfactory" Rating Is Likely To Have Significant Problems. The Study Showed That These Criteria Can Be Developed And Used For The Evaluation Of Sheep Farms, Both In Terms Of Zootechnical Aspects And Animal Welfare.

**Keywords:** Animal welfare, mortality, animal evaluation criteria, principal component analysis, canonical correlation

# Innovative Approaches to Promote Nursery Seedlings Production

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## Abstract

A cost-effective regeneration effort in order to enhance forest biodiversity is priority for Forestry. Nonetheless, overcoming transplanting stress in Mediterranean forest ecosystems is a great challenge, in adverse environments, which affects negatively the regeneration success. Nurseries target to produce the best seedlings that have the potential to overcome transplanting stress and successfully grow on a site. The introduction of new technology based on pre-cultivation protocols in mini-plugs and LED lamps in order to serve large-scale production of forest regeneration material for a wide range of species is an innovative approach for the nursery production. 18 species were studied and their germination and growth protocols were determined. All these species were studied under light-emitting diodes (LEDs) (L20AP67, AP673L,G2, AP67, NS1 -Valoya) or Fluorescent light (FL). Both morphological and physiological variables helped to determine the best growth conditions for each species in order to achieve the best seedling quality. Furthermore, these seedlings were transplanted to pots in the nursery and finally studied under field conditions in a selected site. The use of this new technology integrated to a build prototype will allow a large scale production of seedlings that until now was unreachable through the use of the conventional techniques. Our results provide an insight on the advantages of using LED lights as a regulation tool for seedlings quality in controlled environments; hence those enhanced attributes of the seedlings could be ultimately be useful for the demands of a potential high scale production. The new technology, in conjunction with increased numbers of different plant species will result to increased biodiversity levels that lead to more sustainable restoration sites.

**Keywords:** Mediterranean species, nursery production, LEDs, regeneration material seedlings

# Comparative Analysis of Trend Forecasting Models for Standardized Precipitation Index (SPI) Data for Çanakkale

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## Abstract

Climate change is defined as changes in the average state and variability of the climate over prolonged periods and is described as a global environmental problem. Rising temperatures and changes in precipitation patterns may increase the frequency and severity of natural disasters, such as droughts, observed around the world. Drought is characterized by the decrease in water resources and soil moisture levels as a result of decreases in the amount of precipitation, and has different types: meteorological, hydrological and agricultural. While meteorological drought is defined according to regional climate data, hydrological drought refers to long-term decreases in water resources. Agricultural drought occurs when plant and crop development is negatively affected due to lack of soil moisture. The effects of drought require in-depth analyzes on water management and use in the agricultural sector, which necessitates sustainable management and planning of water resources. In addition, effective monitoring and identification of drought events and the development of drought preparedness plans are of great importance, especially in terms of agricultural activities and water resources. The study aims to monitor the trends of the Standardized Precipitation Index (SPI) for Çanakkale Province using long-term precipitation data from 1929 to 2023. Three distinct modeling approaches were employed: Linear Regression, Autoregressive Integrated Moving Average (ARIMA), and Long Short-Term Memory (LSTM) Networks, to analyze and forecast the SPI values. The linear regression model revealed significant fluctuations in SPI values, with no substantial long-term trend towards wetter or drier conditions. The ARIMA model, after addressing data stationarity issues, also indicated stable conditions without a significant trend. The LSTM network, optimized for sequential data, captured the general trends but highlighted the variability and lack of a clear directional trend in SPI values. The findings underscore the complexity and variability of precipitation patterns over nearly a century, emphasizing the necessity of employing multiple modeling techniques to understand and predict climate variability effectively. The study provides a robust foundation for future research to explore advanced models for enhancing the predictive accuracy of precipitation trends, crucial for climate adaptation strategies.

**Keywords:** Standardized precipitation index, ARIMA, linear regression, long short-term memory, climate variability, precipitation trends, Çanakkale province

# Weed Detection in Rice Paddy from Multispectral Images Using Deep Learning

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## Abstract

Weed is an important problem in rice (*Oryza sativa)* paddy cultivation. For this reason, spraying is frequently done by the producers. As a result, areas where weeds are not present are sprayed and cause significant yield losses. Today, with the developing technology, the processing of images taken from sensors attached to UAVs with artificial intelligence is becoming increasingly widespread in agriculture. The aim of this study is to detect weeds that pose a problem in paddy cultivation with deep learning algorithms using multispectral images. For this purpose, images were taken by flying over paddy producer fields. Images are taken in 6 bands from the multispectral sensor. For each of these bands, an image is formed separately. YOLO (You Only Look Once) Roboflow 3.0 Object Detection model was used for these images. In order to increase the accuracy of the model, synthetic data was also created by increasing the data. In the data set, the model was created with a total of 1483 data, including 1299 train, 123 validation and 61 test data. In the model in question, 69% mAP, 69.7% Precision, 67.8% Recall accuracy rates were achieved. In the model, the species of dandelion grass (*Chinochloa crus-galli L.*) and imam cotton grass (*Abutilon theophrasti Medik.)* were detected. Among the images used for detection, the 3rd band (Red) and 5th band (NIR) provided the highest accuracy rate. It may be possible to enrich the data set by taking more images to increase the accuracy rate.

**Keywords:** Deep learning, UAV, multispectral, computer vision, rice, weed

# Determination of the Detection Threshold of Adulteration of Extra Virgin Olive Oils with Sunflower Oil at Different Ratios by Physical Analysis and Chemical Measurements

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## Abstract

Olive oil is an oil obtained from olive fruits (*Olea europaea* L.) using only physical methods. It has a distinctive aroma and flavour and can be consumed in its natural state. Many other vegetable oils are obtained from oilseeds by solvent extraction, and this 'crude oil' is subjected to refining. Olive oil adulteration is the process of adding other vegetable oils to olive oil for counterfeiting. Olive oil should be consumed in its natural form as it contains many beneficial nutrients for health. However, when the supply of olive oil is insufficient, the production and trade of adulterated olive oil becomes widespread. Adulteration treatments, such as mixing other vegetable oils with olive oil, cause significant economic losses by reducing the quality and nutritional value of the oil. This study aimed to detect practically the adulteration of olive oil, which is evaluated differently from other vegetable oils and is most exposed to counterfeiting. For this purpose, blends were prepared in the laboratory with refined sunflower oil at the ratios of 1%, 2%, 4%, 8%, 16%, and 32% by mass to olive oils of Ayvalık olive variety. Free fatty acidity, fatty acid methyl esters, iodine number and squalene ratio (%) analyses from physical measurement and chemical analysis methods were performed to determine the effectiveness of the adulteration.

**Keywords:** Olive oil, adulteration, sunflower oil, analysis

# The Effect of Glycine Betaine on Crude Oil and Fatty Acid Components of Sweet Corn (*Zea mays* L. *saccharata*) under Boron Toxicity

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## Abstract

Boron (B) is an important micronutrient in plant development, especially in maintaining cell integrity, makes its management difficult in agricultural production due to the narrow range between its deficiency and toxicity. Boron toxicity cause significant yield and quality losses, especially in arid/semi-arid region soils, which are enriched with B from various sources such as irrigation water, fertilizers, sewage sludge and fly ashes. Plants develop mechanisms and different responses to cope with negative results. Glycine betaine, helps to increase the resistance of plant, is an osmo-protectant that can be synthesized in plant or applied exogenously against stress conditions. In this study, the effect of glycine betaine (0.1 mM GB) applied on crude oil ratio, palmitic acid (16:0), stearic acid (18:0), heneicosanic acid (21:0), eicosanoic acid (20:0), lignoceric acid (24:0) with oleic acid (18:1), linoleic acid (18:2) and α-linolenic acid (18:3) contents of sweet corn (*Zea mays* L. *saccharata*, cv. Calipos) grown under B toxicity (0.6 mM) according to three different treatments (Control, B, and B+GB) were determined. Crude oil ratio, contents of stearic, heneicosanoic, oleic and linoleic acid increased with B stress, contents of lignoseric and α-linolenic acid, unsaturated fat ratio and saturated/unsaturated fat ratio decreased, and the changes in other parameters were not found to be significant. Crude oil ratio, contents of eicosanoic and oleic acid, saturated/unsaturated fat ratio of sweet corn increased with GB application under B stress, contents of heneicosanoic, lignoseric and linoleic acid and saturated fat ratio decreased and changes in other parameters were not found to be significant. As a result, it was concluded that GB application had a positive effect on crude oil ratio and ratio of fatty acid components in sweet corn seeds under B stress and may have an effect on providing the parameters that an appropriate oil for use in human nutrition should have.

**Keywords:** Corn, seed, fatty acid, B toxicity, glycine betaine

# Effects of DAP Fertilizer Application on Hay Yield and Quality in Mixtures of Hungarian Vetch and Forage Pea with Oat and Italian Ryegrass

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## Abstract

It was aimed to determine the effect of DAP fertilizer on the hay yield and quality and macro and micro nutrient element contents in mixtures of Hungarian vetch and forage pea from legume forage plants, and oat and Italian ryegrass.This research was carried out in the field of Thrace Agricultural Research Institute in Edirne conditions, in a split plot randomized block design with three replications for three years. In the main plots, three different doses of DAP fertilizer were used: without fertilizer - 8.7 DAP kg/da - 17.4 DAP (Di Ammonium Phosphate 18-46). In the sub-plots, Hungarian vetch (*Vicia pannonica* Crantz.) and forage pea (*Pisum arvense* L. am.), oat (*Avena sativa* L.) and Italian ryegrass (*Lolium multiflorum* L.) were planted alone and in mixtures. Differences between yield and quality values in the experiment were made by variance analysis, and classification was made by LSD test. JMP statistical program was used in statistical analyses.IIn the study, dry grass yield varied between 641.15-720.10 kg/da, crude protein ratio was 14.98-15.67%, crude protein yield was 109.08 kg/da, ADF was 32.17-32.68%, NDF was 50.25-50.49%, and relative feed value was 121.88-122.86%. In macro and micro plant nutrients, nitrogen ratio varied between 1.93-2.09%, phosphorus ratio between 0.25-0.27%, potassium between 2.69-2.75%, calcium between 0.62-0.65%, magnesium between 0.17%, iron between 122.13-156.62 ppm, copper between 7.12-8.06 ppm, zinc between 21.72-23.89 ppm, manganese between 58.81-66.23 ppm.Hay yield and crude protein yield were 641 kg/da - 109 kg/da without fertilizer, 698 kg/da - 122 kg/da in the first dose (8.7 kg/da DAP), 720 kg/da - 126 kg/da in the second dose (17.4 kg/da DAP), respectively. In the statistical analysis, doses without fertilizer and doses with fertilizer were in separate groups, but there was no statistical difference between the first and second doses. According to the results of the study, it was determined that 8.7 kg/da Diamanium Phosphate (DAP-18.46.0) application would be sufficient in Hungarian vetch and forage pea, and in mixtures of oats and Italian ryegrass, but that soil analysis should be performed before fertilization.

**Keywords:** Fertilizer, DAP, mixture, hay

# Assessing the Salt Stress Tolerance of Sorghum During Early Growth and Development with Curve Fitting

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## Abstract

Soil salinity, a major constraint on plant growth and development, can be better managed by gaining a deeper understanding of plant tolerance. Aim of this study is to evaluate the salt tolerance of sorghum genotypes during growth and development. In order to identify the genotypes with low and high salt tolerance, 16 sorghum genotypes were grown in perlite medium between May-June 2024 in a greenhouse experiment, conducted in completely randomized blocks design (CRBD) with three replications and watered every other day with either pure (0 dS/ml) or salty (8 dS/ml NaCl) water solutions.Plants were harvested when majority of the seedlings were reached at 5 leaf stage. Salt susceptibility index (SSI) of sorghum genotypes varied between 1.23 and 0.65 with a total average of 0.97. Representing the dry weight averages of all genotypes, stress tolerance index (STI) of Genotype 14 (PI602852) were found 0.23 and selected as the most susceptible genotype. Contrarily, Genotype 2 (PI601833) were selected as the most salt tolerant sorghum genotype with 0,67 SSI and 0,65 STI averages.Selected genotypes were used in a pot experiment to assess their growth and development under control (0 dS/m) and saline (8 dS/m NaCl) soil conditions, which is also configured according to CRBD with 3 replications. Pot experiment is conducted in Çanakkale Yenice location in 20 July 2024 with 18 liter pots filled with 17.5 kg of field soil. Plants were reduced to one in each pot after plant emergence which was followed by weekly plant samplings to determine fresh weight and plant height growth until the 7th week when flag leaves became visible as a whorl. Logistic curve was fitted to obtained growth data with >0.99 r2 for fresh weight and >0.98 r2 for plant height.Parameter a values with confidence intervals of estimated curves revealed that restrictive effects of salt stress were significant for either genotype. Genotype with high susceptibility to salt stress during early growth initially had a slower growth compared to tolerant genotype but eventually surpassed it during the onset of generative growth. This finding is attributed to the increases of root fresh weight of susceptible genotype around 6th week, indicating that for sorghum, early susceptibility to salt stress may not relate to the later stages of growth.

**Keywords:** Fresh weight, root weight, stress tolerance index, stress susceptibility index, logistic model

# Effects of Microalgae as a Biofertilizer and Chemical Fertilizer Applications on Yield and Quality Parameters of Lettuce

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## Abstract

Lettuce is an important commercially grown leafy vegetable consumed worldwide. In recent years, microalgae has been known as an alternative ecofriendly source with high nutritional value for improving growth of plants in sustainable agriculture. The aim of the study was to assess the effects of using microalgae (*Chlorella vulgaris* Beijerinck) as a biofertilizer on lettuce (*Lactuca sativa* L. var. crispa) cv. Caipira, as well as its potential when combined with chemical fertilizer. The research was carried out in unheated glass greenhouse conditions in the Horticulture Department of Agriculture Faculty at Bursa Uludağ University during the spring season of 2024. The research included four groups of different soil fertilizer applications: (I) control, (II) microalgae (MA) applications with two levels of 100% MA (4*107 alg ml$^{-1}$) and 50% MA (2*107 alg ml$^{-1}$), (III) chemical fertilizer, (IV) chemical fertilizer with the combinations of 100% MA and 50% MA. The chemical fertilizer doses were applied to soil according to the recommendations of the Republic of Türkiye Ministry of Agriculture and Forestry. As yield and quality parameters, avarage head fresh and dry weight (gram plant-1), head length (cm), root collar diameter (cm), number of marketable and non-marketable leaves (number plant-1), leaf chlorophyll content, leaf colour values (l, a and b), soluble dry matter content (°Brix) and leaf relative water content (%) were investigated. In conclusion, the best results were obtained from the %100 MA applications for all yield and quality parameters of curly lettuce plants.

**Keywords:** *Chlorella vulgaris* Beijerinck, *Lactuca sativa* L. var. crispa, leafy vegetables, sustainability

# The Effect of Glycine Betaine on Crude Oil and Fatty Acid Components of Sweet Corn (*Zea mays* **L.** *saccharata*) Under Cadmium Stress

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## Abstract

Throughout their lives, plants are exposed to many negative environmental factors, which may be abiotic or biotic, and as a result, they get stressed. Nowadays, heavy metal stress resulting from anthropogenic activities, inhibits growth and development of plants, and causes decreases in yield. Excessive accumulation of cadmium (Cd) inhibits plant growth by cellularly, morphologically and physiologically. Plants develop mechanisms and different responses to eliminate these negative results. Glycine betaine (GB), which is one of the quaternary ammonium compounds, is an osmo-protectant that helps to increase the resistance of plant to stress. In this study, the effect of glycine betaine (0.1 mM GB) applied on crude oil ratio, palmitic acid (16:0), stearic acid (18:0), heneicosanic acid (21:0), eicosanoic acid (20:0), lignoceric acid (24:0) with oleic acid (18:1), linoleic acid (18:2) and α-linolenic acid (18:3) contents of sweet corn (Zea mays L. saccharata, cv.Calipos) under Cd (100 μM CdCl2) stress according to three different treatments (Control, Cd, and Cd+GB) were determined. While palmitic, stearic, eicosanoic, heneicosanoic and lignoceric acid contents, saturated fat ratio and saturated/unsaturated fat ratio of sweet corn decreased with Cd stress, crude oil ratio, oleic, and α-linolenic acid contents, unsaturated fat ratio increased. Except for the decreases in oleic and α-linolenic acid contents, unsaturated fat and saturated/unsaturated fat ratio of sweet corn, significant increases were determined in parameters examined in glycine betaine application under Cd stress. As a result, it can be said that application of GB may have an improving effect on lipid synthesis metabolism and increasing effect on crude oil ratio in sweet corn seeds under Cd stress.

**Keywords:** Corn, seed, crude oil, Cd stress, glycine betaine

# Performance of GGE Biplot Analysis in Assessing Genotype-by-Environment Interaction

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## Abstract

The change in the differences between genotype means according to the environment is called Genotype-by-Environment interaction. Determining genotypes suitable for environmental conditions is very important in terms of efficiency. At this point, accurate and reliable statistical methods should be used to determine the interaction.It has been observed that GGE biplot analysis is frequently used, particularly in plant breeding studies. GGE biplot analysis does not have a mathematical framework of its own;  it is directly the singular value decomposition itself. This study examines the need for GGE biplot analysis in comparison to Analysis of Variance (ANOVA), which is used to evaluate data from experimental designs and has a robust mathematical framework. It also evaluates the performance of GGE biplot analysis under various experimental conditions. To achieve this, a Monte Carlo simulation technique was used with codes written in the R programming language. In the study, the performance of GGE biplot analysis in determining the interaction was examined in 90 different experimental conditions, each repeated 100,000 times. GGE biplot analysis evaluates the interaction in a two-way graph based on the distances of genotypes to the environments. While determining the performance of GGE biplot analysis, the distance of genotypes to each environment was calculated and compared with their actual rankings. As a result of simulation trials, it was determined how accurately it predicted the ranking of genotypes in the environments. GGE biplot analysis is applied directly to subgroup means. It does not take into account the experimental error, which is the cornerstone of experimental designs. Therefore, it evaluates the differences between group means without accounting for variability within the groups, which can lead to erroneous conclusions. Moreover, simulation studies showed that even when the variance between group means in each environment is 20 times the general mean, it predicted the real ranking of genotypes in the environments correctly at most 67.25%. This decreases to 11.00% as the number of groups increases. Both theory of GGE biplot analysis and simulation results indicate that GGE biplot analysis can lead to misleading results when evaluating data from experimental designs. For this purpose, it is much more reliable to use Analysis of Variance. If a visual analysis is to be preferred, Analysis of Means (ANOM) can be used.

**Keywords:** Singular value decomposition, ANOM, experimental designs, experimental error, monte carlo simulation

# A Review on the Comparative Study of Some Soil Compaction Measurement Methods Used in Agricultural Soils

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## Abstract

The agricultural and industrial sectors are interdependent with cause-effect relationships. Along with the industrial revolution in agricultural production, the increase in soil pollution and other environmental imbalances such as soil compaction have caused the world around us to change. Soil compaction, often caused by the use of agricultural machinery, changes soil properties, reducing the pore space of the soil; therefore, it negatively affects crop product efficiency. This paper reviews the characteristics, causal factors and measurement methods for soil compaction. Some of the test methods outlined include sand cone, nuclear density, rubber balloon tests in-situ or place, and standard and modified proctor and bearing ratio tests in the laboratory. The correct choice of the right test methods depends on the soil types and conditions, i.e. whether the soil is fine or coarse-grained and the moisture status, the purpose and scope of the study (large-scale, frequent and rapid measurement), the availability and cost of equipment, and the accuracy and precision required. Therefore, in this paper, the practical usability and usage procedures of all test methods determining soil compaction are clearly discussed and their status in practice is presented. Additionally, it has been discussed that soil compaction, which is known as a significant soil degradation in agricultural soils, is an obstacle for water infiltration, soil biology and root growth. In this context, this paper also showed that the main principles of conservation agriculture, namely, reduction of tillage, management of crop residues and crop rotation are the basic ways to maintain soil health and productivity for the general benefit of sustainable agriculture.

# The Future of Farming: Leveraging AI, Machine Learning, and Smart Systems for Optimal Agricultural Practices

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## Abstract

In smart agriculture (SA), key applications of intelligent technologies include pest management, weed control, monitoring agricultural products, storage management, disease management and control, weather forecasting and monitoring, irrigation management, yield prediction, soil composition and management, and machinery management. Managing the agricultural production supply chain, measuring soil variability, improving agricultural production and management, reducing resource usage, monitoring water consumption, enhancing agricultural processes, identifying agricultural risks and hazards, and optimizing decision-making are crucial application areas of agricultural technologies.The use of digital technologies in agriculture and livestock is rapidly increasing. Optical, mechanical, electrochemical sensors, air flow, and location tracking technologies provide early warnings for diseases and pests, optimizing harvest processes. Smart monitoring systems enhance agricultural efficiency, while digital technologies improve productivity, sustainability, and effectiveness. Smart greenhouses, irrigation, and fertilization systems support agricultural sustainability by monitoring environmental and plant parameters.In livestock management, environmental and body sensors improve animal health and living conditions. Machine learning algorithms are effective in detecting mating behaviors and diseases in livestock. Precision livestock systems monitor health and welfare parameters, increasing productivity and protecting animal health. Artificial intelligence (AI) and machine learning (ML) applications are effective in analyzing soil data, plant phenotyping, and carbon stock estimation. Smart irrigation systems contribute to water conservation and increased efficiency. Additionally, smart harvesting systems help achieve sustainable production with lower costs and increased productivity. These technologies enhance the sustainability of agriculture and livestock by strengthening the capacity to manage productivity and environmental impacts. This article will discuss the topics that                                          mentioned                                          above.

**Keywords:** Smart agriculture, intelligent technologies, machine learning, data mining

# Agricultural Land Use Trends in Istanbul: An Assessment Using CORINE Land Cover

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## Abstract

Istanbul constitutes a small part of land area in Turkiye. However, Istanbul is home to a substantial portion of the national population, and constitutes a national reference for key economic indicators. The Istanbul Environmental Plan has projected the metropolitan population considering the natural-artificial thresholds, land and building stock. In order to provide the city the ability to compete on a global scale, the projected population is targeted to be employed in the service (70%) and industry (25%) sectors for finance, IT and technology production, but the agriculture remained in the backburner. In this context, the study aims to evaluate the agricultural land use in Istanbul and discuss the city's food production-consumption capacity. The study method is based on the evaluation of land use data obtained from CORINE Land Cover. The study evaluates the land use data obtained from satellite imagery chronologically and examines the changes in agricultural land use over the last three decades. The research material consists of satellite images from the years 1990-2000-2006-2012-2018. According to the research findings, while the land area of the country is 780.043 km², the agricultural land area remains at 238.450 km². The ratio of the country's agricultural land area to the total land area is calculated as 32.79%. Within the total land area of Istanbul, which is 5,461 km², the ratio of cultivated agricultural areas to the total land area of the city is calculated as 14.09%. Agricultural land decreased by 11% between 1990 and 2018. On the other hand, higher value-added planted agricultural land area has increased. Agricultural production is dominant in the rural environment outside the metropolitan area, but is insufficient to meet the needs of the urban population. Households participating in agricultural labor in the rural environment constitute a small portion of the total labor force. In this sense, Istanbul is externally dependent in terms of food supply. The reason is that the agricultural product pattern is unable to compete with the land value of Istanbul. Last but not least, agricultural land use in Istanbul requires to be structured to encourage higher value-added agricultural production.

**Keywords:** Istanbul, land use change, agricultural land, CORINE, sustainable agriculture

# International Balkan Agriculture Congress

# Detection and Characterization of Tomato Brown Rugose Fruit Virus (ToBRFV) in Tomato and Pepper Growing Areas in Adana and Mersin Provinces

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## Abstract

This study was carried out for the detection and characterization of Tomato brown rugose fruit virus (ToBRFV) in tomato and pepper growing areas in Adana and Mersin provinces between 2022- 2024. For this purpose, green parts and fruit samples were taken from a total of 166 plants (115 tomato and 51 pepper plants) suspected to be symptomatically infected with ToBRFV from 45 different greenhouses and open fields. RT-PCR tests were performed using the ToBRFV-specific primer pair ToBRFV-F and ToBRFV-R, and 560 bp bands were obtained from ToBRFV-infected samples. As a result of PCR tests, ToBRFV was detected in 40 samples (34.8%) taken from tomato plants, while all samples taken from pepper plants were found to be negative for ToBRFV. In mechanical inoculation studies ToBRFV was transmitted on tomato and pepper plants and mosaic, yellowing and deformation symptoms were observed in the leaves of these plants. Sequence analysis revealed that the TRy4, TRc9, TR4, TRc11, TR2 and TR6 coded ToBRFV isolates obtained in this study showed 99% similarity with ToBRFV isolates reported from different countries of the world. On the phylogenetic tree, TRy4, TRc9 isolates were included in the same group, while TR4, TRc11, TR2 and TR6 isolates were included in a different group (probably due to a few base differences).

**Keywords:** Tomato, pepper, ToBRFV, RT-PCR, sequence analysis

# Detection and Molecular Diversity of Grapevine Leaf Roll Associated Virus 2 and 4 in Palestine

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## Abstract

Grapevine (*Vitis vinifera*), a member of the Vitaceae family, is the oldest crop of the world while it is Palestine's second most important crop after olives. Grapevine can be infected by up to 60 viruses. Grapevine leafroll caused by several viruses called grapevine leafroll associated viruses (GLRaV-1, GLRaV-2, GLRaV-3, GLRaV-4, GLRaV-5, GLRaV-6, GLRaV-7 and GLRaV-9) is the most widespread and economically important disease in the world. The objective of this study was detection (serological and molecular) and molecular characterization of GLRaV-2 and GLRaV-4 in Palestine. For this aim, surveys were conducted in the principal vineyards of Palestine's West Bank in the Hebron area from Al-Reheia (Al-Fawwar region), Farsh Al-Hawa north of Hebron, Namra in the city center and Baqa'a in the East part of Palestine during 2019 growing season. The plant tissues were collected from the plants with the symptoms with redding, purpling and yellowing with the leaf edges curling and cupping in the leaf and symptomless grapevines of red or white cultivars The infection ratio of GLRV-4 was determined to be 15% when the collected samples were tested with ELISA and RT-PCR, but GLRV-2 was not detected in the any samples from various parts of Hebron. Sequence analysis revealed that the GLRV-4 isolates obtained in this study showed 89-95% similarity with GLRV-4 isolates reported from different countries of the world. The findings of this study can be used as a documented report on the health of grapevines of Palestine and detection of Ampelovirus would pave the way for more investigation into their identification.

**Keywords:** Grapevine, GLRVs, ELISA, RT- PCR, sequence analysis

# Variation in Prepartum Trophic Behavior in Sheep Fed Diets of Three Puma Corn Silages in Mexico

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## Abstract

Animal behavior vary due to internal factors, including the physiological stage of animal. In pregnant ewes, it has been reported that trophic behavior decreases at the end of gestation, however, little has been explored to determine whether diet quality could affect such behaviors. We study the variations in trophic behavior including intake in ewes at the end of gestation when they were fed diets containing silage made with three Puma hybrids selected in Mexico. Sixty-one Columbia and Dorper crossbred ewes were used, on day 60 of gestation animals were distributed into three experimental groups of three corn hybrids: Centli Puma (N=21), Tsiri Puma (N=20) and Tlaoli Puma (N=20) to which a diet containing 50% silage of each hybrids, 18% alfalfa hay, 10% oat hay and 22% of a commercial concentrated feed was given, as well as free access water. The estimated daily intake of food per animal was calculated. Trophic behaviors were measured using the scan sample method in each group. Measurements were made weekly from day 70 to day 140 of gestation and for three hours in the morning and three in the afternoon, every 15 minutes. The number of ewes in each group was recorded according to the behavior shown at that time, which were: eating, ruminating standing and ruminating lying down. The ewes of Tlaoli group had less eating activity than those in the other groups on days 84, 92 and 119 of pregnancy (P<0.03). Standing rumination behavior was lower in ewes in the Tlaoli group than in the other groups during days 77, 84, and 103 of gestation (P<0.03). Ruminating behavior in a recumbent position was lower in ewes in the Tlaoli group than in the other groups on day 77 of gestation (P=0.01). The estimated intake per ewe per day was high in group Centli Puma than groups Tsiri and Tlaoli Puma (P < 0.0001). It was found that the time factor significantly affected the consumption of the animals (P > 0.0001) in all groups the intake increased as gestation progressed until day 133 which remained stable until day 147 of gestation. It is concluded that the behavior, especially the feeding behavior of sheep at the end of gestation, can be affected by the type of diet.

**Keywords:** Pregnancy, behavior, nutrition, intake, sheep

# POSTER

# Effectiveness of Ozone and Chitosan Coating Applications on Storage Stability of Fresh Aronia

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## Abstract

Aronia (Aronia melanocarpa cv. Nero) is a fruit with high antioxidant capacity and anthocyanin content. In this study, ozone application (5 min., 8 ppm), chitosan coating (1%) and chitosan coating after ozone application were applied to fresh aronia fruits and then they were placed in polypropylene (PP) containers (30 µm thick antifog microperforated, 90 µm hole diameter, 3 holes). These fruits were stored (+4°C) and investigated for 4 months. Analyzes were made on the 1st, 15th, 30th, 60th, 90th, and 120th days of storage and pH, water-soluble dry matter, color values (L, a and b), gas exchange concentration ($O_2$/$CO_2$), weight loss, decay incidence, texture properties, monomeric anthocyanin content, and total phenolic content were determined during storage. According to the results, at the end of the 4th month, the weight loss was found to be the least in the coated aronia groups, while it was found to be the highest in the control group. It was measured that the increase in water-soluble dry matter during storage was highest in the control group and least in the coated aronias. The respiration rate was slowed down as the $O_2$/$CO_2$ release balance was achieved with the effect of ozone application and chitosan coating. At the end of the 4th month, minimum decrease in oxygen gas and minimum increase in carbon dioxide gas was measured in coated and ozone-treated aronia. As the respiration rate increases in fruits, an increase in pH value is observed due to ripening. While the pH increase was observed to be the highest in the control group, it was found to be the lowest in the coated groups. An increase was observed in each group. Fruit firmness varies depending on the structure of the cell wall and changes during ripening. At the beginning of storage, the firmness value of the aronia was 5.24 N. At the end of the 4 month of storage, it was determined that the firmness value was measured as 4.18N for control group, 4.41N for ozone applied group and 5.03-5.16 N for coated groups. It was observed that the ozone and chitosan coating application prevented pectin methyl-esterase activity and cell wall degradation.

**Keywords:** Ozone, chitosan, aronia, storage

# Preharvest 1-Methylcyclopropene Effects on Fruit Quality and Harvest Maturity of 'Cripps Pink' Apples

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## Abstract

This research includes the effects of preharvest 1-Methylcyclopropene (1-MCP) (Harvista) treatments on fruit drop, fruit quality and harvest maturity of 'Pink Lady- Cripps Pink' apple cultivar. For this purpose, preharvest 1-Methylcyclopropene treatments at doses of 50, 100, 150 and 200 g ha-1 were applied to 'Cripps pink' apple cultivar in Çanakkale, Lapseki region, Turkey. Samplings collected from trees at application day and 7, 14, 21 and 28 days after applications respectively. Fruit drop rate, flesh firmness, soluble solids content, starch degradation, titratable acidity, skin color, and ethylene emission were evaluated after each sampling date. Furthermore, fruits were kept at 20-22°C temperature and 50-60% relative humidity conditions for 7 and 14 days as shelf life to determine the changes in quality assessments such as fruit firmness, soluble solids content, titratable acidity and ethylene emission According to the results, Harvista applications with 150 and 200 g ha$^{-1}$ doses were found out as the most positive applications because of preventing fruit drop and minimizing the changes of quality parameters. These application doses enlarged the harvest period thus harvest maturity could be prolonged for 21 days with these application doses. Besides the quality changes during shel life were minimized by these application doses of 1-MCP (Harvista) on "Cripps Pink" apples.

**Keywords:** Preharvest; 1-Methylcyclopropene, fruit drop, quality parameters, shelf life

# Determination of Quality Parameters of Olive Oils Produced from Gemlik Olive Variety in 2023 Harvest Year in Bursa Ecology

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## Abstract

Olive is one of the fruit species whose cultivation is important for Turkiye and the world. Especially the Marmara region is the region where Gemlik olive variety is produced intensively. Quality is essential in olive and olive oil production in the region. This research was carried out to determine the quality components in olive oils obtained from different regions from the 2023 harvest period of the Gemlik olive variety cultivated in the ecology of Bursa province. Olive oils obtained from Gemlik variety olives grown in the orchards of producers in Yaylacık village (Nilüfer), Keşlik (Karacabey), Heceler (Orhangazi), Ülküköy and Göynük (Mudanya) regions were used as material for the study. Different analyses were performed to determine the quality parameters of the olive oils. Peroxide content (meq O2/kg oil), total phenolic compounds (mg/kg GAE), and free acidity (% Oleic Acid) were analyzed in olive oils. In addition, the fatty acid composition and iodine content (%) of the olive oils were also determined by utilizing the FAME. At the end of the study, it was determined that the oils obtained from Yaylacık village of Nilüfer district had very high acidity, while the oils obtained from Heceler village/Orhangazi district had the highest total phenolic component. There was no statistical difference between the olive oil samples from other regions as a result of the measurements.

**Keywords:** *Olea europaea* L., South Marmara, fatty acid methyl esters, total phenolic compound

# The Effects of Bacterial Applications Alternative to 1-MCP on the Storage of the Bursa Black Fig Variety

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## Abstract

In the study, in order to extend the post-harvest life of the Bursa Black Fig variety, which has a high export potential, three different bacterial isolates consisting entirely of Bacillus species (RC65, RC502, RC521) and their binary and triple combinations were applied in seven applications. These bacterial isolates promote the production of secondary metabolites and slow down respiration, while inactivating ethylene synthesis. 1-MCP was applied as a control and positive control in nine applications. Following the harvest, the fruits were dipped in a solution of $1 \times 10^8$ colony-forming units per millilitre of bacteria and then dried rapidly. They were then stored in a cold storage facility with 90% relative humidity at 0°C for 21 days. Following the acceptance of 1-MCP as the control group, the most favourable outcome was observed in the RC521 group in single applications. Although the RC502 group yielded comparatively inferior outcomes in comparison to the 1-MCP group, it yielded favourable outcomes in comparison to the normal control group. Consequently, it is hypothesised that the RC502 group may be a viable alternative in instances where the 1-MCP cannot be attained. It is hypothesised that the application of RC521 may be considered an alternative bacterial application to that of 1-MCP. Once more, in combined applications, the most successful were the RC502+RC521 application and the RC65+RC502+RC521 application, which used three bacterial isolates. These applications yielded the most favourable outcomes in terms of preserving weight loss, fruit flesh firmness and fruit acidity, which are crucial factors at the end of the storage period. It is anticipated that these bacterial applications will make a substantial contribution to the enhancement of the product's market potential, particularly given the high level of market demand. It can be predicted that these applications, which are thought to yield superior results to those of 1-MCP, will serve as a source of income not only for the product market but also for the individuals and institutions responsible for the production and development of the application material utilized in the marketing of RC502+RC521 and RC65+RC502+RC521 applications.

**Keywords:** Fig, quality, post-harvest, bacterial treatments

# Potential of CRISPR/Cas9 Technology in Fruit Breeding

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## Abstract

CRISPR-Cas9 technology has revolutionized the field of genome editing, offering a wide range of potential applications in agriculture and fruit breeding. This innovative method allows for rapid and precise modification by targeting specific genes. The ability to modify the genetic characteristics of fruit trees can contribute to increased productivity and quality. By developing disease and pest resistant varieties using this system, the use of chemical pesticides in agriculture can be reduced and environmental sustainability can be increased. In addition, CRISPR technology can eliminate undesirable traits in fruit species. Fruit varieties with low shelf life or poor taste profile can be made more durable and tasty by gene editing. The development of fruit varieties that are more resistant to drought and temperature changes due to climate change is critical for future agricultural practices. The aim of this study is to examine the working principle of CRISPR-Cas9 technology, its potential and application areas in fruit production and to discuss the advantages of this technology. It also aims to provide an important resource for the scientific and agricultural communities by providing predictions on how this technology may shape fruit production in the future. CRISPR-Cas9 has the potential to not only increase productivity and quality in fruit production, but also to contribute to the development of sustainable agricultural practices.

**Keywords:** Plant breeding, molecular genetics, biotic stress, abiotic stress

# A Study of Volatile Aroma Compounds and Protein Value in Wild Collected Lactarius Deliciosus Mushroom in Çanakkale

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## Abstract

The Çanakkale region is home to many wild mushroom species, especially with its unique ecology. These mushroom species are important import and export products. In the Çanakkale region, the Lactarius deliciosus mushroom, called Melki mushroom, is the first among the wild mushrooms evaluated in the domestic market. Mushrooms are a valuable dietary component due to their numerous health benefits, including their low caloric content and rich nutrient profile. They are especially important with their high protein content. At the same time, mushrooms have a high market value due to their unique aroma. The ratio of aroma components that contribute to a product's distinctive scent plays a significant role in its flavor. In addition, 1-octen-3-ol, one of the main components of mushroom aroma, is utilized in the aroma industry and various other applications. Within the scope of the study, the composition of aroma components and protein content of Lactarius deliciosus mushroom were determined. In the study, wild collected Lactarius deliciosus mushrooms were obtained from a regional bazaar in Çanakkale City Centre. Within the scope of the study, it was observed that Lactarius deliciosus mushroom has a high protein content. In terms of aroma composition, it was determined that 1-octen-3-ol component was the major aroma component. It was identified that the other major components, ranked from highest to lowest ratio, were 3-octanone, 3-octanol, and (E)-2-octenal.

**Keywords:** Lactarius deliciosus, wild collected mushroom, 1-octen-3-ol, protein

# Determination of Pomological Characteristics of Sırrı Local Peach (*Prunus persica* L.) Type of Çanakkale Lapseki Ecology

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## Abstract

Peach cultivation is becoming increasingly crucial in fruit production in Turkiye and in the world due to factors such as our country's different ecological regions, peaches' early yielding ability, their ability to find a place in the fruit juice and canning industry as well as fresh table consumption, and the large number of varieties. The ecology of Çanakkale region allows the cultivation of many fruit species. This shows a rich biodiversity regarding fruit species and varieties. In the Çanakkale region, especially Lapseki ecology has registered the quality of peach cultivation with the 'Lapseki Peach' geographical indication obtained on 10.05.2022. Cultivation in the region is intensively carried out with nearly 40 varieties.This study was carried out in 2022 and 2023 to determine the pomological characteristics of Sırrı type, which is a genotype cultivated in Lapseki ecology of Çanakkale province. Within the scope of the study, fruit width (mm), fruit length (mm), fruit weight (g), stone width (mm), stone length (mm), stone weight (g), fruit flesh ratio (%), soluable solid content (%), titratable acidity (% malic acid), fruit juice pH, fruit skin and fruit flesh colours (fruit brightness, chroma and hue angle) were determined in the context of pomological characteristics of Sırrı peach type. For this purpose, the first study findings that can be used in the registration of Sırrı peach genotype were obtained.

Keywords: *Prunus persica* L., pomology, Çanakkale

# Effects of Low Temperature Storage of *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) Eggs in Different Periods on Larval Emergence

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## Abstract

Storage of mass production hosts of biological control agents is a common practice to ensure their availability. The purpose of this study was to determine the larval emergence from *Ephestia kuehniella Zeller* (Lepidoptera: Pyralidae) eggs after storage in two different low temperatures and different storage periods. 1-day old E. kuehniella eggs were stored in 5°C and 8°C temperatures for 5, 10, 15, 20, 25, 30, 35 and 40 days in refrigerators. At the end of these periods, eggs were transferred to a climate chamber with 25±1°C temperature, %60-65 r.h. and 16:8 (L:D) photoperiod conditions. Number of emerging larvae was counted daily. The experiment was conducted with 10 replicates for each storage period with 50 E. kuehniella eggs in each replicate. For control, 10 replicates with 50 1-day old E. kuehniella egg were used. Data were analyzed with two-way ANOVA and TUKEY tests to determine the differences of larval emergence between storage temperatures and storage periods. For 5°C, difference between the larval emergence of storage periods was significant  (p<0,05). At this temperature, the difference between control, 5-day and 10-day storage was not significant, while these storage periods were significantly higher than all the other periods. Similarly at 8°C, larval emergence of storage periods was significantly different between storage periods (p=0,05). At this temperature, the differences between control, 5-day and 10-day storages were also not significant, while they were significantly higher than other periods. The comparisons between the same storage periods at different temperatures showed that, there was no significant difference between temperatures at 5-day and 10-day storages. However, larval emergence numbers were significantly higher at 8°C for 15, 20, 25, 30, 35 and 40-day storage periods. Another difference between the temperatures was the larval emergence periods. Larvae emerged on the 2nd day after storage in 8°C, while emergence took 4 days after storage at 5°C. These results showed that, there wasn't an important difference between unstored eggs, 5-day storage and 10-day storage at both temperatures. Thus, it is possible to store E. kuehniella eggs up to 10 days without any loss in larval emergence. However, larval emergence was higher if the storage period was 15 days or longer, at 8°C. Thus, temperature selection in short term storage is not important, while 8°C is a more suitable storage temperature for long term storage.

**Keywords:** Low temperature, storage, *ephestia kuehniella*, larval emergence, emergence rate

# Effects of Low Temperature Storage of *Trichoramma pintoi* (Voegele) (Hymenoptera:Trichogrammatidae) Adults on Longevity and Parasitism Performance

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## Abstract

Storage of biocontrol agents in low temperatures is a technique used to increase their availability for application periods. The purpose of this study was to determine the effect of cold storage on the longevity and parasitism performance of *Trichoramma pintoi* (Voegele) (Hymenoptera:Trichogrammatidae) adults in 6°C temperature for different storage periods. In the study, 3 different storage periods were used as 5, 10 and 15 days in the refrigerator. For longevity experiment, 20 female and 20 male adult parasitoids were placed into tubes and 10 females and 10 males were fed with honey, while 10 females and 10 males were unfed. They were placed into the refrigerator and checked daily to determine the longevity. Also, control was established as 10 fed and unfed females with 10 fed and unfed males. For parasitism performance experiment, tubes with adults were placed into the refrigerator and parasitoids were collected from these tubes every five days. For each storage period, 1 female and 2 male parasitoids were placed into glass tubes with 100 *E. kuehniella* eggs in them with 10 replicates for each storage period. Host eggs were checked daily to determine the number of parasitized eggs. These tubes were continued to be kept in the climate chamber with 24±1°C, 65-70% r.h. and 16:8 hours Light:Dark photoperiod conditions until adult emergence and the number of adults were recorded. At the end of the study, the difference between the number of parasitized eggs was statistically significant after different storage periods. The mean number of parasitized eggs in control (77,50 eggs) was higher than all of the stored eggs. The difference between the number of parasitized eggs from 5 days and 10 days of storage was not significant, while 15 days of storage was significantly lower than all other storage periods and control. Mean longevity was significantly different between fed, unfed, fed control and fed control for both females and males, which was lower in unfed control than others. There wasn't any significant difference between males and females in unfed, fed control and unfed control, however male longevity was longer in fed adults. As the conclusion, it is possible to keep *T. pintoi* adults alive for two weeks in 6°C, but parasitism performance decreases as storage times increases. Adult storage can be used as a last resort to continue the life cycle of the parasitoid, but it is not suitable for long term storage of *T. pintoi*.

# Morphological Identification of Fusarium Species in Seed Corn in Çanakkale

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## Abstract

The Çanakkale Province has an important role in Turkey's seed corn production. Fusarium spp. are the most prevalent fungal pathogens affecting seed corn. As Fusarium species are responsible for ear rot in corn production, it is crucial to diagnose the species contaminate the seeds. Diseased corn ears were collected from the Central, Biga, Bayramiç and Ezine districts of Çanakkale Province, where seed corn is produced intensively. The diseased ears were brought to the laboratory and the fungi were isolated on Potato Dextrose Agar (PDA) medium. Species other than Fusarium were not included in the study. Carnation Leaf Agar (CLA) and Synthetic Nutrient Agar (SNA) media were employed to produce spore structures and distinctive characteristics for species differentiation specific to Fusarium species. Colony colour and colony shape were observed as macroscopic characteristics whereas microscopic examination was performed on the production of microconidia, macroconidia, chlamydospore and the formation and shape of sporodochium. A total of 90 Fusarium isolates were obtained from the infected ears. Of the total number of isolates, 27% were identified as Fusarium verticillioides, 20% as F. oxysporum, 14% as F. proliferatum, 4% as F. subglutinans, 3% as F. incarnatum and 32% as other unidentified Fusarium species. While F. verticillioides was the most frequently diagnosed species in all districts, F. incarnatum was the least isolated species. It was observed that the Fusarium species exhibited greater diversity in the Central district where production is higher in comparison to other districts. Similar macroscopic and microscopic characteristics can be observed among Fusarium species, therefore this may mislead during diagnosis of the species. We recommend that the macroscopic diagnosis should be supported by molecular studies.

**Keywords:** Fusarium, morphological diagnosis, isolation, corn ears

# Safety Problems in Feed Mixers

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## Abstract

This paper examines in depth the safety problems encountered in the use of feed mixers. Feed mixers are important equipment widely used in the livestock sector to increase feeding efficiency. However, safety problems experienced in the design and use of these machines can lead to serious accidents and human injuries. This study examines the basic safety problems encountered in feed mixers in detail. Factors such as user errors, deficiencies in machine design, and risks in maintenance and operation processes are among the main causes of these safety problems. In addition, other important safety risks such as inadequacy of machine safety protocols, emergency responses, and lack of protective equipment are also examined. The paper evaluates current safety standards and their applications, highlighting the deficiencies of these standards and areas for improvement. In addition, suggestions are presented regarding safety measures and risk management strategies, and how these suggestions can eliminate security vulnerabilities in feed mixers are emphasized. As a result, this study provides important information to professionals and decision makers in the sector by revealing the safety problems in feed mixer machines and strategic approaches to solve these problems. Addressing safety problems is critical to both increasing employee safety and ensuring operational efficiency.

**Keywords:** Technology, security, design, human behaviour

# The Effect of Different Release Ratios of Predatory Mite Phytoseiulus Persimilis Athias-Henriot (Acari: Phytoseiidae) for the Control of Tetranychus Urticae Koch (Acari: Tetranychidae) on Eggplant

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## Abstract

Eggplant is cultivated in open and greenhouse conditions in our country. Although the homeland of eggplant is known as India and China, wild species are also found in Africa. Eggplant was transported to North Africa via Egypt, then to Spain by the Arabs and to Europe via the Balkans by the Turks. Tetranychus urticae Koch. is one of the pests that cause significant economic losses on eggplant, which ranks high in vegetable production in the world and in our country. Phytoseiulus persimilis Athias-Henriot (Acari: Phytoseiidae) is one of the predators used against this pest in biological control. In this study, the effectiveness of different release ratios of the predatory mite Phytoseiulus persimilis Athias-Henriot (Acari: Phytoseiidae) collected from nature and produced in climate chambers for the biological control of the two-spotted red spider Tetranychus urticae Koch (Acari: Tetranychidae) on eggplant plants under greenhouse conditions in Yeniçiftlik Neighborhood of Marmaraereğlisi District of Tekirdağ Province was investigated against T. urticae Koch. As a result of the study, it was observed that P. persimilis controlled T. urticae at three different release ratios (2:5, 2:10, 2:20 predator:prey), but T. urticae population in eggplant plants released at 2:20 predator:prey ratio increased again after the 7th week. Considering the cannibalism and labor force of the predator, it was concluded that 2:10 predator:prey ratio may be a more effective release ratio.

**Keywords:** Phytoseiulus persimilis, population, release ratio, tetranychus urticae, Tekirdağ, eggplant

# Investigation of Mediterranean Fruit Fly's, *Ceratitis capitata* Wiedemann (Diptera: Tephritidae) Developmental Stages on Different Hosts Under Laboratory Conditions

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## Abstract

The Mediterranean fruit fly, *Ceratitis capitata* Wiedemann (Diptera: Tephritidae), is an important agricultural pest. It is quarantined worldwide and causes agricultural damages in more than 350 agricultural hosts, including stone fruits, ornamentals, and vegetable species. This study was aimed to determine the biological stages of Mediterranean fruit fly on 6 different hosts including avocado, dragon fruit, banana, brussels sprouts, green and black olives under laboratory conditions. Adult rearing cages were established by 20X20X20 using pupae of the laboratory reared colony on an artifical diet. Sugar cubes, a mixture of hydrolyzed yeast and granulated sugar (3:1) were used for adult rearing. Experimental cages were set up with 50♀:20♂ individuals (n=3). To determine egg laying preferences, the hosts were placed singly or alltogether in adult cages. As a result, the average number of oviposition stings was 21.00±8.88 in avocado, 10.33±3.05 in dragon fruit, 13.66±8.02 in banana, 2.40±1.01 in brussels sprouts when tested hosts individually. No oviposition stings were detected on green and black olives as hosts. The average developmental duration was 50.78±8.39 days in avocado, 62.83±9.17 days in dragon fruit, and 65.13±11.07 days in banana when hosts tested individually. No larval development was observed in Brussels sprouts. When the hosts were tested alltogether, the number of oviposition stings was 16.66±2.51 on avocado, 6.33±1.15 on dragon fruit, and 15.66±8.50 on banana. No oviposition stings were detected in Brussels sprouts, green and black olives. The average developmental duration was 51.15±6.49 days in avocado, 65.67±11.28 days in dragon fruit, and 64.13±9.36 days in banana fruit. when host tested together. Avocado was determined as the most suitable host for tested biological properties of the Mediterranean fruit fly. In conclusion, it was determined that the host species had a significant effect on development of the pest.

**Keywords:** *Ceratitis capitata*, biological development, host, pupa, pest

# Plant Parasitic Nematod Fauna in Vineyard (*Vitis Vinifera* L.) Areas of Çanakkale Province

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## Abstract

Grape; It is a perennial plant, *Vitis vinifera*, from the genus *Vitis*, a member of the Vitaceae family, of the order Vitales. It is estimated that there are over 10.000 grape varieties in the world, and the homeland of grapes with such a rich diversity is Anatolia. Our country ranks sixth in the world with a production of 3.670.000 tons.As in all cultivated plants, there are many diseases and harmful agents in grapes. Some of these are; Grape Mildew (*Plasmopara viticola*), Grape Powdery Mildew (*Uncinula necator*), Grape Anthracnose (*Elsinoe ampelina*), Grapevine Moth (*Lobesia botrana*), Grape Mealybug (*Plonococcus citri*, *P. ficus*), Phylloxera (*Viteus vitifolii*) and Plant Parasitic Nematodes (PPNs). Although grape growing is quite important and takes up a large place in our country, the number of nematological studies conducted to date is not sufficient. This study aimed to reveal the BPN fauna in the vineyards of Çanakkale province. In this direction, soil samples were taken by making non-periodic land exits in the regions where the vineyards are dense in the province. Accordingly; a total of 150 soil samples were taken, 60 from Bozcaada, 60 from Eceabat and 30 from Bayramiç. Improved Baermann Funnel Method was used to obtain nematodes in the soil samples brought to the laboratory. Then, the obtained nematodes were identified at the genus level by morphological diagnosis. As a result of the studies, *Aphelenchus* spp., *Pratylenchus* spp., *Tylenchus* spp., *Longidorus* spp. and *Dorylaimus* spp. were detected the most in the vineyard areas of Çanakkale province. Repeating the survey studies at different times will reveal the undetected species. This study is a study conducted to determine BPN species in the vineyard areas of Çanakkale province. It will ensure that the control programs against BPNs in these areas will be healthier and more successful and will also shed light on future studies.

**Keywords:** Çanakkale, vineyards, plant parasitic nematodes

# Innovations in Greenhouse Mechanization and Emerging Agricultural Technologies

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## Abstract

This study explores the role of modern technologies in greenhouse farming, with a particular focus on plant protection, precision spraying systems, soilless farming practices, and the use of agricultural machinery. The research emphasizes how advancements in these areas can significantly enhance agricultural productivity while promoting sustainability. One of the key objectives is to improve plant protection by utilizing precision spraying systems, which offer more accurate and efficient application of pesticides and fertilizers. This approach minimizes environmental impact by reducing the amount of chemicals used and ensuring that plants receive only what they need. The study also explores environmentally friendly agricultural practices, highlighting the importance of sustainable methods that do not compromise productivity. By focusing on precision agriculture and the latest technologies, the research demonstrates how farmers can achieve higher yields with less resource consumption. Soilless farming techniques, such as hydroponics and aeroponics, are thoroughly examined for their ability to increase crop output while using less water and space, making them particularly valuable in regions with limited resources. Automation and mechanization in agriculture are crucial aspects of the study, as they are seen as essential tools for modern farming operations. The use of advanced machinery not only reduces manual labor but also enhances the precision of farming processes such as planting, watering, and harvesting. These technologies help farmers optimize their workflows, reduce waste, and increase overall efficiency. By integrating these innovative technologies, the study demonstrates that greenhouse mechanization and new agricultural technologies can contribute to more sustainable, productive, and efficient farming practices. Ultimately, the research offers valuable insights into how the future of agriculture can be transformed through the adoption of modern, environmentally friendly technologies that improve both the quality and quantity of agricultural production.

**Keywords:** Greenhouse, mechanization, systems, farming, sustainable, agricultural, machinery

# Determination of Fusarium (*Fusarium oxysporum* **f. sp.** *melonis*) and Powdery Mildew (*Podosphaera xanthii*) Resistance of Some Melon Cultivars and Genotypes via Molecular Markers

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## Abstract

Approximately 130 genera and 820 species of melon (*Cucumis melo* L.) are recognized, belonging to the Cucurbitaceae family. Melon production is subject to a number of challenges. Significant challenges to melon production are diseases and pests, which result in considerable losses in quality and yield. The most significant disease agents affecting melons are fusarium wilt (Fusarium oxysporum f. sp. melonis) and powdery mildew (Podosphaera xanthii). As is the case with other species, classical breeding methods, in conjunction with biotechnological techniques such as molecular assisted selection, can be employed in the development of disease and pest-resistant varieties. In the context of global breeding programs, markers associated with fusarium and powdery mildew resistance have been developed, and the resistance of these diseases has been transferred using molecular markers. The objective of this study was to ascertain the resistance of the breeding lines in the melon breeding program to Fusarium and powdery mildew diseases through the use of molecular markers. In the study, 88 advanced breeding lines and 4 commercial melon varieties were utilized as materials. Three genotypes exhibiting homozygous resistance to both diseases, namely powdery mildew and fusarium, were identified. Additionally, numerous melon breeding lines displaying separate resistance to these diseases were also determined. The results may prove instrumental in the development of melon varieties exhibiting resistance to Fusarium and Powdery Mildew diseases.

**Keywords:** Melon, fusarium, powdery mildew, diseases, molecular markers

# Determination of Distribution Area and Damage Rate of *Halyomorpha halys* (Stal) (Hemiptera: Pentatomidae) in Hazelnut Areas of Çatalpınar (Ordu) District

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## Abstract

*Halyomorpha halys* (Stal) originating from the Far East, is an invasive polyphagous pest in our country. It causes economic losses in crops, particularly in hazelnuts, as well as in fruits, vegetables and ornamental plants. The pest reduces the market value of hazelnuts by feeding on them, making its control essential. This study was conducted in 2023-2024 to determine the damage rate and distribution area of *H. halys* in hazelnut fields in Çatalpınar district of Ordu province. Sampling was carried out in three hazelnut orchards in three different village from April 15 to September 15 of both years. A pheromone trap containing 100 mg of Murgantiol + 80 mg of Methyl-E,E,Z-2,4,6-decatrienoate was used for capturing the adults. In all three orchards, adults were continuously caught in increasing numbers with pheromone traps during both 2023 and 2024. The highest number of adults was recorded in August. Additionally, the pest continued to cause damage during the harvest, along with the harm it caused on the fruits while on the tree. In hazelnuts, damages such as yellow meld, black meld, empty kernels, shrivelled kernels, and spotted kernels were observed. It was noted that other hosts present in the orchard had a significant impact on the pest's population increase. Control measures include mass trapping, chemical control, and biological control. In biological control, egg parasitoid *Trissolcus japonicus* Ashmead is released. Moreover, it was determined that the presence of other hosts after hazelnut harvest significantly contributed to the population increase in the following year.

**Keywords:** Ordu, hazelnut, *halyomorpha halys*, traps

# Determination of Population Development of Tomato Leafminer (*Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Tomato Fields of Balıkesir Province

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## Abstract

The research was conducted in 2023 in a 10-decare industrial tomato field of the BASF N0287 F1 variety in Balıkesir, with the aim of determining the population development of Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae). Ten delta-type traps, one per decare, were set up on 11.06.2023 in fixed positions and numbered to monitor the population development of T. absoluta adults. Licensed capsules from the KAPAR DG company, containing 0.5 mg of active ingredient (95% E-Z-Z,3-8-11 Tetradecatrienyl acetate + 5% E-Z,3-8 Tetradecadienyl acetate), were used to attract male T. absoluta individuals to the traps. The adults caught in the traps were counted every 5 days and the traps were cleared for the next count. Additionally, eggs, larvae, and pupae of T. absoluta were recorded on a total of 40 leaves, with 4 leaves from each of the 3-meter plant rows surrounding the traps. The counting process ended with the tomato harvest on 04.09.2023. Adults were captured in all traps, with 3-4 flights observed. The adult population density increased in August, and a total of 3,106 adults were recorded during the sampling period. Statistically significant differences were found in the number of adults caught in the traps in the trial plot (P=0.417). Traps 1 and 2, located to the south where a corn field was present, captured fewer adults compared to the traps located to the north and west, which were surrounded by tomato fields. It was concluded that the dominant wind blowing from north to south contributed to the drift of adults from the tomato fields into this plot.

**Keywords:** *Tuta absoluta*, Balıkesir, tomato, host, pheromone, delta type trap

# Investigation of The Biology of Flebane Species (*Erigeron spp.*) in Orchards

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## Abstract

Fleabane species (*Erigeron* spp.) are an important weed and invasive alien plant species in Türkiye, as in many parts of the world. It is seen as a prominent issue in orchards in the Çanakkale Province. Erigeron canadensis, E. bonariensis and E. Sumatrensis have been reported in the region. The fleabane. The fleabane problem needs to be solved via improving weed control application. Knowledge on biology of weeds and current implementations can help to prepare effective integrated weed control. The phenology of fleabane species was monitored in a total of six orchards in 2023 and 2024 without interfering with the farmers' practices. Periodical weed counts were made starting from December-January and ending in early August at five points in each orchard as on-row, between-row and crown projection. The data related to orchards and practices were obtained from owners. May and June were the densest periods for fleabane in both years while other weeds were seen densely between March and May depending on the year. Fleabane densities in orchards were found to be different according to the farmers' practices. Field data will be supported by greenhouse and laboratory studies to reach a precise recommendation to use in developing integrated weed management programs.

**Keywords:** Weed, *Erigeron canadensis, Erigeron sumatrensis, Erigeron bonariensis*

# Development of a Pursuit Form for Herbicide-Resistant Weeds in Imi-Resistant Sunflower in the Marmara Region and Detection of Resistance in Weeds

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## Abstract

Sunflower is one of Türkiye's most important crops for oil production. Most of the sunflower cultivation takes place in the Marmara Region. Weeds are an important problem in sunflower production that can cause serious yield losses. Imazamox is a member of the imidazolinone chemical class and is an active ingredient in different herbicide formulations, which inhibits the acetohydroxyacid synthase (AHAS) enzyme, which catalyzes the basic reactions in the biosynthesis of branched-chain amino acids. IMI technology is a weed control method that enables the use of imidazolinone herbicides in sunflower production. While conventional sunflower varieties/hybrids are sensitive to imidazolinone herbicides, IMI sunflower hybrids have been modified to survive in a resistant manner to these herbicides. On the other hand, long-term and repeated use of herbicides have led to the development of resistance to given herbicides in some weed species. This study aims to collect preliminary information on the response of weeds spreading on IMI sunflower in the Marmara Region, where IMI sunflower is grown for long time, to the active ingredient imazamox and to determine their current resistance to imazamox herbicides through screening and detection studies. 104 surveys were conducted with sunflower producers in 6 provinces and 31 districts in the Marmara Region. As a result of these surveys, five Clearfield (IMI) technology sunflower cultivars (SUN2259, PİOONER-130, PİOONER-146, SY CHALSE and SY ROSETA) and one normal sunflower cultivar (LİDEA) were identified. In 100 of the surveys, BKU containing Imazamox active was used and 21 successful and 79 unsuccessful applications were recorded. Problematic weeds were identified in the fields of 79 unsuccessful producers and a total of 16 different weed samples were taken. The most prevalent weeds were Cocklebur (*Xanthium strumarium*), Experiments to detect the herbicide resistance situation have been going on. This is prepared from masters study.

**Keyword**s: Herbicide, imazamox, sunflower

# Some Deep Learning Applications Using Convolutional Neural Networks in Agriculture

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## Abstract

World population has been increasing rapidly although agricultural resources to feed it are limited or even under the threat of diminishing due to misuse and urbanization. Moreover, agricultural production has been more and more demanding for technology as labor has been costly and in scarcity. Therefore, developments in computer vision and machine learning have great potential in replacing routine tasks that have been usually performed by human. Deep learning developed especially based on convolutional neural networks can mimic human beings in the tasks that require seeing, decision making related with the task being held and finally performing an action to do the job. Agricultural applications such as seed-fruit classification, soil analysis, irrigation-weed management, plant disease identification, livestock management and yield estimation are the areas where deep learning has the potential to perform automated tasks in place of human. In this study, some agricultural applications including deep learning based on convolutional neural networks have been reported emphasizing the developments, advances, limitations and future potentials. With this study it was aimed to discuss and evaluate the developments in application of deep learning techniques in agriculture.

**Keywords:** Deep Learning , convolutional neural , networks in agriculture

# The Role of Transport in Agriculture

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## Abstract

Transport systems are the most important part of efficient farming. The main role of transport is to deliver agricultural products from farms to markets and cities around the world. Proper logistics is the key to managing assets or goods from the point of origin to the consumers. Also, national well-being depends on transportation, but what if the delivery of products stops and supply chain problems arise. To transfer any agricultural goods, whether conventional or mechanized, agricultural transport is required. In many parts of the world, farmers and producers live far from where their products are distributed. This means that many of the supplies must be transported to collection points, whether for storage or sale. Road transport plays a crucial role in bridging the gap between rural agricultural areas, processing facilities in industrial regions and ultimately urban consumers and businesses, facilitating efficient distribution of crops. The future of logistics and agricultural transport must turn to technology and innovation, focusing on sustainability and efficient transport. The issue of greatest concern is unpreparedness for these changes. The transport sector needs to embrace innovation as it has a significant impact on the environment and with the introduction of new technologies it is possible to reduce this impact.

**Keywords:** Efficient agriculture, transport, supplies, logistics, agricultural transport

# Carbon Stocks in Deciduous and Evergreen Oak Ecosystems in Greece

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## Abstract

Most of the terrestrial organic carbon reserves are found in forest ecosystems, which are essential to the global carbon cycle. In this work we investigated the carbon stocks in two oak habitats with distinct phenology (deciduous vs. evergreens) in 6 study plots in the region of Xanthi, Greece. We determined the following carbon pools: aboveground (ABG), belowground (BGB), fine root biomass, deadwood and forest floor. Samples of the forest floor were collected seasonally for a year. Additionally, yearly sampling of fine roots and soil were conducted, and aboveground biomass was determined in each plot. C stock in forest floor was 6.98 t ha$^{-1}$ and 6.9 in evergreens and deciduous oaks, respectively. In addition, C in forest floor picked during the summertime for evergreens and in autumn for deciduous oaks. SOC did not have any significant difference between the two ecosystems, 16 t ha$^{-1}$ and 17.95 t ha$^{-1}$ for evergreens and deciduous oaks, respectively. Carbon of ABG and BGB did not differ among the two ecosystems, and it was around 57-65 t ha$^{-1}$ and 22-24 t ha$^{-1}$ for AGB and BGB, respectively. Carbon of deadwood was 5-fold higher in evergreens (1.25 t ha$^{-1}$) than in deciduous oaks (0.25 t ha$^{-1}$). Finally, carbon of fine root standing biomass is similar (3.25 for deciduous and 4.0 t ha$^{-1}$ for evergreens) among the two ecosystems. Overall, deciduous and evergreen oaks did not present any notable differences in terms of their C stocks.

**Keywords:** Quercus frainetto, quercus coccifera, forest biomass, carbon pools

# International Balkan Agriculture Congress

# Challenges of Sustainable and Innovative Conservation Agriculture: an Assessment Based on Expert and Farmer Experiences

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## Abstract

Development and implementation of conservation agriculture in the world faces various challenges. Turkey is under the same influence. In order to determine challenges, issue was addressed from the focus groups, experts, academics, leading farmers.Findings showed that the challenges can be divided into categories such as institutional-infrastructure, economic, education-research, environmental, and mechanization. Institutional challenges have emerged as fundamental concepts, incompatibility of practices in different sectors, confusion of farmers due to different expert experiences. Economic has emerged as certain issues, the need for mechanization equipment with high purchasing costs and the financial weakness, and the lack of approved budget and credit specific to this. Education-research challenges come together on two fundamental concepts, insufficient education and research, four fundamental environmental challenges have emerged as problems arising from the protection or use of crop residues on farms, different climate conditions, animal grazing, and farm ownerships. Mechanization has emerged as two issues, equipment incompatibility according to different climate and regional conditions and limited access to equipment. Institutional-infrastructure and economic have been observed as the most frequently encountered challenges. It has been determined that the lack of educating farmers for use of equipment with advanced technology. Moreover, the lack of sufficient research conducted and concluded in different climates to guide farmers. It has been concluded that it is necessary to connect agricultural organizations, education-research units, government or non-government organizations to overcome the challenges of conservation agriculture. Location-specific, basin-based sustainable practices should be suggested to farmers as models by experts, and these should firstly be tested by leading-farmers and then disseminated in small-scale family farms. In addition, it has been suggested that farmer education should be practiced and the transition to conservation agriculture should be facilitated. For this purpose, a dynamic and updatable information guide should be published at the national level, this guide should be included in curriculum of agricultural departments.

**Keywords**: Reduced soil tillage, crop rotation, soil/water conservation, sustainable agriculture

# Materials and Ratios Used in the Manufacturing of Small Capacity Olive Oil Production Machines

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## Abstract

The selection of materials for machines manufactured for the food industry is crucial in terms of their compatibility with food. Additionally, when selecting materials, it is important to consider their compatibility with each other, economic feasibility, availability, and processability. This study aims to analyze the materials used in the manufacturing of machines for olive oil production, their structural properties, and usage ratios, and to determine material demand projections. To achieve this goal, boutique-type olive oil production machines with various capacities (50, 100, 200, 300, 400, 600, and 900 kg/h) were examined. These machines, which operate with a combined production system, are agricultural machines made from different materials depending on the interaction between the material and the food in terms of food compatibility. The production catalogs of the machines manufactured by a company producing boutique-type olive oil machines were reviewed, and the types of materials used in the manufacturing process were identified, along with the usage ratios of each material for each machine. Based on the types of materials used and their mass ratios in each machine, data were collected that could serve as a guide for determining material demand projections by machine type, manufacturer, and region. The study reveals how changes in structure and size, associated with increased olive processing capacity, affect the material composition of the machines analyzed. The analysis showed that sheet metal is the most widely used material by weight, with usage ratios of 56%, 67, 64, 59, 66, 67 and 66 in machines with capacities of 50, 100, 200, 300, 400, 600, and 900 kg/h, respectively. To ensure that no structural degradation occurs in the quality of the olive oil, boutique-type olive oil production machines with a combined production system are designed to maintain stability under the required conditions. Various systems, such as sensors, force and motion machines, dough pumps, and hot water circulation installations, have been integrated into the machines to achieve this. These pre-purchased components, including the aforementioned systems, were identified as the second most significant material group in terms of weight, with percentages of 29%, 19, 17, 20, 14, 13 and 14 respectively.

**Keywords:** Material, agricultural machinery, machinery manufacturing, olive oil, material demand projection

# Changes in Colour Parameters of Persimmon Varieties in Drying with Infrared Energy

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## Abstract

Persimmon is a fruit in high demand by consumers in international markets for its appearance, aroma, nutritional, and medicinal value. Due to the limited seasonal consumption and the high moisture content of the product, drying is a practical method to extend its shelf life. Persimmon is a fruit that stands out due to its colour and is expected to maintain its quality and attractiveness after drying. Colour index values show reliable and multidimensional approaches in evaluating the colour-related quality characteristics of products. In this study, the effects of different infrared radiation intensity and air velocity on colour parameters such as browning index ($BI$), whitening index ($WI$), yellowness index ($YI$), colour angle ($\Delta H^*$) and colour saturation change ($\Delta C^*$) of persimmon varieties were investigated. Experiments were conducted at infrared medium wavelength, three different infrared radiation intensities (IP) (1037, 1210, and 1407 W m$^{-2}$), and three different air velocities (Av) (1.0, 1.5, and 2.0 m s$^{-1}$). When the results were examined, the change in colour angle was higher in Hachiya (+29.68) compared to the other varieties, while the change in saturation was similar in all varieties. The whitening index varied between 37.02-42.28 for Fuyu, 43.03-47.32 for Hachiya, and 47.96-52.57 for Rojo Brillante. The yellowness index ranged between 93.65-110.51 for Fuyu, 68.31-96.97 for Hachiya, and 69.13-79.22 for Rojo Brillante. The browning index varied between 88.58-196.07 for Fuyu, 39.36-138.36 for Hachiya, and 41.37-103.69 for Rojo Brillante. Rojo Brillante variety showed significantly higher whitening index values; in other words, less browning occurred. In terms of the yellowness index, higher values were obtained in the Fuyu variety compared to other varieties. The effects of the interactions of variety, infrared radiation intensity, and air velocity on the other properties examined, except the browning index, were significant for dried persimmon slices. In this context, drying all three varieties of persimmon using the infrared drying method gave positive results in colour parameters. Further studies are needed to investigate the effect of different drying methods on colour indices.

**Keywords:** Persimmon, colour indices, infrared radiation intensity

# Sustainable Soil Management in Maize Production

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## Abstract

Although the maize plant belongs to the tropical plant group in terms of its origin and structure, it is primarily produced in temperate climate zones. Maize, whose primary uses are in industry and as animal feed, has a global annual production of 1.2 billion tonnes. In recent years, the increasing costs of fuel used during soil tillage and the desire to prevent soil erosion have led to a global trend towards alternative soil tillage methods. In maize production, both traditional and conservation tillage methods are employed. Traditional tillage involves turning over the soil and processing the entire surface of the field. This method not only reduces the organic matter content in the soil but also accelerates soil erosion, directly affecting soil productivity. To minimise these adverse effects, farmers have increasingly been adopting conservation tillage practices. Among conservation tillage methods, the most commonly used is reduced tillage. In this method, machinery that prepares the soil in one pass is preferred, thus preventing the soil from becoming overly pulverised while also saving fuel. Other conservation tillage techniques include strip tillage (processing only the areas where crops will be planted), ridge tillage (where crops are planted on ridges to preserve soil moisture by shading the soil between the ridges), and no-till farming, which involves planting directly into undisturbed soil without the use of tillage equipment. Studies and field trials have shown that repeated conservation tillage on the same field can lead to an accumulation of plant residues on the soil surface, which may cause problems in subsequent planting operations. One study found that implements which rip the soil, rather than those which turn it over, have a more positive impact on crop growth in maize production. In areas where the soil was ripped, maize plants exhibited more extensive root development, with roots penetrating deeper into the soil compared to areas where the soil was turned over. As a result, the plants were better able to utilise nutrients and moisture from the soil. In light of this information, rising production costs and fuel prices both in our country and worldwide demonstrate that the application of conservation tillage techniques benefits both businesses and national economies.

**Keywords:** Conservation tillage, ridge tillage, strip tillage

# The Future of Animal Husbandry: Mechanization and Technological Innovations

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## Abstract

The future of animal husbandry is shaped by rapidly changing technology and innovations in the field of mechanization. This study presents a comprehensive compilation of mechanization and technological developments aimed at increasing the efficiency and sustainability of modern animal husbandry. Our study examines the latest technological innovations and mechanization applications in the animal husbandry sector, and examines the effects of these innovations on the sector. Modern equipment and automation solutions used in areas such as feeding systems, milking technologies, health monitoring systems, and manure management are discussed. In addition, the environmental impacts of technologies and potential solutions are evaluated, along with developments in energy efficiency and sustainability. The study emphasizes the positive effects of mechanization and technology on efficiency in animal husbandry, while also discussing the challenges encountered and how these challenges can be overcome. Forecasts are presented on the role and future potential of advanced technologies such as artificial intelligence, robotic systems, and data analysis in the sector. In conclusion, this study provides a broad perspective on the future role of technological and mechanical innovations in animal husbandry and provides valuable information for professionals, researchers and policy makers in the sector. The future of animal husbandry will become more efficient, sustainable and innovative with these technological transformations.

**Keywords:** PLF, animal health, animal welfare, prediction, sensors

# Determination of Pesticide Analyzes in Avocado Fruits with the QuEChERS Method

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## Abstract

The avocado (*Persea americana* Mill.), which belongs to the Lauraceae family, is a tropical fruit originated to Central Mexico and is cultivated in nearly 50 countries worldwide. In Turkiye, Mersin province ranks second after Antalya in avocado cultivation. Pests that are harmful to avocado cultivation are, in order of importance, Mediterranean fruit fly (*Ceratitis capitata*; Diptera: Tephritidae), avocado thrips (*Scirtothrips perseae*; Thysanoptera: Thripidae), scale insects (*Aonidiella aurantii*; Hemiptera: Diaspididae), citrus mealybug (*Planococcus citri*; Hemiptera: Pseudococcidae), black rat (*Rattus rattus frugivorus*; Rodentia: Muridae), and root rot caused by *Phytophthora cinnamoni* Rands (Peronosporales: Peronosporaceae). Farmers first prefer chemical control in pest control. However, incorrect pesticide applications may pose environmental risks and residue risks. This study aimed to verify the analysis of pesticide residues in avocado samples collected from commercially grown orchards using the QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe) method. Method verification is a quality parameter in pesticide residue analysis. Analytical methods must be verified before real sample analysis. For this purpose, pesticide free avocado samples will be spiked at 1 x LOQ and 10 x LOQ levels, with five replications. The QuEChERS method will be followed for extraction and clean-up, and chromatographic analyses will be conducted by using LC-MS/MS. Representative matrix-matched calibration (MC) will be used to eliminate matrix effects. The validation criteria will be compared with the SANTE 2021 requirements. For this study, samples will be collected from five orchards, four times a month, for 12 weeks. A minimum of six avocados were sampled for each sampling. Both spiked and collected avocado samples will be analysed with QuEChERS-AOAC Method 2007.01.

**Keywords:** Pesticide residue, QuEChERS, fortification

# Investigation of Pesticide Awareness Levels of Farmers in Çanakkale Province

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## Abstract

In this study, it is aimed to compare the awareness levels of farmers practicing organic farming, good agricultural practices (GAP), and conventional farming regarding pesticide use in the Çanakkale province. The unconscious use of pesticides in agriculture can have negative effects on both human health and the environment. Therefore, increasing farmers' awareness of the correct and safe use of pesticides is of great importance. The main objective of this study is to evaluate the knowledge and awareness levels of farmers applying different agricultural methods and to determine the differences between them in terms of pesticide use. Within the scope of the research, a total of 687 surveys were conducted with 200 organic farmers, 109 GAP farmers, and 378 conventional farmers in Çanakkale province. The data were analyzed using software. The results of the study showed that organic farmers are more conscious about pesticide use and are more cautious about the negative impacts of pesticides on the environment and human health. GAP farmers also demonstrated a certain level of awareness regarding pesticide use, though their awareness was lower compared to organic farmers. On the other hand, it was found that conventional farmers are less aware of the environmental and health impacts of pesticide use compared to the other two production models. It was determined that the awareness levels of conventional farmers regarding pesticide use need to be improved. To address this, it is recommended to implement more comprehensive training programs, advisory services, and enhanced monitoring mechanisms to increase farmers' awareness about pesticide use.

**Keywords**: Agriculture, organic, good agricultural practices, awareness

# The Use of Near Infrared Spectroscopy (NIRS) in Pesticide Residue Analysis

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## Abstract

This study was conducted to explore the possibility of using Near Infrared Spectroscopy (NIR) for the detection of the active substances tebuconazole and imidacloprid. In this context, the potential of NIR spectroscopy to be used as an alternative or complementary method for pesticide residue analysis was evaluated. The study material consisted of solutions prepared with the active substances tebuconazole and imidacloprid, applied to distilled water and blotting paper. While preparing the doses for the differentiation of pesticides based on spectral measurements, the Maximum Residue Level (MRL) residue amounts for tebuconazole (0.9 mg/kg) and imidacloprid (0.5 mg/kg) in tomato plants were taken as a reference. Five different concentrations of these pesticides were prepared, corresponding to 1, 2, 4, 10, and 20 times the MRL values. Two different methods were followed to collect spectral data from these solutions. In this context, spectral data were collected directly from the solutions using transflectance cups in the NIR device and by impregnating the solutions into coarse filter paper and reading in reflectance mode. It was observed that the samples impregnated into the paper and those read directly exhibited different radiation values. It was particularly noted that the samples impregnated with 2 MRL of imidacloprid and 1 MRL of tebuconazole could be distinctly separated from the others based on the spectral data. This preliminary study indicates that NIR spectroscopy can be used for pesticide detection. Future studies involving an increase in the number of samples and experiments on different active substances may provide more detailed information on the potential use of NIR spectroscopy in residue analysis. Moreover, it may also be possible to develop prediction/classification models for pesticide residues.

**Keywords:** Pesticide, near infrared spectroscopy, tebuconazole, imidacloprid

# Effects of Conventional, Strip Tillage, and Ridge Planting Applications on Plant Emergence and Growth in Popcorn Cultivation

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## Abstract

In recent years, rising costs have led the world to experiment with and implement production methods that aim for the highest yield at the lowest cost. In Turkey, fuel expenses have been observed to be the largest input cost in agricultural production. Therefore, alternative methods such as strip tillage and ridge planting, to the conventional production methods practiced in the country, have been tested for feasibility. This study, which includes the initial data from a scientific research project, aims to investigate the effects of conventional and strip tillage, as well as ridge planting methods applied in popcorn cultivation, on soil, plant growth, yield, and product quality in the Sivrihisar region of Eskişehir. This paper presents some preliminary data regarding plant emergence and growth from the ongoing research. The experiment was conducted on 12 da plots in the Upper Sakarya Plain under Central Anatolia conditions according to the randomized block design. For conventional tillage, the seedbed was prepared using a mould-board plow, chisel, rotavator, and spring cultivator. In the plot where strip tillage was to be applied, the soil was processed in strips using a modified inter-row hoeing machine equipped with a tiller, without any additional treatment. For the ridge planting method, the soil was tilled in the fall using a rotavator to eliminate residues from the previous year, and ridges were formed before planting using a ridge machine. Planting and all other cultural practices were kept consistent across the different methods. The average germination time for all three methods conventional tillage, strip tillage, and ridge planting was found to be 8 days, with no significant difference observed between them. However, once plant development was complete, the average plant heights were measured as 2.5 m, 2.7 m, and 2.36 m, respectively. The average stem diameters were 25.6 mm, 23.6 mm, and 25.3 mm, respectively. The first ear heights were found to be 1.33 m, 1.25 m, and 1.30 m, respectively. According to the initial findings, the ridge planting method, selected as an alternative to the conventional method, appears to yield results comparable to the conventional method in terms of plant emergence and growth. Of course, further comparisons will continue as more data are collected from the ongoing research.

**Keywords:** Reduced tillage, ridge planting applications, strip tillage, popcorn

# Importance of Automatic Steering Systems in Agricultural Production

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## Abstract

Today, the use of automatic steering systems in agricultural production technologies is of great importance in terms of agricultural efficiency and precision. These systems enable tractors and other agricultural machinery to be directed automatically, minimizing operator errors and reducing labor costs. Automatic steering systems utilize precision positioning technologies such as GPS (Global Positioning System) and RTK (Real-Time Kinematic) to steer agricultural machines without human intervention. This review comprehensively examines the role of automatic steering systems in agricultural production, the advantages they provide, and their application areas. One of the most significant advantages of this systems is the increase in accuracy in agricultural activities. Traditional methods of agricultural processes are prone to human errors, which can lead to yield losses. However, automatic steering systems operate with millimetric precision, allowing processes such as planting, fertilization, and spraying to be performed more accurately. This not only enhances product quality but also optimizes resource usage. Additionally, these systems reduce the operating hours and fuel consumption of agricultural machinery, contributing to environmental sustainability. Another important benefit of this technology is the reduction of labour costs. Automatic steering systems enable agricultural operations to be conducted more quickly and efficiently without operators needing to constantly steer the machinery. This not only reduces costs for agricultural businesses but also increases workplace safety. Furthermore, these systems can operate day and night, under all weather conditions, ensuring uninterrupted agricultural activities. From an environmental sustainability perspective, automatic steering systems minimize unnecessary spraying and fertilization, thereby reducing harm to soil and water. When used alongside precision farming practices, these systems promote eco-friendly production and enable farmers to achieve high yields without harming the environment. In conclusion, automatic steering systems innovation in agricultural production technologies, offering significant advantages in efficiency, accuracy, and sustainability. This review aims to evaluate the current status of this technology and its potential future developments, highlighting its contributions to the agricultural sector. The widespread adoption of automatic steering systems will allow for higher efficiency and quality standards in agricultural production. In this context, it is crucial for all stakeholders in the agricultural sector to assess and implement the opportunities provided by this technology.

**Keywords:** Automatic steering systems, precision agriculture, GPS technology, agricultural efficiency, sustainability.

# Forecasting and Early Warning Systems in Viticulture

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## Abstract

Forecasting and early warning systems that enables the detection and announcement of the time to fight against diseases or pests. In our contrry, firstly, in the early eighties, forecasting anda early warning systems researched in vineyards. It has been implemented against downy mildew (*Plasmopara viticola)* disease and grape moth in vineyards. There is a close relationship between temperature and organism development. The day degree modeling method is one of the frequently used methods. With the system, air and soil temperature, relative humidity, leaf wetness, pressure, snow and wind sensors are collected under field conditions and is transferred to the computer. The information reaching the center is evaluated computer-aided and announcements are made via text messages and notifications. It is announced to the producers via e-mail. Advantages of Forecast Warning System; unnecessary pesticides are not applied and ensures the protection of human health and the environment, ensures sustainable production and development. The climatic data required for control, the development periods of the plant, the fungus causing the disease or the biology of the bacterium or pest is regularly can be viewed as. Forecasting and early warning systems goals are obtaining high quality products with no pesticide residues, to protect and support beneficial organisms.

**Keywords:** Grapevine, downy mildew, grape moth,early warning

# Carbon Footprint and Management in Turkish Agriculture

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## Abstract

Agriculture is one of the sectors that cause climate change and are greatly affected by this change. It is known that arid and semi-arid regions of the world are becoming more vulnerable to climate change. Imbalances in carbon emissions (climate change, greenhouse gases, etc.) accelerate the process and it is an undeniable fact that it will negatively affect the life cycle in the future. This research aims to reveal the carbon footprint of Turkish agriculture. According to TÜİK data, Turkey's total greenhouse gas emissions in 2022 are 558,3 million tons (Mt) $CO_2$ equivalent. Total greenhouse gas emissions per capita were calculated as 6.8 tons CO2 and 6.6 tons $CO_2$ in 2021 and 2022, respectively. Turkey's agricultural sector emissions increased by 37,9% compared to 1990 and were calculated as 71,5 Mt $CO_2$ equivalent in 2022. Therefore, it is vital to develop carbon footprint reduction strategies and sustainable methods in agricultural production. In a study conducted by researchers, the effects of soil tillage on carbon dioxide ($CO_2$), methane ($CH_4$) and nitrogen oxide ($N_2O$) emissions were evaluated. Researchers determined that zero tillage (NT) significantly reduced $CO_2$, CH4 and $N_2O$ emissions by 35,43%, 67,33% and 339,07%, respectively, compared to conventional tillage (CT). As a result, intensive technological agricultural practices and intensive agricultural inputs increase greenhouse gas emissions, in other words, the carbon footprint in agriculture. Reducing the carbon footprint in agriculture is critical to combating climate change. Strategies such as sustainable agricultural practices, soil management and renewable energy use can help reduce agricultural emissions. The future of the agricultural sector can be shaped by environmentally friendly and sustainable practices. Therefore, it is necessary to develop systems and methods that will reduce the carbon footprint and to provide incentives for the implementation of these systems. In order to develop carbon footprint reduction strategies in agriculture, it will be of great importance to conduct carbon footprint analysis in each section of the agricultural sector.

**Keywords:** Carbon footprint, greenhouse gas emissions, sustainable agriculture

# Effect of Elicitors on Biomass Growth Rate in Callus Culture of Verbascum Scamandri

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## Abstract

*Verbascum scamandri Murb.* known as Kazdağı mullein, is one of the endemic plants of Çanakkale, Türkiye. The aim of the study is to evaluate the effects of elicitor treatments on callus biomass in the callus culture of *V. scamandri*. Leaf explants were cultured on Murashige & Skoog basal medium containing 3% (w/v) sucrose, 0.7% (w/v) agar, and 0.5 mg/L 2,4-Dichlorophenoxyacetic acid with 0.5, 2 and 3 mg/L Kinetin combinations for callus induction. The calli were subcultured for three times in the induction media for propagation. After propagation, methyl jasmonate (MeJA; 0, 50, 100, and 200 µM) and salicylic acid (SA; 0, 50, 100, and 200 µM) elicitors were added to the three media. Each treatment was set up in triplicate. Growth index, color, and texture data of elicitor-treated calli were recorded on the 21st day of culture. The *in vitro* cultures were conducted in a plant growth chamber under dark conditions at 25±2°C with 55-60% relative humidity. The results showed that the growth index of the calli decreased with increasing concentrations of MeJA and SA in all media when compared to the control groups. In MeJA-treated media, although the growth index was highest at 0 µM (range 4.57 to 3.18), it was observed that the growth index decreased with increasing elicitor concentration at 50 µM (3.83 to 2.92), 100 µM (2.82 to 2.41), and 200 µM (1.59 to 1.43). Similarly, in the SA-treated media, the growth index was highest at 0 µM (5.10 to 4.57) and decreased with increasing elicitor concentrations at 50 µM (3.29 to 2.56), 100 µM (1.83 to 1.41), and 200 µM (1.57 to 1.18). In addition, the MeJA-treated calli exhibited yellow or yellow-brown coloration with a compact texture, while the SA-treated calli formed yellow-brown compact calli. The results indicate that both MeJA and SA affect callus growth, although no statistically significant differences were found.

**Keywords:** In Vitro, methyl jasmonate, mullein, salicylic acid

# Protocol of Agricultural Practices for Olive Cultivation in Island Regions

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## Abstract

Aegean islands are facing serious problems related to reduced water supplies and low quality of available water resources. Furthermore, in many island regions, due to the above, but also due to the lack of knowledge in the application of good agricultural practices by producers, there are severe problems of reduced yields in olive cultivation. The main objective of the present study is the creation of a protocol that contributes to: a) the management of reduced quantity and low quality of irrigation water in the Aegean island regions, and b) the management of reduced productivity in olive cultivation through the application of good agricultural practices. The proposed protocol was developed in the frame of the project "Protocol of agricultural practices in olive cultivation in island regions for more efficient use of water and addressing reduced productivity". The agricultural practices protocol for olive cultivation is organized as follows: General cultivation practices: General cultivation practices are presented, including technical application details. The main objective of each practice is also explained, aiming to highlight its importance. Current irrigation water management: The current situation of water management in islands' olive cultivation is discussed. Irrigation strategy: Information on irrigation practices is provided (irrigation system selection factors, irrigation frequency, water quantity and quality, critical periods of irrigation, etc.) in order to provide all necessary input for the formulation of an integrated irrigation strategy. Assessment of crop water needs: The water requirements according to the type of crop and the total water losses need to be determined. To this end, the importance of an irrigation calendar and irrigation based on meteorological data is highlighted. Practices to reduce surface runoff: The following practices for increasing the soil water content are presented: bio-barriers, barriers perpendicular to the slope, soil organic matter increase, cover crops, intercropping, limiting tillage, use of organic fertilizers and soil cover, circular grazing systems. Response to extreme events: Action plans for response to extreme events related to water management (frost, heat waves, and extreme rainfall) are presented. Soil Management: The main soil management practices are presented, including mechanical soil treatment, reduced tillage, cover crops and grass cutting. The implementation of the proposed protocol will contribute significantly to a more efficient use of water in agriculture. The proposed protocol can be utilized as a decision-making tool, thus contributing to the search for viable and practical solutions to the problems of olive cultivation in the Aegean island regions.

**Keywords:** Water management; soil management; climate change; sustainable agriculture

# In-Season Estimation of Winter Wheat Phenology Using Variations of the Heat Unit Model

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## Abstract

Knowledge of crop phenology, particularly for important commodity crops, is vital to ensure stable food systems. Crop phenology is largely affected by temperature, which is a key factor for the timing of biological processes and the development of plants. Thus, monitoring climatic conditions of crop growth allows better understanding of crop development and proper adjustment of management practices during the growth stages. In the present study, growth of durum wheat (*Triticum durum*) was monitored in the province of northern Evros from November 2020 until July 2021 using meteorological data that were collected from the local station of the National Observatory of Athens, Greece. In addition, all stages of the biological cycle (from germination to ripening) were photographed with a Nikon D3500 digital camera. Based on the meteorological data collected, the growing degree-days (GDDs) for each growth stage were calculated, firstly, with the average method as the most common method of calculation and, secondly, with the modified average method. Additionally, four different upper and lower value approaches were applied to each method, resulting in eight scenarios. The growing season lasted 222 calendar days. The vegetative stage (germination to tillering) accumulated the highest values of GDDs. The analysis with the two different ways of calculating the total GDDs where the same limits were used led to the conclusion that the modified average method tended to accumulate higher values of GDDs than the average method. The accumulation of GDDs was correlated with the growth stage of wheat plants according to Zadok's scale.

**Keywords:** Growing degree-days (GDDs), heat units, meteorological data, winter wheat, Zadok's scale

# Industrial Hemp Cultivation in Greece

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## Abstract

Industrial hemp (*Cannabis sativa* L.) is a sustainable, high-yielding crop. According to the European and Greek legislation, cultivated hemp varieties must be registered in the European Catalogue, and their tetrahydrocannabinol (THC) content has to be below 0.3%. Hemp is an annual, wind-pollinated plant with both dioecious and monoecious varieties. It thrives in well-drained, medium-heavy soils with moderate fertilization. The performance of hemp in the field is the result of the interaction between genotype, environment, and crop management. Key factors influencing final yield and quality include plant density, mineral nutrition, and irrigation levels. The primary products of hemp cultivation are bast fibers for cordage and textiles, seeds for food and seed oil, and flowering tops for medicinal and psychoactive purposes. In the growing season 2023, two monoecious hemp varieties, Fedora 17 and Ferimon, were cultivated in Evros, Serres, and Thessaloniki regions in Greece, as a part of the CANNABOTYCHERO program (PAA M16SIN2-00402). Sowing was conducted using a pneumatic seeder at a rate of 20 kg/ha, with a row spacing of 80 cm. Soil and agronomic measurements were taken during the growing season, and the THC content was also analyzed. Both tested varieties were well adapted to the Greek climatic conditions without exceeding the minimum THC limits, with an average seed yield of 300 kg/ha and an oil content of 25%. Furthermore, the produced hemp seed oil was of high nutritional value and could be considered as an alternative source for industrial hemp use in Greece.

**Keywords:** Hemp (*Cannabis sativa* L.), tetrahydrocannabinol, seed oil, nutritional value

# Forage Yield and Quality of Barley-Annual Medic Intercrops

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## Abstract

Legumes are very important in sustainable agriculture. Annual medic, which is widely found in natural vegetation in our country, should be used in agriculture. It should be used especially in agricultural areas where the amount of organic matter is very low. Forage yield and quality were determined by mixed planting with barley (*Hordeum vulgare* L.) and annual medic (*Medicago orbicularis*) in the same row at the rates of 100%, 75%, 50% and 25%. The study was conducted in Çanakkale Onsekiz Mart University Dardanos Campus experiment fields between 2022-2023 years. The research was established according to the randomized parcel trial design with 3 replications. Harvest for forage was made during the flowering period of barley. Forage green yield, forage dry yield, NDF, ADF, ADL and crude protein ratio were determined. The highest forage green and dry yield was obtained from barley + 100% annual medic mixed plots. No significant difference was determined between plant heights. While there was no difference between the NDF, ADF and ADL ratios of forage, the highest crude protein ratio was detected in the barley + 100% annual medic plots. As a result of the study, in terms of forage yield and quality, it may be recommended to plant barley mixed with 100% button clover instead of of barley alone.

**Keywords:** Hordeum, annual medic, intercrops, forage yield, forage quality

# Availability of Macro- and Micro Elements in Wastes Obtained from Soft Processing of Oriental Tobacco

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## Abstract

Macedonian oriental tobacco has high-quality color, aroma, and flavor, and exhibits excellent burning properties due to suitable soil characteristics and climate conditions. The leaf is considered the only commercially valuable part of the oriental tobacco, while during soft processing, leaf scrap, fines, and dust are separated. This solid tobacco waste, which originates from primary processing, is produced in significant quantities of approximately 20% of the input materials, and its effective use is limited. Biodegradation through composting is an acceptable solution because it reduces the volume of waste, accelerates the breakdown of nicotine, and results in the production of a less toxic and more useful organic amendment. In this study, the research objective was the determination of the physical–chemical properties of waste (scrap, fines, and dust) from the tobacco type Prilep, grade AB, and the reuse of tobacco waste as an ingredient in an organic fertilizer mixture. Macro- and microelements in samples were determined by microwave-assisted acid digestion, followed by analysis using atomic absorption spectroscopy- AAS. Total phosphorus was determined by the ammonium molybdate spectrophotometric method, and total nitrogen by the Kjeldahl method. According to the results, the content of macroelements such as N, P, K, and the N/P and C/N ratios showed higher concentrations in scrap and fines. The concentration of microelements—Ni, Cd, Cr, Pb, Cu, Zn, Fe, and Mn—in the samples ranged between 0.09 and 146.75 mg kg$^{-1}$. Although the concentrations of elements varied among the samples, their accumulation pattern was found to be similar, with the contribution of microelements to the total concentration of elements being below 1%. Regarding the concentration of heavy metals in all examined tobacco wastes, the concentrations were below the standard limits proposed for organic composts, allowing their use in agricultural soils.

**Keywords:** Oriental tobacco, macroelements, microelements, composition, AAS

# Comparison Antioxidant Content of Red and Blue Maize Genotypes Using Different Extraction Methods

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## Abstract

Colored agricultural products have scientifically proven health benefits. Colored maize genotypes have the potential to become important color pigment raw materials. The natural color pigments that give color to maize are anthocyanin, phlobaphene, carotenoids and chlorophylls. These color pigments are used as colorants in the industrial industry. However, these substances, which can be synthesized in different tissues of maize, need to be extracted first. For this purpose, the ultrasonic extraction method is one of the alternative and effective methods. In this study, the amount and content of anthocyanin, the natural color pigment that gives red and purple color to the maize kernel, were compared by different extraction methods (chemical and ultrasonic) from red and purple kernel maize genotypes. Anthocyanin, phenolic compounds and antioxidant activities of the genotypes were analyzed and compared according to the extraction methods. The data obtained were evaluated in accordance with the completely randomized design. According to the extraction methods, the anthocyanin content of the genotypes was found between 27.82-44.39 mg/kg GAE, phenolic compound content between 1438.3-2038.5 µg/g, Trolox values between 9.51-15.8 and FRAP values between 0.47-0.90. According to the results of the study, it was observed that ultrasonic extraction method gave significantly higher results than chemical extraction in both genotypes for investigated traits. It was observed that purple maize genotype had higher mean values than red genotype in terms of all traits except Trolox value. The results of the research showed that antioxidant substances can be obtained very effectively by ultrasonic treatment in coloured maize in a short time (30 min 20 kHz). It was observed that purple coloured maize genotypes gave better results with ultrasonic assisted extraction.

**Keywords:** Phenolic, anthocyanin, kernel, *Zea mays*

# Comparison Polen Characteristics and Seed Set of Stock-6 Inducer Line Under Greenhouse and Field Conditions

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## Abstract

Seed multiplication of inducer lines is a critical step for the sustainability of in vivo doubled haploid technique. Stock-6 is one of the inducer lines that is currently used as a gene source for the development of other inducer lines and is currently public. This study was carried out to investigate the pollen production dynamics and seed set level of Stock-6 inducer line under field and greenhouse conditions. In the study, two separate experiments were established in greenhouse and field conditions using a completely randomized design. When the plants reached flowering stage, pollens were collected from the plants and weighed. Some of the pollens were used to determine pollen viability and morphometry (width, length, circumference, area) by the use of tetrazolium staining, and the rest was used for artificial (in vitro) pollination in laboratory conditions. For this, silk samples taken from the designated plants were used.  Twenty-four hours after the dusting of silk with pollens, the attachment of the pollen on the silks was checked with aniline blue staining. The designated ears in the field and greenhouse were harvested upon maturity,  and number of kernels on them were recorded. The amount of pollen collected from a plant ranged between 0.32 and 1.24 gr/plant in the greenhouse experiment, while the range was between 0.04 and 0.10 gr/plant in the field conditions. The viability values, determined by tetrazolium test, were determined as 93.27% and 91.88% in greenhouse and field conditions, respectively. Aniline blue staining showed that in vitro pollination on the samples from both greenhouse and field conditions was succesfull. On the other hand, pollination of the plants resulted in 90.75 seeds/plant in greenhouse conditions, while no seed was obtained in the field. Although the pollen viability levels were similar, the fact that there was no seed set in the field conditions can partly attributed to the environmental factors such as temperature and humidity at the time of pollination, as well as ear silk dynamics. As a result, under the environmental conditions similar to the experimental year, greenhouse conditions were found to be more suitable for the Stock-6 inducer line for seed multiplication.

**Keywords:** Kernel number, in vivo, double haploid, *Zea mays*

# Production Potential of Perennial Energy Crops in Different Agro-Ecological Conditions of the Republic of Croatia

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## Abstract

Biomass is the most widely used renewable energy source and can be used as a primary fuel or converted into a secondary fuel. It is expected that one of the main sources of agricultural biomass in the future will be biomass derived from the cultivation of energy crops. Energy crops are characterized by a long lifespan, high yields, the possibility of cultivation on poor quality soils, low agotechnical investments and the possibility of conversion into various forms of biofuel. The aim of the work is to present data on the production potential (yield - t ST/ha and yield components - height and/or number of shoots) of selected perennial energy crops (*Miscanthus x giganteus*, *Panicum virgatum* and *Sida hermaphrodita*) under different harvesting season and agroecological conditions in the Republic of Croatia. The plantations were established in 2011 and 2016 at three different locations. The average yields in the fall harvest after the third cultivation period were: 9.52 t/ha DM - *Sida hermaphrodita*; 19.08 t/ha DM - *Panicum virgatum* and 23.68 t/ha DM - *Miscanthus x giganteus*. In the spring harvest season, the average yields were: 6.53 t/ha DM - *Sida hermaphrodita*; 13.27 t/ha DM - *Panicum virgatum* and 12.43 t/ha DM - *Miscanthus x giganteus*. The highest yields of biomass dry matter per unit area among the observed energy crops were recorded for the species *Miscanthus x giganteus*.

**Keywords:** Energy crops, biomass, renewable energy, production potential

# Cytogenetic Verification of Haploid Samples Classified by Visual (Eye) Discrimination

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## Abstract

The in vivo doubled haploid technique is a widely adopted method in maize breeding for developing homozygous lines. A crucial step in this technique is the separation of haploid seeds, which involves determining their ploidy level. In general, this classification is performed based on visual inspection, relying on the coloration of different parts of seeds, seedlings, or young plants. However, visual classification can be prone to errors due to human or environmental factors, leading to high misclassification rates. Because of these potential errors, it is essential to validate visual classification using more precise techniques, such as cytogenetic or molecular methods, to ensure accurate haploid identification. In this study, 30 seed samples visually classified as haploid, derived from a reducing line crossed with various donor materials, were subjected to cytological analysis to confirm their ploidy levels. Chromosome counts were performed using Feulgen staining and observed under a microscope (100x magnification). Results showed that 18 out of the 30 visually classified seeds were actually haploid, revealing a 60% accuracy rate for visual selection. These findings indicate that visual discrimination may be insufficient for accurately identifying true haploids in the in vivo doubled haploid technique. Consequently, validating visually classified samples with additional methods could significantly enhance the efficiency and accuracy of haploid identification, thus improving the effectiveness of this breeding technique.

**Keywords:** Feulgen Stain, chromosome number, ploidy, *zea mays*

# Trace Element Content of Oriental Tobacco- Evaluation Over Different Nutrition Rates

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## Abstract

Nitrogen fertilization significantly impacts the chemical properties of tobacco plants, influencing their growth, development, and composition. Oriental tobacco (Nicotiana tabacum L) responds markedly to nitrogen quantities. Nitrogen fertilization can also alter the uptake, availability, and distribution of trace elements in plants. In the present study we evaluate the influence of increasing nitrogen rates to the chemical characteristics and trace element content of oriental tobacco varieties. Filed experiment was caried under different nutrition rates. Fertilization involved nitrogen rates of 20 kg/ha and 30 kg/ha and constant amount of phosphorus (60 kg/ha) and potassium (40 kg/ha). Two domestic (P-23 and P-79) and two introduced (Basma and Elenski) tobacco cultivars were grown on typical non-contaminated agricultural soil in locality Dobrushevo. Soil and plant samples were analyzed for a range of elements, including Al, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, P, Pb, Sr, V, and Zn, using atomic emission spectrometry with inductively coupled plasma (ICP-AES). It has been observed that the bioaccumulation capabilities vary among individual elements. Notably, the Basma variety exhibited the highest bioaccumulation factors for Cu (8.2%), Mn (5%) and Zn (2.3 %) compared to other varieties. It was found that Cu and Zn content in all tobacco varieties was higher in the samples from unfertilized control ranging from (15-38) mg/kg for Cu, and (55-88) mg/kg for Zn. Content of the rest of the studied elements in oriental tobacco leaves, for most tested varieties tended to decrease with higher nitrogen dosage. In all varieties subjected to higher nitrogen rates, a notable increase in nicotine and mineral matter content was observed.

**Keywords:** Nitrogen fertilization, trace elements, tobacco

# Fe Contents of Agricultural Soils Formed on Serpentine in Çanakkale/Türkiye

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## Abstract

Ultramafic rocks are rocks composed almost entirely of ferromagnesian minerals and containing <45 wt% silica ($SiO_2$). These rocks include both peridotites and serpentinites. The general formula of serpentine group minerals is $(Mg,Mn,Fe,Co,Ni)_{3-x}SiO_2O_5(OH)_4$. These serpentine group minerals are formed by metamorphic transformation of ultramafic rocks such as peridotite and pyroxenite, which are composed of iron (Fe) and magnesium (Mg) rich silicate minerals such as olivine and pyroxene in the Earth's crust. The present research was conducted to determine the Fe content of agricultural soils formed on serpentine from Çanakkale, Türkiye. Soil samples were taken from 24 different cultivated sites and analyzed for Fe concentrations. Soils were extracted by *Aqua regia* wet digestion method to determine Fe concentration in soil samples. A flame atomic absorption spectrometer was used for analyzing the Fe concentrations in the soil samples. A wavelength of 248.3 nm and a slit width of 0.2 nm were used for Fe measurements. A hollow cathode lamp was used for Fe measurements and air-acetylene gases were used as flame source. Fe in soil samples ranged from 19.31 g/kg to 75.93 g/kg with an average of 36.71±18.58 g/kg. The average total Fe values found in the soil samples were higher than the upper continental crust values of 30.89 g/kg.

**Keywords:** Serpentine, Fe, agricultural soils

# Effect of Some Fertilizer Types on the Viability of Micropropagated Spathiphyllum in the Acclimatization Stage

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## Abstract

Tissue culture methods are an effective way to make profits in agriculture where acclimatization loss and contamination can be overcome. Tissue culture vessel conditions are very stabile in order to get highest multiplication performance so plant loss are very high when plantlet are transferred to ex vitro conditions.  Spathiphyllum is a plant that attracts attention and spreads widely in the markets as an ornamental plant. In the study Spathiphylium wallisi micropropagated with Murashige Skoog Media with 0.5mg/L benzylaminopurine (BAP) and 0.1mg/L Indole butyric acid (IBA) plant growth regulators, 8% agar, 30g sucrose with B5 vitamins under tissue culture condition. Growth room condition was 24oC room temperature, 60% humidity and 3000lux light intensity. Plantlets transferred to ex-vitroconditions with 30x40mm paper pots in the acclimatization stage under mini-greenhouses. Light sources decreased to 1000lux, and natural day light conditions applied on august 2024. 5% nitrogen with ammonium nitrate ($NH_4NO_3$), 5% phosphor with mono ammonium phosphate ($NH_4H_2PO_4$), 5% phosphor potassium dihydrogen phosphate ($KH_2PO_4$), 1-2-4% zinc with zinc sulphate heptahydrate ($ZnSO_4 \cdot 7H_2O$), 100-200-400ppm Indole butyric acid (IBA) applied separately. Roots were evaluated that crossed out of paper pot fabric. Ammonium nitrate with 5% nitrogene is superior in 100% viability, 3.53 root number, 3.19cm plant length in 45th day. The study shows that nitrogen fertilization is crucial in the acclimatization stage on micropropagated spathiphylium.

**Keywords:** Hardening, micropropagation, nitrogen, rooting, tissue culture

# Effect of Pyrolysis By-Products on Ammonia Volatilization From Surface Application of Urea

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## Abstract

Effect of pyrolysis by-products on ammonia volatilization from surface application of urea As a result of applying nitrogen (N) fertilizers to the soil, some nitrogen is lost as gas, while another portion is lost through leaching. Several mechanisms have been proposed to mitigate nitrogen loss in biochar-amended soils, including the application of biochar itself. However, studies examining the effects of tar produced during biochar production on nitrogen loss are limited. Tar is generated from the condensation of high molecular weight compounds present in the pyrolysis gas produced during the slow pyrolysis of biomass. This study was conducted to determine the effect of tar, obtained from the pyrolysis of olive pomace to produce biochar, on the gaseous nitrogen released from urea fertilizer added to both moist and dry soils. Tar, produced during the pyrolysis of olive pomace at 300°C, was used to coat urea fertilizer, and nitrogen release was determined through a 28-day laboratory incubation study. In this study, pure water was applied to the soils at 50% of their field capacity to simulate moist soil conditions. Prior to the experiment, the samples were pre-incubated by moistening them for seven days. According to the experimental results, the release of ammonia from urea fertilizer coated with tar was lower than that from uncoated urea.

**Keywords**: Pyrolsis, ammonia, tar

# Relationship Between Trace Element Contents and Soil Properties in Agricultural Soils of Kumkale Plain (Çanakkale, Türkiye)

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## Abstract

Soils are an important component of the environment and a vital interface for terrestrial ecosystems. Soils constitute the largest sink for trace metals formed by various natural processes, such as chemical weathering of geological parent materials and erosion, and by anthropogenic activities such as agrochemicals, industry, transport and mining. This research was carried out to determine Cu, Ni, Pb and Zn concentrations in agricultural soils of Kumkale plain (Çanakkale, Türkiye) using a wet digestion procedure. For this purpose, 15 surface soils (0-20 cm) were taken from cultivated areas. In addition, some physicochemical properties (pH, electrical conductivity, organic matter content, calcium carbonate content and texture) of the soils were determined. As the analysis of total trace element contents found in soil samples indicate, except Ni, trace element values were lower than the common value in agricultural soil. However, Ni value (70.26 ± 34.02 µg/g) was higher than the common value in agricultural soil (50 µg/g). The reason for the high Ni values is thought to be due to the serpentine rocks in the surrounding geology. Correlation analysis was applied to determine relationships between selected properties of soil samples and the total trace metals. A positive correlation was detected between the calcium carbonate content and the concentration of Cu. A positive correlation was detected between the soil organic matter content and the concentration of Pb. Also, a positive correlation was found between the clay content of soil and the concentration of Pb and Zn. On the other hand, a negative correlation was found between the sand content of soils and the concentration of Cu, Ni, and Zn.

**Keywords:** Soil, trace element, physicochemical properties

# Study on the Life History Traits of the Blackmouth Catshark (*Galeus melastomus Rafinesque, 1810*) around the Gökçeada Coasts

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## Abstract

*Galeus melastomus*, commonly known as the blackmouth catshark, is a significant species within the family Etmopteridae. Found in the deep, cold waters of the Mediterranean Sea and the Atlantic Ocean, this species plays a crucial role in demersal ecosystems and serves as an important indicator of marine health. Typically inhabiting depths of 200 to 800 meters, *G. melastomus* is notable for its ecological and economic relevance due to its role in the food web and its vulnerability to fishing pressures. Understanding the life history parameters of this species, including its growth, reproduction, and population dynamics, is essential for advancing scientific knowledge and developing effective management and conservation strategies. The presence of *G. melastomus* in the Northern Aegean Sea highlights the region's ecological diversity and underscores the need for targeted conservation efforts to protect this species and its habitat from increasing fishing pressures. For this purpose, the blackmouth catsharks' life-history parameters were determined for samples of 795 individuals (44.9% males, 55.1% females) collected by from commercial bottom trawl vessels between February 2019–February 2020. The total lengths of individuals range from 10 to 48 cm, and their total weights range from 2.30 to 322.16 g. The dominant total length values observed for males and females were 15 cm and 20 cm, respectively. The von Bertalanffy growth parameters calculated for the blackmouth catshark, combining both males and females, were determined as follows: theoretical asymptotic length ($L_\infty$) = 51.45 cm, growth coefficient (K) = 0.11 year$^{-1}$, and theoretical age at birth ($t_0$) = -1.35 years. The length-frequency analyses indicated that the age groups ranged from 0 to 18 years. The clasper lengths of male individuals ranged from 0.1 to 1.8 cm. For females, it was determined that all individuals, except those sampled in June, were in the first maturity stage. This could indicate a specific reproductive pattern or cycle for the species, where the maturity stage changes during certain times of the year, possibly due to environmental factors, availability of food, or other ecological conditions. Also, the observation that the female population in the studied area is not yet mature highlights the need for specific conservation efforts to address potential reproductive vulnerabilities and ensure sustainable population levels.

**Keywords:** Galeus melastomus, Northern Aegean Sea, growth, reproduction

# Heritability Estimation of Placental Traits in Turkish Saanen Goats

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## Abstract

Reproductive success plays a key role in livestock bred for yield traits. During gestation, nutrition, protection, and regulation of the endocrine system of the offspring are mediated by the placenta. The morphological and physiological evaluation of the placenta allows conclusions to be drawn about the viability of the newborn and gives information about prenatal period. In the last period of pregnancy, birth weight is formed and the nutrient carrying capacity of the placenta begins to decrease. It is thought that many factors such as effective placental blood circulation, maternal nutrition and genetics should be considered during this period. Morphological characteristics of the placenta such as the weight of the placenta, the number of cotyledons, the efficiency of the placenta and the density of the cotyledons provide important information about mother and offspring in the prenatal and postnatal period. It is known that the characteristics of the placenta significantly influence the birth weight of newborns and contribute to survival. Therefore, it is important to investigate the genetic background of these traits. This study was conducted to evaluate the model that can be used for genetic-statistical analysis of placental morphology in Turkish Saanen goats. The morphological characteristics of 799 placenta samples collected over eight years and the birth weights of kids were used in the research from the animals of the Research Farm of the Çanakkale Onsekiz Mart University. Placenta weight, number of cotyledons, placenta efficiency, cotyledon density and total cotyledon area characteristics of the placenta samples were analyzed using a sire-dam model with dam and sire as random factors, interactions of year, dam age, sex and birth type as fixed factors. It was also found that the statistical genetic model used in the study was an appropriate model for estimating the sire and dam variance components in general. In this context, the maternal and paternal heritability of birth weight was found as h2dam=0.614; h2sire=0.248, paternal and maternal heritability of placental weight was found as h2dam =0.253; h2sire =0.065, and the heritability of cotyledon number was found as h2dam =0.608; h2sire =0.123. The heritability of placental activity was found to be close to each other and at a low level (h2dam =0.143; h2sire =0.194). As a result, according to the statistical genetic model used in the study, the dam variance components were higher than the sire variance components for all traits.

**Keywords**: Placental weight, placental efficiency, cotyledon number, heritability, sire-dam model

# Milk Components of Turkish Saanen Goats According to Different Lactation Stages and Farm Quality

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## Abstract

While goat breeding is done for home consumption and as a source of income for low-income segments around the world, in developed countries, products produced from goats are consumed as "niche products". Previous studies have determined that the goat breed raised in our country causes changes in the breeding and environment in which the goat lives. For example, hair goats maintain lower quality conditions compared to other goat breeds. While consumer demands and legal regulations determine the status of the food product in the market, it is observed that these regulations do not apply to the environment of the animals from which the product is obtained. Today, it is observed that expectations from the food industry go beyond quality production and also relate to the environment in which the animals whose products are consumed live. In short, today, when consumers are more conscious, there is a need for evaluations in terms of animal welfare and business quality. In Çanakkale, which is the breeding center for Turkish Saanen Goats in our country, the enterprises where this breed is bred most intensively are the Ezine and Bayramiç districts. In this study, information obtained from visits to different enterprises dealing with goat breeding and at different lactation stages in Ezine and Bayramiç districts was used. In this context, a business quality score was created by evaluating shelter conditions, general condition of animals, feeding conditions, animal welfare, health protection practices, and milking and milk hygiene. Farms with a score below 72 points are classified as "Low", those between 72-82 are classified as "Medium", and farms with a score above 82 points are classified as "High" quality. Evaluations and milk sampling were made in the "Early", "Middle", and "Advanced" stages of lactation. As a result, milk fat (P<0.0001), total dry matter content in milk (P<0.0001), fat content in kefir obtained from milk (P=0.0004), total dry matter content in kefir (P=0.0007), and kefir pH (P=0.0191) were found to be statistically significant. In general, it has been observed that farms with higher values have higher farm quality scores. This means that the number of animals in the group called "low" quality is lower. In future studies, it is recommended to investigate the effects of the scores obtained as a result of more comprehensive research in more farms until the final product.

**Keywords**: Intensive farm quality, milk fat, kefir fat, dry matter content, ph in kefir

# The Economic Impact of Climate Change on Horticultural Production and Modern Biotechnological Approaches within the Context of Adaptation Studies

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## Abstract

Climate change is causing significant changes and challenges in the global economy, particularly in the agricultural sector. Horticultural production is highly sensitive to climate change, with rising temperatures, erratic rainfall and extreme weather events reducing productivity and negatively affecting product quality. The main consequences of this situation are reduced production and yields, fluctuations in product prices and economic losses. To mitigate these adverse effects and support sustainable agricultural practices, the adoption of new production techniques and modern biotechnology methods is crucial. These techniques include the development of climate-resilient crop varieties, greenhouse and controlled environment agriculture, drip irrigation and water-saving techniques, digital agriculture and precision farming technologies. Climate-resilient crop varieties offer significant benefits to growers because they are more resilient to extreme conditions. Greenhouse and controlled environment agriculture optimises growing conditions, increasing productivity and reducing seasonal dependency. Drip irrigation systems use water more efficiently, while digital and precision farming techniques optimise production processes. Modern biotechnology is revolutionising agriculture. Genetic engineering, particularly CRISPR-Cas9 technology, is enabling the development of climate-resilient and high-yielding crop varieties. Tissue culture facilitates the propagation of disease-free and genetically homogeneous plants, while biofertilisation techniques enhance nutrient uptake and resilience to stress. Precision genomic selection allows the identification of more efficient and resilient plant varieties. This study uniquely highlights innovative production techniques and biotechnological methods that can mitigate the economic challenges of climate change in agriculture. It synthesises existing literature to identify effective strategies for enhancing sustainability and resilience, and discusses how to support sustainable agricultural practices and reduce economic losses for producers.

**Keywords:** Climate change, economy, adaptation studies, new production techniques, modern biotechnology

# A Glance A St John's Worts Existing in Çanakkale Province T

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## Abstract

Türkiye is known with its rich biodiversity. Having three phytogeographic regions which intersect causes more species diversity from other places. Çanakkale is one of the places with plant and endemic rate is extremely high. The province is affected by Mediterranean elements mostly and also has some Irano-Turanian Region species. *Hypericum* Tourn ex. L., as known as St. John's Worts, is a cosmopolitan genus belongs to family Hypericaceae. This genera leaves have a lot of little dotes, a specific feature which makes it different from other plants. Hypericum has been widely used plant in medicine and cosmetic fields. The aim of this presentation is reveal current situation of Hypericum species in the Çanakkale province. Known locations of *Hypericum* were visited and plant specimens were collected from six locations, where *Hypericum* species were most common. It was concluded that there is 12 species, with one endemic on the list, in Çanakkale Province. When we compare all the locations with the species rate, we found that Ida Mountain location has the most *Hypericum* species. On morphology, parts of flowers were cut into pieced and studied. It has founded that *H. perfoliatum* and *H. montbretii* has the same flower shapes but differs from black glands on calyx. *H. veronense* was subspecies of *H. perforatum* but in the latest studies it has discovered that it differs in molecular level. When these two species were studied in macromorphological, it has found that they have different capsule shapes and glands. *H. kazdaghense* was a species found in 1995 by Y. Gemici & E. Leblebici but it went into synonym for *H. aucheri* after Robson's monograph. These two species were also studied, and it is founded some differences that cannot be counted as same species. We built a molecular phylogenetic tree of *Hypericum* species that founded in Çanakkale, using NBCI system. It has found that *H. calycinum* has been the species closest the ancestors. IThe tree also shows that *H. triquetrifolium* and *H. aucheri* are close in molecular level even though they don't in morphological level.

**Keywords:** Systematics, hypericum, taxonomy, morphology