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Research Article

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Adaptation of Some Blackberry Varieties in Konya Ecological Conditions

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ABSTRACT

This study was conduted to determine the adaptability of four blackberry varieties (Jumbo, Chester, Arphe, Boata) to the ecological conditions of Konya province in 2017-2018. For this purpose, phenological, pomological, chemical and plant properties of blackberry varietes were investigated. According to the research results; The first flowering took place on May 20 (Jumbo), 23 May (Chester), June 3 (Arphe), June 15 (Boata). The first harvest dates was July 5 (Jumbo and Chester), July 15 (Boata), July 22 (Arphe) and the last harvest dates are July 26 (Boata), 17 August (Arphe), 10 September (Jumbo), 16 September (Chester). On the other hand, after September 16 new fruits were produced by the Chester cultivar but could not be harvested owing to the fact that they did not mature. In terms of fruit weight, the highest values was determined in Jumbo (3.60 g) followed by Chester (2.82 g), Arphe (1.19 g), Boata (0.72 g) cultivars, respectively.
According to the research results, it can be said that Chester and Jumbo varieties are superior to other varieties and can be recommended for the Konya ecology.

1. Introduction

Blackberry is located in the genus Eubatus of the genus Rubus of the Rosaceae family. This view of blackberries, which are included in the list of plants that should be destroyed in agricultural areas, continued until the second half of the 19th century. Many varieties have been developed with the discovery of hybrid blackberries in wild form by researchers and the cultivation and cultivation studies in America in the 1850s (Poling, 1997). Blackberry breeding work first began in the US state of Texas about 150 years ago (Moore, 1984).

Research on the cultural forms of blackberries began in the mid-18th century, and in 1931 Darrow reformed Thornless Evegreen, the first thornless blackberry variety (Hall et al., 1986).

Turkey's climate, a great product with very few countries around the world has created growing potential and diversity (Agaoglu et al., 2006). Turkey is located within the natural spreading areas of grape fruits. These species are both highly sought after by consumers and have a wide range of uses. These species are easily propagating, early fruit lying, also used as hedge plants, orchards in the garden can be evaluated as plants. Since these fruits are consumed in large amounts in high income countries, they have a large market in the world. Wild forms of this kind in Turkey for many years consumption the cultural forms in recent years have also begun to be recognized. Raspberries and currants can be grown on the north-facing slopes of the North Anatolian Mountains and at altitudes higher than 1000 m and blackberries can be grown naturally in almost all regions. Central Anatolia and Black Sea regions, especially Çorum, Amasya, Yozgat, Gümüşhane and Rize provinces are at the beginning of these areas (Onur, 2006).

In recent years, studies have shown that blackberries are very important for human health and contain anticarcinogenic and antioxidant chemicals. These plants have 4-6 grams of fiber per 100 grams and although they contain small amounts of vitamins A, B, C have been reported to be effective against heart disease and colon cancer. Ellagic acid, which is highly anticarcinogenic in all of these species, has been shown to prevent tumor development in animal studies under laboratory conditions. The colors, taste and aromas, structures and odors of blackberries are attractive. Therefore, it is used in the production of fruit juice, ice

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cream, jam, marmalade as well as fresh consumption (Pehluvan and Güleryüz, 2004).

Blackberry with an economic life of 15-20 years is not very selective in terms of climate requirements and can easily adapt to different climatic conditions. Abundant sun, protected from winds, rain at harvest time, soil moisture is sufficient and can be easily grown in places where the winters are warm (Barut, 2004).

In recent years, there has been an increasing interest in blackberry cultivation in Turkey due to its richness in vitamins, minerals and antioxidant capacity, highlighting its benefits in terms of human health and increasing the usage areas in industry. In the Black Sea and Marmara Regions, commercial orchard gardens have been established. But there is no production yet to record. Increasing the production and trade of blackberries will help to develop different areas of industry on blackberry as well as to solve problems such as unemployment and migration (Kaplan et al., 1999).

As a result of breeding studies on blackberries, high yields were obtained as a result of the development of large fruit varieties and application of new finishing systems. This situation especially increased the interest of small farmers to this fruit (Çetiner et al., 1993).

In the agricultural statistics of Turkey, blackberry production first took place as 1319 tons in 1995 and after that year, production increased slowly, it increased to 1800 tons in 2000, 2200 tons in 2005, and 4989 tons in 2010 (TUİK, 2019).

In recent years, there has been an increasing interest in blackberry growing in Konya. However, the lack of a scientific study on the varieties that can be grown in the province in a large number of blackberries is an important deficiency. This study was carried out in order to determine the growth characteristics and adaptability of different blackberry varieties in Konya ecological conditions.

2. Materials and Methods

2.1. Materials

The study was conducted in 2017-2018 in the district of Büyükkovanağzı in Meram district of Konya. Arphe, Boata, Chester and Jumbo blackberries were used as plant material. Phenological, morphological, pomological and chemical properties and yields of plants were investigated during the study. Plant materials were obtained from a special nursery plant in tubular form.

2.2. Methods

The research was conducted between 2017-2018 in open land conditions. The study area was prepared in October 2016. Plants were planted again in October and ' double T ' training system and drip irrigation system were applied.

Blackberry plants were planted with 3 replications with 10 plant in each repetition and 1 m above the row and 2 m between the rows. In both years, fruit samples taken during harvest period were brought to the laboratory and examined. Since the study area was established in autumn 2016, the plants did not yield fruit in 2017.

Phenological observations in plants due to Islam et al. (2009) according to the swelling date of vegetative buds, the date of waking up of vegetative buds, vegetative buds of the date of the first shoot, the date of the release of the flower table, the date of the beginning of flowering, full flowering date, the last flowering date, the first fruit formation date, the first harvest date, the last harvest date.

The number of canes per plant, cane height, cane diameter, number of clusters in cane, number of fruit in clusters and cane yield for Islam et al. (2009).

Fruit width and length (mm) and fruit weight were determined in 25 fruits taken randomly.

Fruit color (L *. A *. B *) was measured with Minolta color meter. L is the brightness value, 0 is black and 100 is white. "A" shows redness (-a green) and b yellowness (-b blue) (McGuire, 1992).

The taste and aroma status of the varieties were evaluated according to the 1-5 scoring system by taking the average of the taste and aroma analysis evaluations made to 5 people. (1: very bad, 2: bad, 3: moderate, 4: good, 5: very good).

Fruit shape (spherical, long conical, short conical, conical) was determined by visual evaluation of 25 fruits taken randomly in determining fruit shape.

Amount of total soluble solids (%) was determined by digital hand refractometer, fruit juice pH was determined by pH meter, the amount of titratable acid (%) was determined by titration method and vitamin C was determined by spectrophotometric dichlorophenol indophenol method (mg / 100g) (Pearson, 1976).

The experiment was set up in a randomized plot design with three replications. The data obtained were analyzed using JMP (version 7.0 SAS Instute, Cary, NC, USA).

3. Results and Discussion

3.1. Phenological observations

The results of the 2017-2018 phenological observations for the four blackberry varieties used in our research are given in Tables 1 and 2. Variety of vegetative buds swelling in 2017 were in 24 February (Boata), 28 February Arphe, 29 February (Chester) and 3 March (Jumbo), in 2018 were in 26 February (Boata), 1 March (Arphe), 3 March (Chester), 5 March (Jumbo). Akbulut et al. (2003), in their study in Samsun conditions reported that the vegetative buds of the blackberry varieties swell between the second week and the third week of March. Kurt et al. (2003), in the study conducted in Giresun, it was determined that the swelling date of vegetative buds is between 24 February and 2 April.

The awakening date of the vegetative buds in 2017 takes place on 29 February (Boata), 6 March (Chester), 7 March (Arphe), 3 March (Chester); in 2018 was held on March 3 (Boata), March 9 (Chester), March 10 (Arphe), March 12 (Jumbo). In an adaptation study conducted in Isparta, vegetative buds awakened between April 3-21 (Göktaş et al., 2006).

In 2017, vegetative buds continued on March 5 (Boata), March 10 (Chester), March 12 (Arphe) and March 14 (Jumbo). In 2018, it took place on 10 March (Boata), 15 March (Chester), 16 March (Arphe) and 17 March (Jumbo). Agaoglu et al. (2003), in Ankara Ayaş conditions in the study conducted on April 1 vegetative buds of Chester variety was determined.

The first exits were in March 2017 (Jumbo), April 2 (Arphe), April 6 (Boata), April 7 (Chester); In 2018, it was held on 5 April (Jumbo), 8 April (Arphe), 19 April (Chester) and 14 April (Boata).

The date of the first flowering in 2018 is 13 May (Jumbo), 15 May (Chester), 27 May (Arphe), 8 June (Boata); The first flowering took place on May 20 (Jumbo), May 23 (Chester), June 3 (Arphe), June 15 (Boata). Full flowering periods June 3 (Jumbo), June 5 (Chester), June 15 (Arphe), June 20 (Boata); the last flowering occurred on July 13 (Boata), July 20 (Arphe), September 3 (Jumbo), September 10 (Chester). Kurt et al. (2003), Giresun in the study of flower clusters were determined to be between 19 March and 10 May. In the study of Göktaş et al. (2006), in Isparta in the study of the cluster of flowering dates were determined between 11-28 May. In the study conducted by Cangi and İslam (2003) in Ordu, it was determined that the first flowering occurred between 2 May and 7 June. In the study conducted in Giresun, the first flowering took place between 4 April and 5 June (Kurt et al., 2003). Akbulut et al. (2003), by the full bloom period of the blackberries in Samsun Çarşamba region was determined to be between the first week of May and the second week of July. In the study of Göktaş et al. (2006), some blackberry varieties in the first flowering period in Isparta conditions between June 3 to July 12 have determined that.

In 2018, the first fruit formation took place on 1 July (Jumbo), 3 July (Chester), 12 July (Boata) and 20 July (Arphe). In the study of Göktaş et al. (2006), in the study conducted in Isparta in the first fruit formation dates were determined between June 5-30. Agaoglu et al. (2003), in the study conducted in the region of Ankara by the date of the first fruit formation was found between 4-19 July.

The first fruit harvest dates for 2018 are 5 July (Jumbo and Chester), 15 July (Boata), 22 July (Arphe) and the last harvest dates are 26 July (Boata), 17 August (Arphe), 10 September (Jumbo), 16 September (Chester). In addition, since September 16, new fruit has been formed in Chester variety but could not be harvested because it is not ripe. In the study conducted in Ayaş district of Ankara, the first harvest dates of blackberry varieties were determined between 11-22 July and the last harvest dates were between 16-22 August (Ağaoğlu et al., 2003).

Defoliation dates for 2017 are 10 November (Jumbo), 12 November (Chester), 16 November (Boata), 20 November (Arphe); In 2018, it was determined as 12 November (Jumbo), 15 November (Chester), 20 November (Boata) and 25 November (Arphe). It is important that blackberry varieties enter early to rest in cold winters in order to avoid winter damage of annual shoots. In the cultivars cultivated under Konya conditions, no damage was detected during winter shoots during the annual shoots. Agaoglu et al. (2003), the study conducted by Ankara conditions in the blackberry variety was determined to occur between 7-25 December defoliation.

3.2. Plant characteristics

Some cane characteristics of cultivars in 2017-2018 are given in Tables 3 and 4. Accordingly, the differences between the varieties were found to be statistically significant in terms of all the characteristics examined. When the exile numbers of the varieties were examined in 2017; Arphe was the first with 4.03 cane, followed by Jumbo (2.5), Chester (2.43) and Boata (1.96). In 2018, Arphe had the highest number of cane with 6.53. This was followed by Jumbo (4.53 units), Chester (3.80 units) and Boata (2.53 units). Kurt et al. (2003) in the study conducted in the region of Giresun Chester variety of 6, Jumbo was found to give 2 cane.

In 2017, the maximum cane length was Arphe with 260.26 cm, followed by Jumbo with 225.03 cm. In 2018, Arphe (350.8 cm) had the highest cane length, followed by Jumbo (260.56 cm), Chester (247.73 cm) and Boata (147.96 cm), respectively (Table 4.). Esmek et al. (2011) in a study conducted in the region of Erzincan cane length of 275.90 cm in Jumbo variety, 272.36 cm was found in Chester.

In 2017, the difference between cane varieties was found to be statistically significant, with Chester (2.96 mm) in the first place, followed by Jumbo (2.52 mm), Arphe (2.42 mm) and Boata (2.31 mm) (Table 3). In 2018, cane diameter was between 3.25 mm (Boata) and 4.26 mm (Chester).

When the number of clusters per cane is examined, Chester ranks first with 0.60, while Jumbo variety ranks second with 0.43. In a study conducted in Ordu region, the number of clusters per cane was found as 2 in Jumbo cultivar (Cangi and İslam, 2003).

According to fruit number per cluster, Jumbo with 13.63 and Chester with 13.33 had the highest fruit, followed by Chester with 9.76 and Boata with 3.33. In a study conducted in Ordu, the number of fruit paer clusters was 8.96 in Chester and 5.50 in Jumbo (Cangi and Islam, 2003).

When the yield per cane was examined, Jumbo ranked first with 14.07 g, followed by Chester with 9.1 g, Arphe with 1.75 g and Boata with 1.01 g.

3.3.Pomological features

The results of the fruit colors of the varieties are given in Table 5. The differences between the L and H values of the varieties were statistically insignificant and the difference between the C values was significant. The highest C value was found in Boata variety (11.53).

According to 2018 data, Arphe was the best variety with the best taste and aroma, while the other varieties took the same score and ranked second in terms of taste. Arphe, with the highest aroma score, was followed by Chester. Agaoglu et al. (2003), in Ankara, the highest scores in terms of taste and aroma Chester (5) and Jumbo (5) varieties. In the study conducted in Trabzon, Chester received 4 points and Jumbo 3 points in taste scoring (İslam et al., 2009).

As a result of the visual evaluation of 25 fruits taken randomly in terms of fruit shapes, it was determined that Jumbo varieties had long-conical, Chester varieties had short-conical, Arphe varieties had round and Boata varieties had short-conical fruits.

Fruit varieties with the least width 4.88 mm Boata, the highest variety with 17.47 mm was found as Chester. In a study conducted in Erzincan, fruit width was found to be 19.47 mm in Jumbo cultivar and 18.08 mm in Chester cultivar (Esmek et al., 2011).

The fruit length of blackberry varieties was between 5.07 mm (Boata) and 18.45 mm (Jumbo) and the differences between varieties were found to be statistically significant. Islam et al. (2009), in the study conducted by Trabzon in fruit Jumbo variety was found to be 21.00 mm, while Chester was 20.09 mm.

The differences between the varieties in terms of fruit weight were found to be statistically significant. The highest fruit weight was Jumbo (3.60 g), followed by Chester (2.81 g), Arphe (1.19 g) and Boata (0.72 g), respectively. In a study conducted by Cangi and İslam (2003) in Ordu, the fruit weight was found to be 4.1 g in Jumbo cultivar and 2.91 g in Chester. In a study conducted in Ankara Ayaş region, fruit weight was found to be 5.7 g in Chester variety and 4.13 g in Jumbo (Ağaoğlu et al., 2003). The differences between the results are related to the ecology of aquaculture sites.

Chemical Properties

The difference between the TSS values of the varieties was found to be statistically significant. Arphe (17.13%), followed by Boata (16.53%), Jumbo (16.03%) and Chester (14.20%), had the highest TSS.

Kurt et al. (2003) in the study conducted in Giresun TSS Chester 13.13% and 9.98% in Jumbo was determined. In the study conducted in Samsun Chester and Jumbo varieties TSS values were found to be 9.9% and 10.3%, respectively (Akbulut et al., 2003). Similarly, ecological factors were also effective here. Under the conditions of Konya, TSS is higher than the blackberries grown in the Black Sea region, it is a result of high temperature, low relative humidity and high day and night temperature differences. In addition, an increase in altitude increases the accumulation of dry matter.

The differences between the pH values of the varieties were found to be statistically significant, while the highest pH value was Arphe (3.93), followed by Boata (3.90), Jumbo (3.71) and Chester (3.57), respectively. In the study conducted in Trabzon, pH was found to be 3.34 and 3.16 in Jumbo and Chester varieties, respectively (İslam et al., 2009). Gerçekçioğlu et al. (2003), in their study in Tokat Jumbo varieties have determined the pH as 3.15.

The difference between the titratable acidity of the varieties was found to be statistically significant, in terms of acidity, Jumbo cultivar (0.60%) was first, followed by Chester (0.38%), Boata (0.34%) and Arphe (0.34%). In the study of Göktaş et al. (2006) in a study conducted in Isparta, titratable acid amounts were found to be 1.26% in Jumbo cultivar and 1.19% in Chester. In the study conducted in Trabzon, acidity value of Jumbo and Chester varieties was 1.38% and 1.27%, respectively (İslam et al., 2009). The difference between the results is related to the ecology of production regions.

The differences between the varieties in terms of vitamin C content were found statistically insignificant. Vitamin C values in the varieties between 24.98 mg / 100 g (Arphe) and 26.67 mg / 100 g.

4. Conclusions

According to the results of the study carried out on four blackberries in 2017-2018 in Meram district of Konya, Jumbo was in the first place with 14.07 g in yield per shoot, followed by Chester with 9.1 g. In terms of fruit taste and aroma, Arphe came to the forefront, followed by Chester. Jumbo was in the first place when the cultivars were compared in terms of yield, followed by Chester. According to the research results, it can be said that Chester and Jumbo varieties are superior to other varieties and can be recommended for the region.

5. Acknowledgement

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Table 1
Phenological data of blackberry varieties

Varieties	Years	Vegetative buds swelling date	Awakening date of the vegetative buds	Vegetative buds continued date	First shoot date	The first flower formation	First flowering date
Jumbo*	2017	03.03	10.03	14.03	29.03	-	-
	2018	05.03	12.03	17.03	05.04	13.05	20.05
Chester*	2017	29.02	06.03	10.03	07.04	-	-
	2018	03.03	09.03	15.03	10.04	15.05	23.05
Arphe*	2017	28.02	07.03	12.03	02.04	-	-
	2018	01.03	10.03	16.03	08.04	27.05	03.06
Boata*	2017	24.02	29.02	05.03	06.04	-	-
	2018	26.02	03.03	10.03	14.04	08.06	15.06

* No flower in the first year

Table 2
Phenological data of blackberry varieties

Varieties	Years	Full flowering date	Last flowering date	First fruit formation date	First harvest date	Last harvest date	Defoliation date
Jumbo*	2017	-	-	-	-	-	10.11
	2018	03.06	02.09	01.07	05.07	10.09	12.11
Chester*	2017	-	-	-	-	-	12.11
	2018	05.06	10.09	03.07	05.07	16.09	15.11
Arphe*	2017	-	-	-	-	-	20.11
	2018	15.06	20.07	20.07	22.07	17.08	25.11
Boata*	2017	-	-	-	-	-	16.11
	2018	20.06	13.07	12.07	15.07	26.07	20.11

* No flower in the first year

Table 3
Plant characteristics of blackberry varieties (2017)

Varieties	Cane number	Cane length	Cane diameter
Jumbo	2.50 b	255.03 b	2.52 b
Chester	2.43 b	194.46 b	2.99 a
Arphe	4.03 a	260.26 a	2.42 b
Boata	1.96 b	92.36 c	2.31 b
LSD 0.05	1.27	32.45	0.40

Values shown in different letters in the same column are different at 0.05 (Duncan test)

Table 4
Plant characteristics of blackberry varieties (2018)

Varieties	Cane number	Cane length	Cane diameter	Cluster number per cane	Fruit number per cluster	Cane yield (g)
Jumbo	4.53 ab	260.56 b	3.57 c	0.43 ab	13.62 a	14.07 a
Chester	3.80 b	247.73 b	4.26 a	0.60 a	9.76 ab	9.10 ab
Arphe	6.53 a	350.80 a	3.90 b	0.13 b	13.33 a	1.75 b
Boata	2.53 b	149.96 c	3.25 d	0.06 b	3.33 b	1.01 b
LSD 0.05	2.32	45.76	0.31	0.44	8.39	12.22

Values shown in different letters in the same column are different at 0.05 (Duncan test)

Table 5
Fruit colors of blackberry varieties (2018)

Varieties	L	C	H
Jumbo	14.94 a	5.64 b	30.66 a
Chester	16.23 a	4.99 b	28.13 a
Arphe	16.67 a	5.01 b	27.61 a
Boata	16.65 a	11.53 a	20.26 a
LSD 0.05	N.S.	3.81	N.S.

Values shown in different letters in the same column are different at 0.05 (Duncan test)
N.S.: Non-significant

Table 6
Pomological characteristics of blackberry varieties (2018)

Varieties	Fruit shape	Fruit taste	Fruit aroma	Fruit width (mm)	Fruit length (mm)	Fruit weigth (g)
Jumbo	Long-conical	3	3	17.39 a	18.45 a	3.60 a
Chester	Short-conical	3	4	17.47 a	15.69 a	2.81 a
Arphe	Spherical	4	5	12.25 ab	10.71 ab	1.19 b
Boata	Short-conical	3	3	4.88 b	5.07 b	0.72 b
LSD 0.05	-	-	-	7.92	8.15	1.27

Values shown in different letters in the same column are different at 0.05 (Duncan test)

Table 7
Chemical characteristics of blackberry varieties (2018)

Varieties	TSS (%)	pH	Titrable acidity (%)	Vitamin C (mg/100 g)
Jumbo	16.03 b	3.71 c	0.60 a	26.39
Chester	14.20 c	3.57 d	0.38 b	26.67
Arphe	17.13 a	3.93 a	0.33 c	24.98
Boata	16.53 ab	3.90 b	0.34 c	25.55
LSD 0.05	0.63	0.02	0.02	Ö.D

Values shown in different letters in the same column are different at 0.05 (Duncan test)

N.S.: Non-significant

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Economic Analysis for Groundwater-Irrigated Oil Sunflower Farming in Konya Region

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ABSTRACT

In this study, economic analysis was conducted for groundwater-irrigated oil sunflower farming in Konya region. This study was conducted over the agricultural fields of 20 oil sunflower farmers operating within the irrigation scheme of groundwater irrigation cooperative of Başgötüren districts of Karatay town of Konya province in 2019. Within the scope of this study, inputs used in oil sunflower farming, input quantities and unit prices, yields and unit sales prices of the farmers were determined. Cost-benefit analysis was performed with the resultant data and economic assessments were performed for irrigated oil sunflower farming. Average total production cost of groundwater-irrigated oil sunflower farming was calculated as 4683.4 TL ha^{-1} (821.6 \$ ha^{-1}). Of such a cost, 50% was constituted by irrigation costs. Electricity constituted the greatest cost item in irrigation costs. Average gross production value was calculated as 8208.3 TL ha^{-1} (1440.1 \$ ha^{-1}). Together with state supports, average net income was calculated as 5057.3 TL ha^{-1} (887.2 \$ ha^{-1}).

1. Introduction

Sunflower is an annual herbaceous plant which has been produced for oil since the beginning of the 18th century. It is among the most important oil crops worldwide. Sunflower is originated from the Central America. Annual oil sunflower production of the world was 26 533 596 ha in 2017. Russia and Ukraine are the leading sunflower producer countries of the world. Among the first 10 countries with the greatest sunflower production lands, Turkey has the 7th place (FAOSTAT, 2019). Turkey is also among the important sunflower producer countries. In Turkey, oil sunflower was cultivated over 648 934 ha land area in 2018. However, only 26.1% of these production lands are under irrigation (TÜİK, 2019). In this sense, Konya province has an important share in sunflower production of Turkey. According to TÜİK data, in 2018, 11.3% of sunflower production and about 16% of oil sunflower production of Turkey was practiced in Konya province. Sunflower farming is generally practiced under irrigated conditions in Konya region and the province alone constitute about 43% of total irrigated sunflower farming lands of Turkey. In Konya region, irrigation is the most significant input in sunflower and other crops farming, and a large ratio of crop water consumption was compensated by irrigation water because of low rainfall. The compensation rate of ET by applied irrigation was determined as at sugarbeet 88% (Topak et al., 2016), at sunflower 80% (Yavuz et al., 2016; Yavuz et al., 2018) and at confectionary pumpkin 82% (Yavuz et al., 2015) for full irrigation conditions. Groundwater-based irrigation operations use quite much energy and thus constitute a significant cost item in agricultural practices. Groundwater resources are used in majority of irrigated lands in Konya region (Topak et al., 2008).

Previous researchers conducted experimental studies for economic analysis of sunflower farming (Das and Rout, 2018; Karaağaç et al., 2018; Sethar et al., 2015; Unakıtan and Aydın, 2018; Semerci et al., 2007). For instance, Sethar et al. (2015) conducted a survey study in Pakistan for economic analysis of oil sunflower farming and indicated total production cost as 481.4 \$ ha^{-1}, gross income as 797 \$ ha^{-1} and net income as 315 \$ ha^{-1}. Das and Rout (2018) conducted an economic analysis of oil sunflower farming in India and reported total production costs as 564 \$ ha^{-1} and net in-

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come as 584 $ ha^{-1}**.** Unakıtan and Aydın (2018) conducted an economic analysis of oil sunflower farming in Thrace region of Turkey and indicated net income as 26 $ ha^{-1}. Karaağaç et al. (2018) conducted a study under provincial conditions of Adana, Turkey and indicated production cost of oil sunflower farming as 3454.7 TL ha^{-1}, gross income as 5040 TL ha^{-1} and net income as 1585.3 TL ha^{-1}.

In this study, economic analysis was conducted for oil sunflower farming practiced under Konya conditions and produced with groundwater irrigations. In this sense, cost-benefit analysis method was used to determine some economic indicators.

2. Material and Method

This study was conducted over the agricultural fields of 20 oil sunflower farmers operating within the irrigation scheme of groundwater irrigation cooperative of Başgötüren districts of Karatay town of Konya province in 2019. Başgörüren irrigation cooperative was put into operation in 1978. The cooperative has actively operating 43 wells and total irrigation water discharge is 4 536 m^3 h^{-1}. Total land size opened for irrigation is 1847 ha and pressurized irrigation is practiced over the irrigated lands of the cooperative (KBSKB, 2017). Discharge of operating wells varies between 54 m^3 h^{-1} and 144 m^3 h^{-1}.

Soil analyses revealed that experimental soils were clay-loam in texture with high lime contents. All of the oil sunflower farmers selected in this study were using groundwater in irrigations. Drip and sprinkler irrigation methods are used in irrigations. The research site has a dominant terrestrial climate. Some meteorological data for the research site are provided in Table 1. Climate data were supplied from the nearest climate station located at Esentepe district (Karatay town). Long term average precipitation for sunflower growing season (March – October) is 124.2 mm and the amount realized in the research year was 134.3 mm.

Table 1
Temperature and precipitation data for the research site (MBM, 2019)

		Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Annual Average
Long-term averages	Temperature (^{0}C)	-0.2	1.4	5.6	11.1	15.8	20.1	23.5	23.2	18.5	12.5	6.3	1.7	11.6
	Precipitation (mm)	37.6	28.5	28.9	31.9	43.6	25.5	6.3	4.6	12.3	30.0	32.0	42.1	323.3
2019	Precipitation (mm)	17.1	41.3	14.7	26.2	17.1	71.6	0.0	12.8	6.6	-	-	-	207.4

Within the scope of field works, 20 oil sunflower farmers practicing under groundwater irrigation cooperative were selected randomly. During the growing season of 2019, farmer's practices and required inputs, input quantities and monetary values, products and product unit prices were determined through regular monitoring and face-to-face meetings with the farmers. Within the scope of such works, farmer-scale data were gathered about the basic production inputs such as seed, fertilizer, machine, diesel fuel, electricity for irrigation and irrigation system. Machine and equipment economic lives were taken from ASAE (1999) and economic life values of pressurized irrigation system were considered as farmer's opinion. Product price of oil sunflower varies based on oil content. The criteria considered for product unit prices are provided in Table 2.

Table 2
Sunflower purchase prices (Konya Sugar Co., 2019)

Oil ratio (%)	Price (TL kg^{-1})
52	2.965
51	2.927
50	2.890
49	2.852
48	2.815
47	2.777
46	2.740
45	2.702
44	2.665

Cost-benefit analysis (Layard and Glaister, 1994; Ballestero, 2000) method was used to calculate economic indices in irrigated sunflower farming. In this sense, initially total production costs (irrigation + other costs) and gross income per unit area (ha) were calculated. Then, these values were used to determine some economic assessment indicators. Equations used in such calculations are provided below:

- Irrigation cost (A) (TL ha^{-1}) = Irrigation system cost + energy cost + irrigation labor cost

- The other costs (B) (TL ha^{-1}) = Soil tillage + seedbed preparation + seeding + seed + fertilizer and fertilization + hoeing + chemicals and applications + harvest

- Total production costs (C) (TL ha^{-1}) = A + B

- Contribution of irrigation to total production costs (%) = A /(A + B) x 100

- Gross production value (D) (TL ha^{-1}) = Yield (kg ha^{-1}) × sales price (TL kg^{-1})

- Net income (TL ha^{-1}) = D - C (Ballestero, 2000)

- Economic productivity (EP) (kg TL^{-1}) = Yield (kg ha^{-1})/C (TL ha^{-1})

- Economic irrigation water productivity (EIWP) (TL m^{-3}) = Net income (TL) / amount of applied irrigation water (m^3) (Pereira et al., 2012; Çetin and Kara, 2019)

- Breakeven point (kg ha^{-1}) = (C) / Sales price (TL kg^{-1}) (Layard and Glaister, 1994; García-García et al., 2004).

3. Results and Discussion

3.1. Irrigation and yield values

Seasonal amount of irrigation water applied to sunflower was determined and provided in Table 3. Amount of applied irrigation water varied from one farmer to another. The lowest amount of applied irrigation water was 2304 m^3 ha^{-1} and the greatest value was 6352 m^3 ha^{-1} and average of research sites was calculated as 4004 m^3 ha^{-1}. There were differences in yields of farmers as provided in Table 3. Yields of participant farmers varied between 2200 - 4000 kg ha^{-1} with an average value of 3256 kg ha^{-1}. As can be inferred from the table, the greatest yields were not obtained by the farmers applying the greatest amount of irrigation water and vice versa. A two-year field experiment conducted by Yavuz et al. (2019) in the same region, reported that seed yield for oil sunflower irrigated at different irrigation levels was between 3243 (3412 m^3 ha^{-1}) and 5445 kg ha^{-1} (6900 m^3 ha^{-1}) and, the maximum yield was achived at full irrigation condition.

Table 3
Amount of applied irrigation water and yields of farmers

Farmers	Field size (ha)	Well discharge (m^3 h^{-1})	Irrigation duration (h)	Amount of applied irrigation water (m^3 ha^{-1})	Yield (kg ha^{-1})	Number of irrigations	Irrigation method
1	4.75	144	133	4032.00	3728	4	SI
2	3.00	144	132	6336.00	2660	4	SI
3	5.25	72	208	2852.57	3000	4	SI
4	10.00	108	260	2808.00	2200	3	SI
5	10.00	54	1040	5616.00	2600	4	SI
6	5.00	144	80	2304.00	3680	6	DI
7	2.50	108	96	4147.20	3600	4	SI
8	2.35	144	63	3860.43	3770	5	SI
9	7.50	108	357	5140.80	3600	4	DI
10	3.00	108	95	3420.00	3480	4	SI
11	7.50	108	209	3009.60	2800	4	SI
12	2.30	108	88	4132.17	2200	4	SI
13	5.00	90	165	2970.00	3800	5	SI
14	6.90	144	220	4591.30	4000	4	DI
15	3.25	108	75	2492.31	3000	3	SI
16	1.70	90	120	6352.94	2400	4	SI
17	6.25	108	258	4458.24	3800	6	DI
18	7.50	144	168	3225.60	3400	4	SI
19	6.00	144	200	4800.00	3400	4	DI
20	4.75	108	156	3546.95	4000	6	DI
Avrg.	5.23	114	206	4004.81	3256		

SI: Sprinkler irrigation; DI: Drip irrigation

3.2. Economic analysis

3.2.1. Irrigation costs

Irrigation costs of each farmer were calculated for oil sunflower cultivation with groundwater irrigations and resultant values are provided in Table 4. The lowest cost of irrigation was calculated as 1207.7 TL ha^{-1} (211.9 $ ha^{-1}) and the greatest value was calculated as 4404 TL ha^{-1} (772.6 $ ha^{-1}) and average of the research site was calculated as 2383 TL ha^{-1} (418 $ ha^{-1}).

Table 4
Irrigation costs of oil sunflower cultivation

Farmers	Land size (ha)	Hourly price of well (TL h^{-1})	Total operation duration of well (h)	Electricity cost (TL ha^{-1})	Irrigation system cost (TL ha^{-1})	Labor cost (TL ha^{-1})	Total irrigation cost (TL ha^{-1})	Total irrigation cost ($ ha^{-1})	Ratio of electricity cost to irrigation costs (%)
1	4.75	64	133	1792	50	0	1842.0	323.2	97
2	3.00	64	132	2816	60	400	3276.0	574.7	86
3	5.25	32	208	1268	38	0	1305.8	229.1	97
4	10.00	48	260	1248	69	1000	2317.0	406.5	54
5	10.00	24	1040	2496	55	0	2551.0	447.5	98

Table 4 (Continuation)
Irrigation costs of oil sunflower cultivation

6	5.00	64	80	992	680	0	1672.0	293.3	59
7	2.50	48	96	1843	220	0	2063.2	362.0	89
8	2.35	64	63	1716	247	480	2442.7	428.6	70
9	7.50	60	357	2856	888	660	4404.0	772.6	65
10	3.00	48	95	1520	153	400	2073.0	363.7	73
11	7.50	48	209	1338	20	0	1357.6	238.2	99
12	2.30	48	88	1837	91	630	2557.5	448.7	72
13	5.00	40	165	1320	100	0	1420.0	249.1	93
14	6.90	64	220	2041	1014	0	3054.6	535.9	67
15	3.25	48	75	1108	100	0	1207.7	211.9	92
16	1.70	40	120	2824	20	0	2843.5	498.9	99
17	6.25	64	258	2642	704	770	4115.9	722.1	64
18	7.50	64	168	1434	56	0	1489.6	261.3	96
19	6.00	64	200	2133	753	500	3386.3	594.1	63
20	4.75	48	156	1576	715	0	2291.4	402.0	69
Avrg.	5.23	52.1	206.2	1839.9	301.7	242.0	2383.5	418.2	80.12

Total irrigation cost was mostly constituted by electrical energy cost. The ratio of electrical energy cost to irrigation cost varied between 54 – 99% and average of the research site was 80.1%.

3.3. The other production costs

The other production costs apart from irrigation was also determined and provided in Table 5. The lowest other costs were 1437.1 TL ha^{-1} (252.1 $ ha^{-1}), the greatest value was 3573.8 TL ha^{-1} (627.0 $ ha^{-1}) and the average of the research site was calculated as 2263.0 TL ha^{-1} (397.0 $ ha^{-1}). As can be inferred from Table 5, fertilizer cost had the greatest ratio in the other costs apart from irrigation. Fertilizer costs of the farmers varied between 00.0 TL kg^{-1} (0.0 $ kg^{-1}) – 1240 TL ha^{-1} (217.5 $ ha^{-1}) with an average value of 704.2 TL ha^{-1} (123.1 $ ha^{-1}). Such differences were mostly resulted from unit price and quantity of the seeds used since the seeds are usually priced based on their yield potentials and resistance to pests and diseases.

Table 5
The other production costs

Farmrs	Soil Tillage cost (TL ha^{-1})	Seedbed preparation cost (TL ha^{-1})	Seed Cost (TL ha^{-1})	Seeding Costs (TL ha^{-1})	Chemical cost (TL ha^{-1})	Hoeing cost (TL ha^{-1})	Fertilizer cost (TL ha^{-1})	Harvest cost (TL ha^{-1})	Total cost (TL ha^{-1})	Total cost ($ ha^{-1})
1	82.5	60.4	283.5	120.0	0.0	117.3	0.0	280.0	1943.7	341.0
2	113.8	164.7	360.0	120.0	0.0	0.0	504.0	280.0	1542.5	270.6
3	123.4	177.4	540.0	120.0	400.0	120.0	1020.0	240.0	2740.8	480.8
4	122.2	158.4	440.0	160.0	60.0	0.0	724.0	240.0	1904.6	334.1
5	106.5	136.7	408.0	160.0	0.0	160.0	1240.0	280.0	2491.2	437.1
6	107.5	160.3	640.0	120.0	36.0	140.0	1000.0	280.0	3573.8	627.0
7	107.2	168.9	384.0	120.0	0.0	65.5	1040.0	280.0	2165.6	379.9
8	149.3	614.3	378.0	82.0	0.0	69.9	462.0	280.0	2035.5	357.1
9	100.3	141.2	720.0	120.0	0.0	64.5	1040.0	320.0	2506.0	439.6
10	87.9	175.5	400.0	120.0	0.0	32.6	420.0	280.0	1516.0	266.0
11	84.6	85.4	383.0	140.0	0.0	44.1	420.0	280.0	1437.1	252.1
12	81	163.2	425.0	160.0	104.0	51.7	260.0	280.0	1524.9	267.5
13	200	160.0	640.0	120.0	0.0	120.0	642.0	240.0	3452.0	605.6
14	141.2	175.5	585.0	160.0	35.2	160.0	780.0	320.0	2356.9	413.5
15	101.9	159.5	338.0	120.0	50.5	32.6	1200.0	280.0	2282.5	400.4
16	116.3	81.9	360.0	120.0	71.6	0.0	1100.0	280.0	2129.8	373.6
17	112.1	211.2	480.0	70.0	52.1	35.3	768.0	280.0	3408.7	598.0
18	100.1	159.0	627.0	120.0	0.0	41.1	440.0	240.0	1727.2	303.0
19	113.4	147.9	424.0	66.0	0.0	48.6	764.0	280.0	1843.9	323.5
20	117.6	88.8	640.0	82.0	0.0	48.6	260.0	240.0	2677.0	469.6
Avrg.	113.4	169.5	472.8	120.0	40.5	67.6	704.2	274.0	2263.0	397.0

3.4. Total production costs

Total production costs of the oil sunflower farmers using groundwater irrigations were calculated and provided in Table 6. The lowest total production cost was 2794.7 TL ha^{-1} (490.3 $ ha^{-1}), the greatest value was 7524.6 TL ha^{-1} (1320.1 $ ha^{-1}) and the average of the research site was calculated as 4646.5 TL ha^{-1} (815.2 $ ha^{-1}). About 29-68% of total production costs were constituted by irrigation cost. As can be seen in Table 6, there were two groups for the ratio of irrigation costs in total costs (the first group had a ratio of between 29.15 - 34.61% and the second group had a ratio of between 46.13 - 68.00%). The group with the lowest ratio of irrigation costs (4 farmers) was composed of the farmers using the least amount of irrigation water (230 - 290 mm) and not paying for irrigation labor. The group with greater ratios of irrigation costs generally composed of the farmers using greater quantities of irrigation water and paying for irrigation labor. The average ratio of irrigation costs in total costs was identified as 50%. In other words, about half of total production costs was constituted by irrigation costs.

3.5. Gross production value

Gross production values of the oil sunflower farmers of the research site were calculated and results are provided in Table 7. As can be seen from the table, the lowest gross production value was calculated as 5500.0 TL ha^{-1} (964.9 $ ha^{-1}), the greatest gross production value was calculated as 10070.0 TL ha^{-1} (1766.7 $ ha^{-1}) and the average value was calculated as 8208.3 TL ha^{-1} (1440.1 $ ha^{-1}). As can be inferred from Table 7, the net incomes gained from harvested yields varied between 906.7 TL ha^{-1} (159.1 $ ha^{-1}) and 6371.2 TL ha^{-1} (1117.8 $ ha^{-1}) with an average value of 3561.8 TL ha^{-1} (624.9 $ ha^{-1}).

Table 6
Total production costs

Farmers	Irrigation Cost (TL ha^{-1})	The other Costs (TL ha^{-1})	Total Production Cost (TL ha^{-1})	Total Production Cost ($ ha^{-1})	Ratio of irrigation cost to total production cost (%)
1	1842.0	1943.7	3785.7	664.2	48.7
2	3276.0	1542.5	4818.5	845.4	68.0
3	1305.8	2740.8	4046.6	709.9	32.3
4	2317.0	1904.6	4221.6	740.6	54.9
5	2551.0	2491.2	5042.2	884.6	50.6
6	1672.0	3573.8	5245.8	920.3	31.9
7	2063.2	2165.6	4228.8	741.9	48.8
8	2442.7	2035.5	4478.2	785.7	54.5
9	4404.0	2506.0	6910.0	1212.3	63.7
10	2073.0	1516.0	3589.0	629.6	57.8
11	1357.6	1437.1	2794.7	490.3	48.6
12	2557.5	1524.9	4082.4	716.2	62.6
13	1420.0	3452.0	4872.0	854.7	29.1
14	3054.6	2356.9	5411.5	949.4	56.4
15	1207.7	2282.5	3490.2	612.3	34.6
16	2843.5	2129.8	4973.3	872.5	57.2
17	4115.9	3408.7	7524.6	1320.1	54.7
18	1489.6	1727.2	3216.8	564.4	46.3
19	3386.3	1843.9	5230.2	917.6	64.7
20	2291.4	2677.0	4968.4	871.7	46.1
Avrg.	2383.5	2263.0	4646.5	815.2	50.6

Table 7
Gross production value

Farmers	Yield (kg ha^{-1})	Sales price (TL kg^{-1})	Gross production value(TL ha^{-1})	Gross production value($ ha^{-1})	Net income (TL ha^{-1})	Net Income ($ ha^{-1})
1	3728.0	2.64	9841.9	1726.7	6056.2	1062.5
2	2660.0	2.40	6384.0	1120.0	1565.5	274.6
3	3000.0	2.50	7500.0	1315.8	3453.4	605.9
4	2200.0	2.50	5500.0	964.9	1278.4	224.3
5	2600.0	2.30	5980.0	1049.1	937.8	164.5
6	3680.0	2.45	9016.0	1581.8	3770.2	661.4
7	3600.0	2.70	9720.0	1705.3	5491.2	963.4
8	3770.0	2.60	9802.0	1719.6	5323.8	934.0
9	3600.0	2.42	8712.0	1528.4	1802.0	316.1
10	3480.0	2.65	9222.0	1617.9	5633.0	988.2
11	2800.0	2.45	6860.0	1203.5	4065.3	713.2
12	2200.0	2.50	5500.0	964.9	1417.6	248.7
13	3800.0	2.65	10070.0	1766.7	5198.0	911.9
14	4000.0	2.37	9480.0	1663.2	4068.5	713.8
15	3000.0	2.51	7530.0	1321.1	4039.8	708.7
16	2400.0	2.45	5880.0	1031.6	906.7	159.1
17	3800.0	2.46	9348.0	1640.0	1823.4	319.9
18	3400.0	2.82	9588.0	1682.1	6371.2	1117.8
19	3400.0	2.48	8432.0	1479.3	3201.8	561.7
20	4000.0	2.45	9800.0	1719.3	4831.6	847.6
Avrg.	3255.9	2.52	8208.3	1440.1	3561.8	624.9

3.6. Economic indicators

Some economic indicators calculated within the scope of this study are provided in Table 8. In Turkey in 2018, fertilizer and fuel support were implemented as 230 TL ha-1 and direct yield support was implemented as 0.40 TL kg-1. State supports were added to net incomes provided in Table 7 and resultant net incomes per unit area are provided in Table 8. The lowest net income for oil sunflower production was calculated as 2096.7 TL ha^{-1} (367.8 $ ha^{-1}), the greatest net income was calculated as 7961.2 TL ha^{-1} (1396.7 $ ha^{-1}) and average of the research site was calculated as 5094.1 TL ha^{-1} (893.7 $ ha^{-1}).

Table 8
Economic Assessment Indicators

Farmers	Production supports		Fertilizer + fuel support		State-supported net income		Economic productivity		Economic irrigation water productivity		Breakeven point
	TL kg^{-1}	$ kg^{-1}	TL ha^{-1}	$ kg^{-1}	TL ha^{-1}	$ ha^{-1}	kg TL^{-1}	kg $$^{-1}$	TL m^{-3}	$ m^{-3}	kg ha^{-1}
1	1491.2	261.6	230.0	40.4	7777.4	1364.5	0.98	5.61	1.93	0.34	1434.0
2	1064.0	186.7	230.0	40.4	2859.5	501.7	0.55	3.15	0.45	0.08	2007.7
3	1200.0	210.5	230.0	40.4	4883.4	856.7	0.74	4.23	1.71	0.30	1618.6
4	880.0	154.4	230.0	40.4	2388.4	419.0	0.52	2.97	0.85	0.15	1688.6
5	1040.0	182.5	230.0	40.4	2207.8	387.3	0.52	2.94	0.39	0.07	2192.3
6	1472.0	258.2	230.0	40.4	5472.2	960.0	0.70	4.00	2.38	0.42	2141.1
7	1440.0	252.6	230.0	40.4	7161.2	1256.4	0.85	4.85	1.73	0.30	1566.2
8	1508.0	264.6	230.0	40.4	7061.8	1238.9	0.84	4.80	1.83	0.32	1722.4
9	1440.0	252.6	230.0	40.4	3472.0	609.1	0.52	2.97	0.68	0.12	2852.1
10	1392.0	244.2	230.0	40.4	7255.0	1272.8	0.97	5.53	2.12	0.37	1354.3
11	1120.0	196.5	230.0	40.4	5415.3	950.1	1.00	6.30	1.80	0.33	1034.6
12	880.0	154.4	230.0	40.4	2527.6	443.4	0.54	3.07	0.61	0.11	1633.0
13	1520.0	266.7	230.0	40.4	6948.0	1218.9	0.78	4.45	2.34	0.41	1838.5
14	1600.0	280.7	230.0	40.4	5898.5	1034.8	0.74	4.22	1.28	0.23	2281.6
15	1200.0	210.5	230.0	40.4	5469.8	959.6	0.86	4.90	2.19	0.39	1390.5
16	960.0	168.4	230.0	40.4	2096.7	367.8	0.48	2.40	0.33	0.04	2029.9
17	1520.0	266.7	230.0	40.4	3573.4	626.9	0.51	2.88	0.80	0.14	3058.8
18	1360.0	238.6	230.0	40.4	7961.2	1396.7	1.06	6.02	2.47	0.37	1140.7
19	1360.0	238.6	230.0	40.4	4791.8	840.7	0.65	3.71	1.00	0.13	2109.0
20	1600.0	280.7	230.0	40.4	6661.6	1168.7	0.81	4.59	1.88	0.33	2027.9
Avrg.	1302.4	228.5	230.0	40.4	5094.1	893.7	0.73	4.18	1.44	0.25	1856.1

Economic productivity (EP) values varied between 0.48 - 1.06 kg TL^{-1} with an average value of 0.73 kg TL^{-1}. These values revealed that the lowest values belonged to the farmers applying more than 400 mm irrigation water. As can be inferred from Table 8, net income per unit of irrigation water varied from one farmer to another. Economic irrigation water productivity (EIWP) of the farmers varied between 0.33 TL m^{-3} - 2.47 TL m^{-3} with an average value of 1.44 TL m^{-3}. Again, the farmers applying greater than 400 mm irrigation water had low EIWP values. In this study, production quantities corresponding to production costs of oil sunflower cultivation were also determined. This indictor so called as breakeven point varied between 1034.6 - 3058.8 kg ha^{-1} with an average value of 1856.1 kg ha^{-1}.

4. Conclusion

In this study, economic analysis was conducted for groundwater-irrigated oil sunflower farming in Konya region. Present findings revealed that irrigation was the most significant input, thus constituted the greatest cost item in oil sunflower production. Electricity had the greatest ratio in irrigation costs. Electricity cost of groundwater-irrigated oil sunflower farming constituted 80.12% of irrigation costs and 39.6% of total production cost. Some farmers of the research site had low net incomes because of excessive or high quantities of irrigation water they used. It was observed that there were not significant differences in yields of the farmers applying the lowest irrigation water quantities (2304 m^3 ha^{-1}) and the greatest irrigation water quantities (6352.94 m^3 ha^{-1}). It was concluded based on present findings that farmers applying high quantities of irrigation water did not get high yield level and vice versa. It was also concluded that under provincial conditions of Konya, 250 - 350 mm irrigation water was sufficient and such a quantity provided the greatest net income.

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Effect of Enzyme Addition to Diets Containing Different Levels of Alfalfa Meal on Performance and Egg Quality Parameters of Laying Hens

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ABSTRACT

This study was conducted to investigate the effect of enzyme addition to diets containing different levels of alfalfa meal on performance, egg quality and egg yolk color in laying hens. Twenty-four weeks-old, 144 Lohmann-LSL laying hens were allocated to 8 experimental groups. The experiment, 4 different levels of alfalfa meal (0, 4, 8 and 12 %) and 2 different levels (0 and 1000 mg/kg) enzyme containing 8 different experimental diets were carried out with 6 replications according to 4x2 factorial design.

The results of study indicated that there were no differences in egg production, feed intake, feed conversion ratio, egg weight, egg mass and eggshell breaking strength among the treatment groups (P> 0.05). The eggshell thickness had no significantly affected by the dietary alfalfa meal levels and interaction groups, but eggshell thickness was significantly higher in group fed with containing enzyme than the group of without enzyme (P< 0.01). In the egg yolk color parameters, the L* value was significantly affected by dietary alfalfa meal levels (P<0.01), and the groups fed with alfalfa meal containing diets at 8 and 12% levels were significantly lower than the others (0 and 4 %). The a* and roche values were significantly and similarly affected by the interactions (P<0.05), and the groups fed with alfalfa meal (with or without enzyme) diets at 8 and 12% levels were significantly lower than the other groups.

In conclusion, the study results were observed that the addition of alfalfa and enzyme to laying hens diets did not cause a significant change in performance and egg quality parameters. However, it can be said that the addition of alfalfa meal at least 8% without adding enzyme to the diet causes an increase in egg yolk color.

1. Introduction

Alfalfa meal is rich in protein but has high cellulose concentrations. Alfalfa is well balanced in amino acids and is a rich source of vitamins as well as minerals. Dehydrated alfalfa meal is often used at very low levels in poultry diets, due to its high crude cellulose and low metabolic energy content, but it is a rich source of vitamins and carotenoids. Enzymes are added to improve the ability of birds to digest fibers, increase energy use, and overcome the negative effects of fibers on intestinal lumen activity and fecal consistency (Leeson and Summers, 2008). In particular, the use of enzymes to eliminate the negative effects of cellulose, which restricts the use of high amounts of alfalfa meal, is believed to contribute positively. In addition, beta-glucanase and arabinoxylanase can be added to alfalfa-containing diets to increase the performance and energy use of poultry (Mourao et al. 2006). When exogenous enzymes are supplemented, it may be possible to use alfalfa meal at moderate levels in poultry diets. Anhydrous alfalfa meal is high in xanthophylls and is generally used at very low levels in poultry feeding to increase the degree of pigmentation of egg yolk (Fetcher and Papa, 1985).

Recent studies (Güçlü et al., 2004) reported that the addition of alfalfa meal up to 9% had no negative effect on body weight, egg production, feed intake and feed efficiency in quail. Mourao et al. (2006) reported that alfalfa meal supplementation in diet reduces the intake, egg weight, egg production and egg mass in laying hens. Laudadio et al. (2014) reported that the partial substitution of soybean meal with low-fiber alfalfa meal had no adverse effect on the growth performance of laying hens. In addition, none of the egg production and egg quality characteristics examined were affected by dietary treatment except egg yolk color. Egg yolk color was higher in chickens fed with low-fiber alfalfa meal diet. Heywang (1950) reported that the addition of alfalfa meal to egg diets at 5, 10, 15 and 20% levels did not affect feed intake, but that more than 5% of the drugs reduced egg production.

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The aim of the study was to evaluate the effect of the addition of alfalfa meal and enzyme on performance and egg quality characteristics of laying hens.

2. Materials and Methods

Twenty-four weeks-old, 144 Lohmann-LSL laying hens were randomly allocated to 8 experimental groups with 18 hens each, 6 replicates per group. Hens were fed on a basal diet, containing 16.5 % crude protein and 2750 ME Kcal/kg (Table 1). Basal diet was formulated to meet or exceed nutrient requirements of laying hens as recommended by the NRC (1994). The diets were consisted of 4 different levels of alfalfa meal (0, 4, 8 and 12 %) and 2 different levels (with/without) enzyme (Farmazyme 3000 PROENX). A total of 8 experimental diets consisting of 4 different dietary alfalfa and 2 different enzyme levels were tested in 2x4 factorial design for 12 weeks. The hens were housed in an environmentally controlled room equipped with 48 metal battery cages. Hens were kept in cages (50 cm length, 50 cm width, 45 cm height) with 3 hens per cage. Feed and water were offered ad-libitum throughout the experiment. The lighting program was provided 16h lighting: 8h darkness in a day throughout the experimental period.

The body weight of hens was determined by weighing the hens individually at the beginning and end of the experiment. Egg production (EP) was recorded daily. Feed intake (FI) was calculated as the mean for the subgroup for the 12-week trial period (FI= given total feed - remaining feed in manger). Egg mass (EM) was calculated from the EP and egg weight (EW) data using the formula: EM = (EP % × EW)/Period (days). The feed conversion ratio (FCR) was calculated using the formula; FCR = FI/EM.

Table 1
Composition of experimental diets

Ingredients, %	Dietary alfalfa meal levels, %			
	0	4	8	12
Corn	52.0	50.0	46.5	45.6
Barley	10.0	6.0	4.35	0.0
Soybean meal (43.8 % crude protein)	26.05	26.40	26.10	26.30
Alfalfa meal[2]	0	4	8	12
Vegetable oil	0.40	2.15	3.80	5.40
Limestone	9.10	9.00	8.80	8.70
Di-calcium phosphate	1.70	1.70	1.70	1.65
Salt	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25
DL-Methionine	0.20	0.20	0.20	0.20
TOTAL	1000	1000	1000	1000
Calculated nutrient (% dry matter, DM)				
Metabolizable energy, Kcal/kg	2750	2753	2753	2750
Crude protein	16.48	16.55	16.51	16.53
Calcium	3.91	3.93	3.92	3.93
Available phosphorus	0.41	0.42	0.42	0.42
L-Lysine	0.88	0.88	0.88	0.89
DL-Methionine	0.44	0.44	0.44	0.44
Methionine+cystine	0.77	0.78	0.79	0.80

[1] Premix provided the following per kg of diet: retinly acetate, 4.0 mg; cholecalciferol, 0.055 mg; DL- α-tocopheryl acetate, 11 mg; nicotinic acid, 44 mg; calcium-D-pantothenate, 8.8 mg; riboflavin sodium phosphate 5.8 mg; thiamine hydrochloride 2.8 mg; cyanocobalamin, 0.66 mg; folic acid, 1mg; biotin, 0.11 mg; choline, 220 mg; Zn, 60 mg; Mn, 60 mg; Fe, 30 mg; Cu, 5 mg; I, 1.1 mg; Se, 0.1 mg.
[2] Alfalfa meal contains 13.2 % crude protein, 28.1 % crude cellulose.

The eggs were examined to determine the EW and eggshell quality characteristics (shell breaking strength, shell weight, and shell thickness) for collected eggs produced end of each period (28 days) for consecutive 2 days and sampled and analyses were done. Eggshell breaking strength was measured using a cantilever system by applying increasing pressure to - the broad pole of the shell using an Egg Force Reader (Orka Food Technology Ltd., Ramat Hasharon, Israel). The eggs were then broken, and eggshell, albumen, and yolk were separated and weighed. The egg yolk colour was determined using the Egg Analyzer (ORKA Food Technology Ltd, Ramat Hasharon, Israel) based on Roche Yolk Colour Fan and Minolta CR-400 colorimeter (Konica Minolta, Japan).

The L*, a*, b* parameters correspond to the lightness (0 = black, 100 = white), redness (–100 = green, 100 = red), and yellowness (–100 = blue, 100 = yellow), respectively. Eggshells were weighed using a 0.01 g precision scale. Eggshell weight was calculated using the formula: eggshell weight (%) = [(eggshell weight (g)/EW (g))/100]. Eggshell thickness (including the membrane) was determined at three points on the eggs (one point on the air cell and two randomised points on the equator) using a micrometer (Mitutoyo Inc., Kawasaki, Japan).

Data were subjected to ANOVA using General Linear Model (GLM) procedure in Minitab (2000). Tukey's multiple range tests were applied to separate means. Statements of statistical significance were based on probability of $P<0.01$ and $P<0.05$.

3. Results and Discussion

The performance parameters are presented in Table 2. Dietary alfalfa and enzyme levels as a main factor, and their interactions had no significant effects on egg production, feed intake, feed conversion ratio, egg weight and egg mass among the treatment groups (P>0.05).

The findings of present study in terms of performance parameters were consistent with the results of Khajali et al. (2007) who reported that the inclusion of alfalfa meal had no significant effect on egg production, egg weight, egg mass, feed conversion ratio. Laudadio et al. (2004) reported that the group containing 15 % alfalfa meal to diet had no significant effect on feed intake and feed efficiency compared with the control diet. Yuxin et al. (2004) showed that supplementation of alfalfa meal to laying hens diet had no significant effect on feed intake, egg weight and feed conversion ratio compared to untreated meals. As a result, they reported that diets containing 5% alfalfa meal are most suitable according to production performance in laying hens. Al-Shami et al. (2011), the addition of rations alfalfa and enzyme in laying hens, feed consumption, feed conversion rate, egg weight and egg production did not cause a significant difference. Olgun and Yıldız (2015) reported that the different dietary levels of alfalfa meal had no significant effect on body weight change, egg production, egg weight, egg mass, feed conversion ratio in quails. However, Maurao et al. (2006) demonstrated that egg production, egg mass and feed intake were significantly reduced by inclusion of alfalfa to laying hen diets at level of 15% and addition of beta-glucanase and xylanase could not overcome the situation. Halaj et al. (1998) showed that the addition of alfalfa meal to diet of laying hens rations had a positive effect on egg weight and egg mass. Feed consumption was higher in experimental groups, but had no effect on egg production.

Table 2
Effect of enzyme addition to diets containing different levels of alfalfa meal on performance of laying hens

Treatments	Egg production,%	Feed intake, g/d/hen	Feed conversion ratio, g feed/g egg	Egg weight, g	Egg mass, g/d/hen
Alfalfa meal (%)					
ALM-0	97.49	106.4	1.84	59.50	58.02
ALM-4	96.64	105.0	1.82	59.85	57.85
ALM-8	96.92	105.3	1.83	59.51	57.68
ALM-12	96.99	105.9	1.82	60.17	58.38
Pooled SEM	*0.536*	*0.666*	*0.025*	*0.674*	*0.775*
Enzyme (g/kg)					
0	96.70	105.6	1.85	59.36	57.41
1000	97.32	105.7	1.79	61.04	58.55
Pooled SEM	*0.379*	*0.471*	*0.018*	*0.476*	*0.548*
*Alfalfa*Enzyme*					
ALM-0*0	97.49	107.1	1.84	59.87	58.38
ALM-0*1000	97.49	105.6	1.84	59.13	57.66
ALM-4*0	95.32	104.4	1.87	58.95	56.19
ALM-4*1000	97.95	105.7	1.78	60.74	59.51
ALM-8*0	96.89	104.6	1.82	59.31	57.48
ALM-8*1000	96.96	106.0	1.84	59.72	57.88
ALM-12*0	97.09	106.2	1.85	59.31	57.60
ALM-12*1000	96.89	105.6	1.79	61.04	59.16
Pooled SEM	*0.758*	*0.942*	*0.035*	*0.952*	*1.100*

The eggshell quality parameters are presented in Table 3. Dietary alfalfa levels and enzyme addition, and their interactions had no significant effects on eggshell weight and eggshell breaking strength (P> 0.05). Eggshell thickness was significantly affected by the dietary enzyme addition (P<0.05), but it was not affected by dietary alfalfa and interactions of groups.

Similar results have been reported in previous studies. Khajali et al. (2007) found that the inclusion of alfalfa in the laying hen diet had no significant effects on eggs shell thickness and shell breaking strength. In another study, the use of alfalfa meal in laying hens diets have determined that there is a significant level effect on the relative eggshell weight. However, eggshell thickness was found to be significantly higher in alfalfa meal groups than in the control group (Yuxin et al., 2004). Laudadio et al. (2004), reported that the use of alfalfa meal to laying hens diets does not adversely affect any feature related to egg shell quality. It was stated that they have similar average values between the groups using alfalfa meal and control group for eggshell thickness and eggshell breaking strength parameters. These findings agree with those reported by Al-Shami et al. (2011), who observed that eggshell thickness increased due the addition of enzyme to the diets containing 5 or 7% alfalfa meal compared to control and 2% alfalfa meal diet. Olgun and Yıldız (2015) reported that the different dietary levels of alfal-

fa meal had no significant effect on egg shell breaking strength in quails. Some research results, which are partly inconsistent with the current results, that Mourao et al. (2006) and Khajali et al. (2007) who reported that addition of alfalfa meal and enzyme to laying hens diets had no effect on eggshell thickness.

Table 3
Effect of enzyme addition to diets containing different levels of alfalfa meal on egg quality parameters of laying hens

Treatments	Eggshell weight, g	Eggshell thickness, mm	Eggshell breaking strength, kg
Alfalfa meal (%)			
ALM-0	5.87	0.395	4.68
ALM-4	5.92	0.393	4.54
ALM-8	5.98	0.399	4.85
ALM-12	5.97	0.398	4.77
Pooled SEM	*0.077*	*0.0023*	*0.087*
Enzyme (g/kg)			
0	5.89	0.394[b]	4.69
1000	5.98	0.399[a]	4.79
Pooled SEM	*0.541*	*0.0017*	*0.062*
*Alfalfa*Enzyme*			
ALM-0*0	5.86	0.392	4.60
ALM-0*1000	5.88	0.398	4.76
ALM-4*0	5.75	0.386	4.44
ALM-4*1000	6.09	0.400	4.64
ALM-8*0	5.99	0.398	4.97
ALM-8*1000	5.97	0.401	4.72
ALM-12*0	5.94	0.399	4.75
ALM-12*1000	5.99	0.397	4.79
Pooled SEM	*0.108*	*0.0033*	*0.123*

[a, b, c:] Within a column, values not sharing a common superscript are statistically different; P<0.05

The parameters of egg yolk color are presented in Table 4. In the egg yolk color parameters, the L* value was significantly affected by dietary alfalfa meal levels (P<0.01), and the groups fed with alfalfa meal containing diets at 8 and 12% levels were significantly lower than the others (0 and 4 %). The a* and roche values were significantly and similarly affected by the interactions (P<0.05), and the groups fed with alfalfa meal (with or without enzyme) diets at 8 and 12% levels were significantly lower than the others. The b* value was not affected by any of the treatments. The effect of enzyme addition to diet on all egg yolk color parameters were insignificant.

According to the results of the present study, in general, an increase in egg yolk color density was observed with the use of alfalfa meal to the diet. Khajali et al. (2007) found that laying hens fed with diets containing alfalfa meal tended to produce eggs with higher score of yolk pigmentation assessed by egg yolk color fan. In this study, enzyme supplementation had no impact on egg yolk color. It is known that alfalfa meal causes an increase in egg yolk pigmentation due to its high xanthophyll content (Laudadio et al., 2004). Yuxin et al. (2004) reported that the alfalfa meal increased, egg yolk color increased and was significantly higher than those who did not add alfalfa flour. It recommends the addition of 5% alfalfa flour to be optimal. Halaj et al. (1998) found that egg yolk colour scores revealed significant differences among all treatments with the increase of yolk colour as the level of alfalfa increases. Al-Shami et al. (2011) reported similar results. In this study, it was observed that the egg yolk color improved by increasing the alfalfa meal level in the diets that the containing the enzyme of laying hens.

Table 4
Effect of enzyme addition to diets containing different levels of alfalfa meal on egg yolk color parameters of laying hens

Treatments	L*, Lightness	a*, Redness	b*, Yellowness	Roche Color Score
Alfalfa meal (%)				
ALM-0	62.69[A]	4.35	49.65	7.24
ALM-4	61.74[A]	4.90	48.84	7.93
ALM-8	59.99[B]	7.22	48.62	9.07
ALM-12	59.99[B]	7.32	48.44	9.14
Pooled SEM	*0.296*	*0.162*	*0.524*	*0.117*

Table 4(Continuation)
Effect of enzyme addition to diets containing different levels of alfalfa meal on egg yolk color parameters of laying hens

Enzyme (g/kg)				
0	61.37	5.69	49.32	8.27
1000	60.84	6.21	48.46	8.42
Pooled SEM	*0.210*	*0.114*	*0.371*	*0.083*
*Alfalfa*Enzyme*				
ALM-0*0	62.72	4.35^{c}	49.50	7.36^{c}
ALM-0*1000	62.66	4.36^{c}	49.81	7.11^{c}
ALM-4*0	62.02	4.23^{c}	49.08	7.56^{c}
ALM-4*1000	61.43	5.56^{b}	48.60	8.31^{b}
ALM-8*0	60.21	7.22^{a}	49.42	9.14^{a}
ALM-8*1000	59.78	7.23^{a}	47.81	9.00^{a}
ALM-12*0	60.49	6.97^{a}	49.26	9.03^{a}
ALM-12*1000	59.50	7.67^{a}	47.62	9.25^{a}
Pooled SEM	*0.419*	*0.228*	*0.741*	*0.166*

$^{A, B:}$ Within a column, values not sharing a common superscript are statistically different; P<0.01
$^{a, b, c:}$ Within a column, values not sharing a common superscript are statistically different; P<0.05

In conclusion, according to the results of this study, it was observed that the addition of alfalfa meal and enzyme to the laying hens diets did not cause a significant change in performance and egg quality parameters. Addition of alfalfa meal to the diet at 8% level caused an increase in egg yolk color without adding enzyme to the diet. However, the addition of enzyme to diets containing 4% alfalfa meal had an effect on egg yolk color increase.

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Determination of the Effect of Some Acidic Solutions on the Tenderness and Quality Properties of Chicken Breast Meat

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ABSTRACT

In this study, it was aimed to determine the quality characteristics of chicken breasts treated with different ratios of acetic acid and apple cider vinegar solutions. Chicken breasts were allowed to marinate for 48 hours at 4°C using solutions containing apple cider vinegar prepared with concentrations in 50% (E1) and 100% (E2) concentrations and 0.1 M (A1) and 0.2 M (A2) acetic acid. Pure water was used for the control group (C). Texture profile analyzes and Meullenet-Owens Razor Shear (MORS) analysis with pH, color (*L**, *a**, *b**), cooking loss, water holding capacity and marinade absorption were applied to each treatment group. According to the results of the analysis, it was determined that the pH value of chicken breast meat samples marinated with apple cider vinegar was lower than the other groups. It was determined that the lowest hardness value was in E2 group according to the results of the texture profile analysis. According to the MORS analysis, the lowest shear force was found in E2 group. It is observed that the shear force has the lowest value in group including 100% apple cider vinegar in parallel to the hardness value. As a result, it was observed that apple cider vinegar had a very good source to increase tenderness of chicken breasts compared to acetic acid.

1. Introduction

Chicken meat is among the foods preferred by consumers in our country and worldwide with its nutritional value and reasonable price. Marination, one of the most widely used techniques to increase the flavor and tenderness of the meat, is a common technique known as a means of improving the quality of meat (Gault, 1991; Rao et al., 1989).

In acidic marination, substances such as organic acids (e.g. acetic, lactic and citric acid) and pH-lowering ingredients (e.g. soy sauce) are used as part of a flavor enhancing mixture, in contrast to sweetening additives. However, it has been reported that acidic substances have been play an important role in tenderness and flavor of processed meat (Berge et al., 2001; Gault, 1984).

In this study, it was investigated which the effect on the marination process of different concentrations of acetic acid and apple cider vinegar on the tenderness and quality characteristics of chicken breast meat.

2. Materials and Methods

2.1 Materials

Chicken breast meats and apple cider vinegar used as materials were obtained from local market (Konya, Turkey). All the reagents and chemicals used for the research were of analytical grade and procured from Sigma Chemical Co. (St. Louis, MO).

2.2. Sample preparation

Chicken breast meats (2x3 cm) were cut vertical to the muscle fibre direction from muscle samples using a knife. Solutions containing 0.1 M acetic acid (A1), 0.2 M acetic acid (A2), 50% apple cider vinegar (E1), 100% apple cider vinegar (E2) were prepared in distilled water. Chicken breast meats were immersed for 48 h in 500 milliliters of solutions at 4ºC. Distilled water was used for the control group (C).

Moisture and fat level analysis were performed in the chicken breast meat. Cooking loss (CL), water holding capacity (WHC), marinade absorption (MA), pH and colour analyses were performed in the marinated chicken breast meat. Texture profile analysis was performed in marinated chicken breast meat samples cooked in the oven for 40 minutes at 250˚C until the internal temperature reached 72^{o}C.

2.3. pH measurement

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pH values of the samples were measured by penetrate with a pH meter (Testo 205 T-Handle pH Meter/Thermometer w/ Penetration Tip) before marination and after marination (Lambooij et al., 1999).

2.4. Proximate analyses

Moisture (hot air oven) and fat (ether extraction) contents of the samples were determined using standard methods of AOAC (2000).

2.5. Determination of cooking loss (CL)

The method described by Young and Buhr (2000) was used to determine weight loss of chicken breast meat after cooking. Approximately 8-10 grams of sample was put into polyethylene bags and cooked in a water bath for 30 minutes at an internal temperature of 75°C. The separated water was removed from the samples and the loss of cooking was calculated by weighing the samples.

2.6. Determination of water holding capacity (WHC)

Centrifugation method was used to determine the WHC of the samples. 2 g homogenized chicken breast meat samples were weighted on filter paper and placed in centrifuge tubes. After centrifugation at 2000 rpm for 10 minutes, the wet filter paper was weighted (W1). The filter paper was then dried in the oven at 60°C until constant weight and then reweighted (W2). The WHC of chicken breast meats was calculated as the amount of sample remaining after centrifugation (Gómez-Guillén et al., 2000).

2.7. Determination of marinade absorption (MA)

The MA of the marinated samples was determined on a weight basis before marination process and after the marination process, according to the method given by Young and Buhr (2000).

2.8. Color properties of chicken breast meats

The surface colour of the cooked marinated chicken breast meats was evaluated using a chroma meter CR-40 (Konica Minolta, Inc., Osaka, Japan) with illuminant D65, 2° observer, Diffuse/O mode, 8 mm aperture of the instrument for illumination and 8 mm for measurement, calibrated against a white tile. Colour measurements (CIE L^*, a^* and b^* values representing lightness, redness and yellowness, respectively) were taken marinated uncooked samples and marinated cooked samples. For colour measurement, cooked samples were cooled to room temperature. L^* (lightness), a^* (redness, +60, red; −60, green) and b^* (yellowness, +60, yellow; −60, blue) color coordinates according to the CIE L^* a^* b^* color coordinate system (CIE, 1976). The measurement was made by directly upon three different parts of the samples placed on a white background.

2.9. Texture measurement

TPA parameters (hardness (N), cohesiveness, chewiness (Nxmm), gumminess (N) and adhesiveness (g.sec)) of the marinated cooked chicken breast meat samples were performed using a Texture Analyzer (TA.HD Plus Texture Analyser, UK) at room temperature and following specifications were applied: 50 N load cell, 1 mm/min speed before the test, 5 mm/min speed during and after the test, cylindrical probe with 36 mm diameter (Modi et al., 2009).

For MORS analysis, Meullenet-Owens Razor Shear probe connected to TA.HD Plus texture analyzer was used. Blade penetration depth was set at 20 mm (Sawyer et al., 2007). Analysis probe was dipped into 3 different regions of each chicken breast meat. 50 N load cell, 2 mm/min speed before the test, 10 mm/min speed during and after the test was set.

2.10. Statistical analysis

The data obtained as a result of the analyzes were subjected to variance analysis using MINITAB release 16.0 program as tables prepared in accordance with the experimental design. Tukey test was used for comparison of means, with significance assigned at $p<0.05$ and $p<0.01$. Each parameter was tested in triplicate samples with two replications.

3. Results and Discussion

According to result of research, it was found that the moisture and fat content of unmarinated chicken breast meat was 74.6% and 3.6%, respectively. The pH values of unmarinated chicken meat, 0.1 M and 0.2 M acetic acid solution, 50% apple cider vinegar and 100% apple cider vinegar were determined as 6.11, 3.03, 2.86 and 2.97 and 2.89 respectively.

The pH values of chicken breasts treated with different concentrations of acetic acid solution and apple cider vinegar are given in Table 1. The pH of the samples decreased significantly with the addition of acetic acid and apple cider vinegar ($p<0.01$). pH is an important criterion for changes in foods treated with acidic marinades. It is thought that the difference between the pH values of the marinated chicken breasts is due to the different pH values of the marinades used. It is shown that the pH values of chicken breast meat decreased in parallel with the marinad pH values in Table 1. The highest pH value (5.66) belongs to the control group, while the lowest pH value (3.53) was observed in the E2 group. Aktaş et al. (2003) were also obtain similar results in their study with organic acids. In a study in which chicken breast meats were marinated with apple cider vinegar, pomegranate juice and lemon juice at different temperatures and times, it has been reported which the pH values of chicken breast meats treated with lemon juice were lower than the others, on the other hand those with marinated pomegranate juice had the highest pH value (Lytou et al., 2017). In study carried out by Serdaroglu et al. (2007) also reported that the highest and lowest pH values of turkey meat marinated using citric acid solution and grapefruit juice belonged to the control group and the group treated with 0.2 M citric acid solution, respectively.

Table 1
pH, water holding capacity (WHC), cooking loss (CL) and marinade absorption (MA) values of chicken breast meats treated with different concentrations of acetic acid and apple vinegar.

Treatment	pH	WHC (%)	CL(%)	MA(%)
Control	5.66±0.04^{a}	20.69±3.10^{a}	37.81±0.92^{a}	4.40±0.57^{c}
A1	4.93±0.37^{ab}	27.35±4.03^{a}	22.44±4.04^{bc}	5.01±0.01^{c}
A2	4.14±0.28^{bc}	28.67±5.89^{a}	25.72±0.21^{b}	20.69±0.98^{b}
E1	4.32±0.26^{bc}	15.14±0.40^{a}	20.24±2.74^{bc}	22.88±1.25^{b}
E2	3.53±0.03^{c}	18.70±4.52^{a}	15.19±0.26^{c}	41.06±1.50^{a}

$^{a-c}$ Means within a column with different letters are significantly different. (p<0.01). Means based on six values. (n=6)

Control: Distilled water; A1: 0.1 M acetic acid; A2: 0.2 M acetic acid; E1: 50% apple cider vinegar; E2: 100% apple cider vinegar.

The WHC of meat is very important because many physical properties such as color and texture are partly dependent on WHC (Ketnawa and Rawdkuen, 2011). Table 1 shows the WHC of chicken breasts treated with acetic acid solution and apple cider vinegar. Chicken breast meats treated with 0.1 M and 0.2 M acetic acid have the highest WHC (27.34%, 28.66%). At the same time, samples containing apple cider vinegar showed lower WHC than the control group. WHC increased in parallel with acetic acid and apple vinegar concentration. However, the difference between them is statistically insignificant (p>0.05). It is thought that this difference between treatments may be due to the fact that the marinade solutions have different acetic acid ratios. It has been reported in several studies that low pH has a strong effect on proteins, that the effect of acids on tissue can be depends on the type of fiber in the meat, whereas high pH promotes the swelling of collagen surrounding the muscle fibers (Aktaş et al., 2003; Rao and Gault, 1989; Rao et al., 1989).

The CL (%) values of all samples are shown in Table 1. CL values of the samples treated with acid solution and apple cider vinegar were lower than the control group (p<0.01). While the cooking loss of chicken breast meats treated with acetic acid solution increased with increasing concentration, CL of apple cider vinegar decreased with increasing concentration. The least CL (15.19%) occurred in chicken breast meat treated with 100% apple cider vinegar. At the point where the positive and negative charges of chicken breast meat proteins are equal (pH=6.00), they cause the amount of water bound to the proteins to decrease due to the pulling of these loads. As the pH value moves away from this point, the less water is removed from the structure. Therefore, it is thought that the loss of cooking decrease with increasing acidity value. In the study of Aktaş et al. (2003) that they marinated beef with 0.5, 1, 1.5% lactic acid and citric acid solution, the lowest CL in beef was obtained in marinated samples at the highest lactic and citric acid concentrations. They reported that this might occur from the effect of acidic pH on proteins.

MA varies depending on the selected region of poultry meat. It has been stated that chicken breast meats absorb marinade more than thigh meats (Arganosa and Marriott, 1989). The MA values of all treatment groups are shown in Table 1. The group with the highest value was group applied 100% apple cider vinegar (41.06%) while the lowest value belong to the control group (4.40%). The difference between the treatments in terms of MA was statistically significant (p<0.01). However, it was found that the MA values of the treatment groups increased proportionally with decrease in pH. This situation is thought to be related to the isoelectric point of the proteins in the structure of chicken breast meat as in the loss of cooking values. It is thought that in parallel with these data, in another study investigating the sensory and some technological properties of marinated poultry meats by using different ratios of citric acid, it has been reported that MA was increased final weight of all treatment groups as the function of pH effect and the highest value was obtained at pH 4.00 (Yusop et al., 2010).

The color parameters of each treatment group were determined as raw and cooked and all values are given in Table 2. According to the results of the study, L^*, a^*, b^* values of all groups showed statistically significant changes. Among the marinated raw samples, the highest L^* and a^* values were determined in the control group and the highest b^* values were determined in the E1 group while the lowest L^* and a^* values were found in E2 and the lowest b^* values were found in A2 group. Among the cooked groups, the highest L^* value belongs to the control group and the highest a^* and b^* values belong to the A1 group, while the lowest L^* and b^* values was determined in the E2 group and the lowest a^* value was determined in the A2 group. Although pH change did not have a significant effect on color, it was concluded that color parameters decreased due to increase in concentration between treatments. In a study, it was reported that a^* values did not differ in turkey meat samples treated with citric acid and grape juice (Serdaroğlu et al., 2007). Nadzirah et al. (2006) indicated that the brightness values of the marinated samples increased and a^* value decreased. In another study, it was reported that the L^* value of marinated chicken breast meats decreased (Smith and Young, 2007). Northcutt et al. (2000) reported that there was statistically no difference between the brightness values of marinated and unmarinated raw and heat treated chicken fillets. In general, it is thought that the color of the acidic fruit or organic acid used may change the color characteristics of the meat treated with it.

Table 2
*L**, *a** and *b** values of raw and cooked chicken breast meats treated with different concentrations of acetic acid and apple cider vinegar.

	Treatment	*L**	*a**	*b**
Raw	Control	62.48±0.03[a]	0.84±1.25[a]	7.20±0.69[a]
	A1	61.80±0.31[ab]	0.16±1.35[a]	8.36±0.17[a]
	A2	57.09±2.32[bc]	-0.32±0.63[a]	3.25±0.07[b]
	E1	62.16±1.61[ab]	-1.02±0.13[a]	9.31±0.34[a]
	E2	54.61±0.71[c]	-1.06±0.05[a]	4.00±1.20[b]
Cooked	Control	76.76±0.55[a]	1.65±1.34[a]	18.53±1.18[b]
	A1	67.17±1.74[b]	1.72±0.19[a]	23.31±0.90[a]
	A2	72.41±1.98[ab]	0.27±1.99[a]	18.18±0.88[b]
	E1	72.75±1.88[ab]	0.74±0.00[a]	17.07±0.06[b]
	E2	64.52±3.32[b]	0.43±0.22[a]	13.25±0.61[c]

[a-c] Means within a column with different letters are significantly different. (p<0.01). Means based on six values. (n=6)

Control: Distilled water; A1: 0.1 M acetic acid; A2: 0.2 M acetic acid; E1: 50% apple cider vinegar; E2: 100% apple cider vinegar.

The results of the texture profile analysis of the samples marinated with acetic acid and apple cider vinegar are given in Table 3. According to the results of the analysis, there was a significant difference between the values of shear strength (MORS) (p<0.05). It has found that the highest hardness value was group including 0.1 M acetic acid with 134.1 N while the lowest hardness was group including 100% apple cider vinegar with 60.28 N. Both concentrations of apple cider vinegar and 0.2 M acetic acid reduced the hardness of chicken breasts significantly compared to the control group. The shear force of all treatment groups was between 9.7-5.1 N and the highest and lowest values were found to be the control and E2 groups, respectively. In terms of shear force, the difference between chicken breast meat marinated with 100% apple cider vinegar and other groups was statistically significant (p<0.01). The cohesiveness values of chicken meat samples varied between 0.26 and 0.32. In terms of these values, the difference between treatments was not statistically significant, and acetic acid solution treated groups were increased more than compared to control group. It is reported that the mechanism of the tenderising action of acidic marinades is affect to several factor including increased proteolysis by cathepsins, weakening of structures, and increased conversion of collagen to gelatin at low pH during cooking. It has been reported that when the pH drops below the isoelectric point, the hardness increases and the acidic marinades used are responsible for increasing the hardness of chicken breast meats (Önenç et al., 2004; Sheard and Tali, 2004). In a study in which marinated turkey meat using mixed vegetable and fruit juices, it was reported that the lowest hardness value was found in pomegranate and red grape juice and the hardness values increased with cooking process (Gök and Bor, 2016). Goli et al. (2014) have reported that 0.25 M aqueous acetic acid solution was decreased hardness and shear force of turkey breast meat over time, but it was increased slightly in presence of salt.

Table 3
Texture profile analysis results of chicken breast meats treated with different concentrations of acetic acid and apple cider vinegar.

Treatment	Hardness (N)	Gumminess (N)	Cohesiveness	Chewiness (Nxmm)	Adhesiveness (gxs)	Shear Force (N)
Control	123.31±17.08[a]	33.35±8.46[a]	0.27±0.03[a]	18.61±5.23[a]	-3.34±2.18[a]	9.70±0.61[a]
A1	134.18±2.16[a]	42.97±6.51[a]	0.32±0.04[a]	25.90±4.60[a]	-7.25±1.78[a]	9.33±0.77[a]
A2	124.92±47.59[a]	40.66±17.16[a]	0.32±0.01[a]	20.96±7.17[a]	-8.60±9.69[a]	8.67±0.39[a]
E1	76.16±6.82[a]	21.18±3.54[a]	0.28±0.02[a]	11.33±2.60[a]	-2.49±0.07[a]	8.67±1.01[a]
E2	60.28±8.40[a]	17.47±2.05[a]	0.29±0.01[a]	8.72±0.61[a]	-16.83±7.50[a]	5.11±0.35[b]

[a-b] Means within a column with different letters are significantly different. (p<0.01). Means based on six values. (n=6)

Control: Distilled water; A1: 0.1 M acetic acid; A2: 0.2 M acetic acid; E1: 50% apple cider vinegar; E2: 100% apple cider vinegar.

In this study, quality and textural properties of chicken breast meats marinated with different concentration of acetic acid solution (0.1 M and 0.2 M) and apple cider vinegar (50% and 100%) for 48 hours were investigated. Thus, it was investigated whether apple cider vinegar can be used as a natural alternative to an organic acid solution in marinating chicken meat. It was determined that chicken breast meat samples treated with acetic acid and apple cider vinegar have much more acceptable structure and hardness values decreased. It was observed that the lowest hardness value was belong to chicken breast meats treated with 100% apple vinegar. When the results of the analysis are view, it was seen that the apple cider vinegar solution improved in a positive way the quality and textural properties of chicken breast meats. It is concluded that apple cider vinegar is more effective on the textural properties of chicken breast meat than acetic acid which is an organic acid in the natural structure of vinegar. Therefore, it can be suggested that apple cider vinegar may be a natural alternative source for use as a marination solution.

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Research Article

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A Crop Model for Improvement Water Use Efficiency and Durum Wheat Production in the Siliana Region

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ABSTRACT

In Tunisia, the development of the irrigation within the water scarcity context, remains one of the crucial issues in agricultural activity. The phenomenon of climate change is likely to make the problematic while threatening the country's food security. Thus, high water use efficiency is essential to overcome these constraints and to facilitate sustainable agricultural activity. This work aims to optimize irrigation water use and to increase the production of the durum wheat (DW) through improving irrigation practices. For this, a field survey was carried out with a sample of 43 farms from the Siliana region. In data collection process, current study focused on the DW activity during the agricultural compain of 2015 in terms of the applied doses of water and fertilizer as well as the crop rotation. A crop model, CROPSYST, has been developed. The model used DW activity during three consecutive crop production periods as 2015, 2016 and 2017. Three strategies of varied mix in terms of irrigation water and fertilizer doses were simulated. The results showed the improvement of the yield by 9% that allowed an improvement of the water productivity up to 8,2 $kgha^{-1}mm^{-1}$.Given these results the Gross Margin may increase by 3% up to 11%.

1. Introduction

In Tunisia, irrigation development remains a strategic activity to increase agricultural production as well as national economy.The irrigated activities use only 8% of the arable land but ensure up to 40% of the national agricultural production value.

Thanks to irrigation, Tunisia has achieved self-sufficiency in fruits and vegetables, even generating surpluses for export. However, within the context of limited water resources (quantity and quality) and climate change, this orientation is increasingly problematic.As a result, Tunisia is currently facing an imminent risk of water scarcity and even if the water volumes allocated to the agricultural sector will tend to decline with an annual growth rate of around 1.3%, this sector will remain the main consumer with an average of 80% of available water resources (Hammami et al.2017). In addition, despite the huge efforts made over the past 40 years to save water, the current situation shows an overconsumption that sometimes exceeds 30% which highlights lack of mastering the technology production mainly the irrigation practices (Bhouri et al.2015; Chemak et al.2010). Thus improving the water productivity of strategic crops, particularly DW is required to better value this scarce resource and to deal with the challenges of food security. In Tunisia, the irrigated DW occupies an average of 48806 ha equal to 36% of the total area of irrigated cereals and provides about 67% of the total production of irrigated cereals (MA.2018). The DW crop is grown in large-scale crops for human consumption only. Indeed, this activity represents, depending on the period, between 40 and 50% of the vegetal food availability (Ben Zekri.2017).

However, yields of the DW are still insufficient, with a–high fluctuating national average of around $36qha^{-1}$ (1q=100Kg; $1ha=10^4m^2$) compared to a target of $70qha^{1}$ (Maihol et al.2007). Indeed, Hammami et al.(2016) confirm that it is possible to obtain a yield greater than 70 qha^{-1} for irrigated DW with a good match between the potential of the medium and the high-yielding varieties.

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Rajram and Braun (2008) stated reasons behind the low yields (10qha^{-1} at 60 q ha^{-1}) of the Razak variety (with a production potential of 95 q ha^{-1}) are drought effect and the poor crop management. Other authors (Mouelhi et al.2016; Latiri et al.2010) have also reported the low yields observed due to the variability of pedoclimatic conditions, the inadequacy of sowing date with varietal choice, the monoculture and inappropriate rotation of crops.

Nevertheless, despite the variability of the mentioned factors above, water and nitrogen remain the main limiting factors of DW production in Tunisia (Ben Zekri 2017; Latiri et al. 2010).

Within this context, the maximization of production through a good match between the new irrigation and fertilization practices was the major concern of agricultural economists who seek to design sustainable production systems and meet the growing demand for products for a rapidly growing population. However, the proposal of novice practices of irrigation and nitrogen fertilization is based on a preliminary evaluation phase of these practices. Thus several approaches are available to agronomists to accomplish these evaluation tasks among which the experimental evaluation in the field (Guillaume 2011).

Nevertheless, Guillaume (2011) showed that applied experimentation techniques reach their limits as soon as we try to estimate the impact of technical change or to evaluate the effects of climate or agricultural practices on production systems.To overcome this obstacle, agronomists took advantage of advances in the field of computer language to develop cropping system models that simulate farms' actions in a simplified form. According to Guillaume (2011), agricultural models make it possible to simultaneously evaluate the effect of interactions between climates, soil type and cultivation techniques on the performance of the system under study.Thus, these models offer the possibility of exploring a wider range of situations in a short timeframe.

This work aims to evaluate the performance of the irrigated DW in the governorate of Siliana and to analyze, with the CROPSYST model, the possibilities of jointly increasing the yields and the efficiency of water use in DW farming systems.

Before identifying and evaluating the alternative levers, it was first necessary to carry out a detailed characterization of agricultural diversity and to evaluate, based on the concept of resources use efficiency, the performance of each agricultural household constituting this diversity.

2. Materials and Methods

2.1. Study area and data collection

This study was conducted in the region of Siliana, which is located in the Northwest of Tunisia (Figure 1). The region is characterized by continental climate with average annual precipitation of about 486 mm.The economy of the region is mainly based on agriculture where the areas arable land reaches 313,000 ha. Agricultural activity consists of cereals wich is carried out by 9269 farms, representing 43% of all grain producers in the country (Khaldi et al.2017). Irrigated cereal crops occupy only 3% of the total area of cereal crops.

On the other hand, this activity contributes with an average of 13% of the total production of cereals reaching more than 30% in the dry year.The most irrigated cereal is DW with an average area of about 3000 ha, representing about 68% of the irrigated cereal area in the region.

The data required for our study was collected by performing survey with a sample of 43 farmers who practiced irrigated cereals during the cropping year 2014/2015

The survey questionnairy was designed with the aim of characterizing the production system practiced, but also with a focus on cropping practices in irrigated cerealso (Sowing, tilling, fertilization, irrigation, treatment, harvest) as well as the achieved yields.Through this database, we will characterize the agronomic and economic performances of this activity.

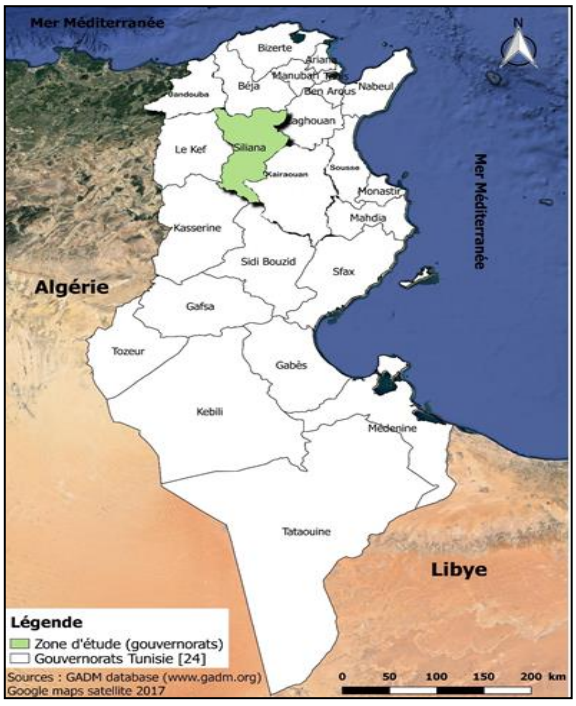

Figure1
Location of study area

Indeed, to evaluate agronomic performance analysis of grain yields and water productivity were assessed.The economic performance is estimated by gross margin.

2.2. CROPSYST for Biophysical modeling

In order to evaluate success of irrigation practices on durum wheat yields, CROPSYST, biophysical simulation model, cropping systems simulation multi-year model was used (Stockle et al.2003).

This model was developed for a large number of cultivated species including wheat, maize, sorghum and works with a daily time step. This model has been used and adapted to the Tunisian context in order to analyze the impact of climate and technical management on the productivity of cropping systems (Belhouchette 2004; Jeder 2011). Cropsyst needs five inputs files (Figure 2) that describe location (latitude,weather file, ET model selection Penman-Monteith (Pm) or Priestly-Taylor (PT) on automatic model), Soil file (soil type, pH, fieldcapacity and hydraulic conductivity), Crop file (emergence,thermal time accumulation,phenology and harvest), management file (irrigation, fertilization, planting and harvesting) and simulation control (a combination of different input files such as start and ending days, simulation of soil salinity and crop rotation) for simulation (Umair et al.2017). To run this model, all these modules should be properly defined one after the other. In present study, the daily climatic data on rainfall, temperature,solar radiation,relative humidity and wind speed are provided by the National Institute of Meteorology of Tunis (INM).While the soil analysis data are obtained from CRDA's soil boundaries. The technical itinerary of the wheat crop is obtained via technical and economic data sheets completed in consultation with farms and CTV technicians in the delegations.The phenological characteristics of crop are drawn from research work that has been carried out and adapted to the Tunisian context (Belhouchette 2004; Abbess 2007; Jeder 2011). To calibrate model we first introduced in CROPSYST the current technical itineraries related to DW cultivation whose yields were known and we launched a first simulation.Then, based on data from the bibliography, we adapted the parameters of the model to bring the simulated yields closer to those actually achieved at the level of the farm.

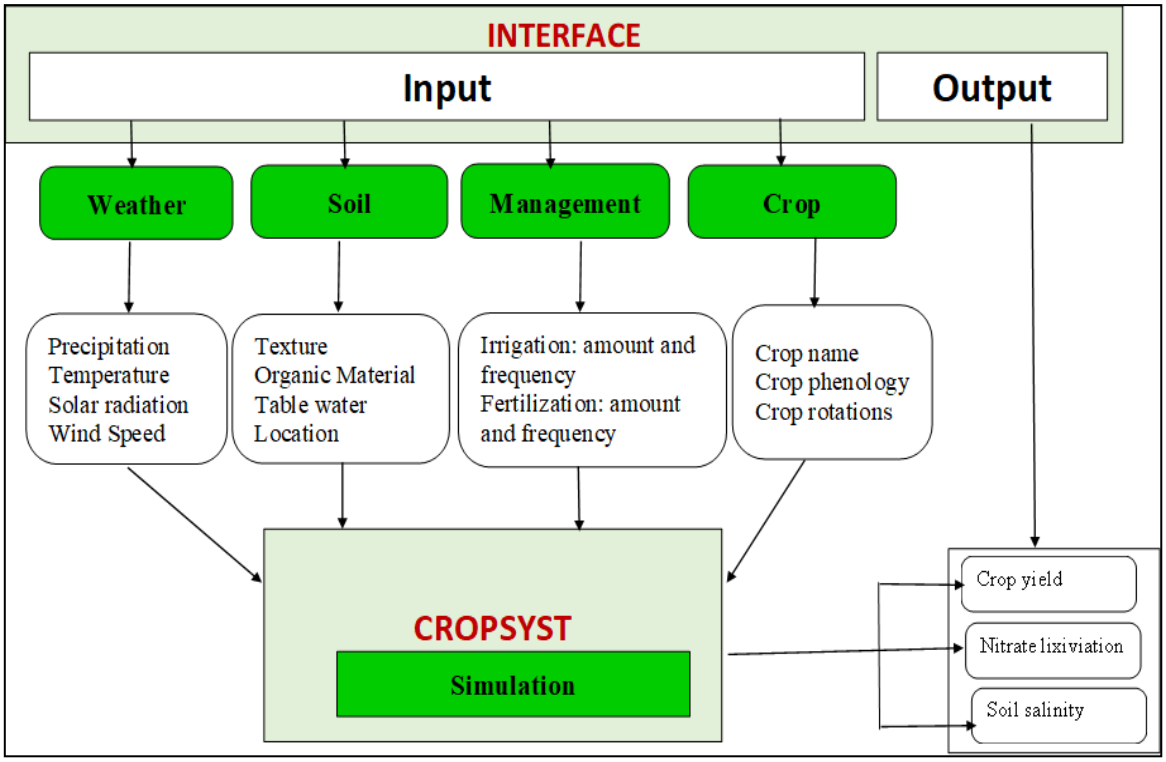

Figure2
Presentation of CROPSYST Model

Once calibrated, the model is validated for different soil, climate and crop conditions. The validation is based on the only available criteria, mainly the yields of DW irrigated in the 2014/2015 crop season identified by our survey. Indeed, it consists in comparing simulated yields with those currently obtained for a series of farms, depending on the type of soil, irrigation practices and climate, assuming that these farms apply the same technical itinerary (fertilization rate, sowing dates and harvest date) than the typical farm for each system. Similarly, considering the importance of the representativity of the simulations to properly evaluate the robustness of CROPSYST, we adopted the method of survey by stratum in setting our survey rate at 15%. Thus, the final sample chosen to validate our model is 5 farms belonging to very heterogeneous zones from the point of view of nature of the climate and the type of soil.

3. Results and discussion

Before identifying and evaluating the alternative levers it is necessary to carry out a detailed characterization of the crop system and the technical management of the DW and to evaluate, based on the concept of water productivity, the performance of this activity.

3.1. Management of the durum wheat

The results showed that the total agricultural surveyed land reached 460 ha. The analysis of the land use during the cropping year 2014/2015 showed that the cropping system involves, cereal crops (82%), horticulture (15%), fruit trees (2%) and fodder crops (1%). The the cultivated area of irrigated DW reached 195 ha which represents 58% of the total cereal area.

In terms of technical management of the crop, results showed that sowing seeds is carried out during the period from mid-November to mid-December at varying dose from 180 kg ha^{-1} to 200$kgha^{-1}$.

The fertilization program applied depends on the vegetative stage of the plant. Indeed DAP (Diammonium phosphate) is often provided with an average dose of 170 $kgha^{-1}$ before sowing.While nitrogen is supplied as an ammo nitrate at varying doses from 150 $kgha^{-1}$ to 350 $kgha^{-1}$ and in one to three intakes (Table1).

Then in order to irrigate the DW, the results showed that farmers had used the available water at the level of 650 m^3 ha^{-1}. However, the average of applied water volume varies from one farm to another depending on the availability of water resource (Table1).The results showed also, that irrigation is practiced without taking into account either the theoretical need of the plant or the monthly distribution.

Table 1
Average quantity of inputs using during 2014-2015

variables	unit	Average
Seeds	$Kgha^{-1}$	200
DAP	$Kgha^{-1}$	170
Nitrogen	$Kgha^{-1}$	350
Applied water volume	m^3ha^{-1}	650

3.2. Agronomic and economic performance of durum wheat

The results showed that achieved yield of the DW reached an average of 36 q ha^{-1}. The average ranges within 11qha^{-1} and 60 q ha^{-1} and it remains under the potential expected level that should reach 70 qha^{-1} (Figure3).

This low yield of DW may be explained by the water supplies, which were always below the crop water requirement (Figure4).The results showed also that the variation in yield depends on the quantity of nitrogen. Indeed an analysis of figure 5 showed that, yield can increase by increasing nitrogen fertilization until reaching a maximum value from wich it tends to decrease with increasing nitrogen fertilization (Bhouri et al.2015). In fact given our results and by taking into account the quantity of the rainfalls, the water productivity reached only 7.8 $kgha^{-1}mm^{-1}$ which is the half of the potential level that should be reached following agronomical studies (Chemak et al.2018; Lasram et al.2015; Wim and Pasqueleto.2014). This result allowed farmer to earn 1836 $TNDha^{-1}$ (Tunisian Dinar; 1TND=0.32 Euros) as Gross Margin

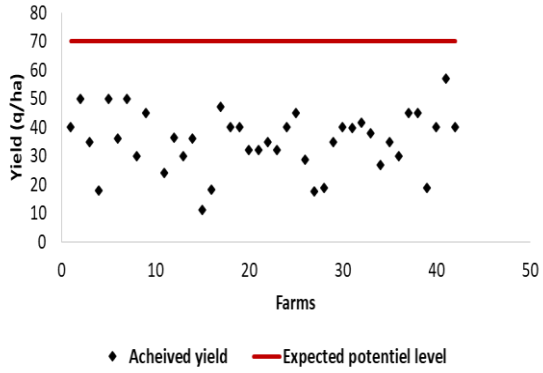

Figure 3
Acheived yield for he cropping year 2014-2015

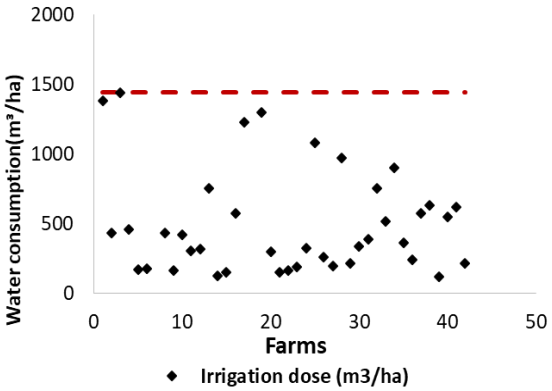

Figure 4
Variability of Applied water volume during the cropping year 2014-2015

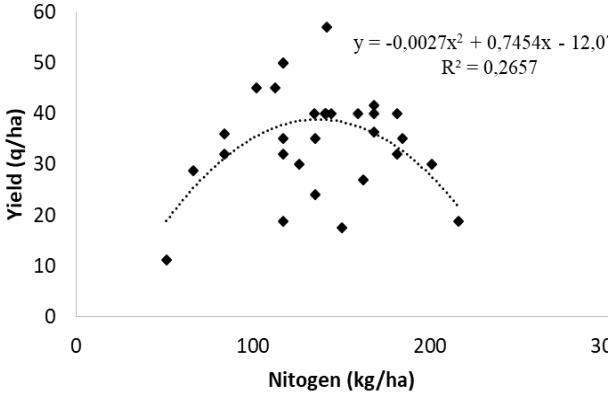

Figure 5
Variability in yield depending on the amount of nitogen during the cropping year 2014-2015

3.2. CROPSYST results

Results of the calibration confirm that CROPSYST simulates the yields quite correctly. Thus, the comparison of the simulated yields (34 q ha^{-1}) with those actually observed (36 q ha^{-1}) shows a slight difference of 5%.

Once calibrated the model was then tested on a sample of 5 farms (15% of the total sample) based on the yields of the 2014-2015 crop year. The results of validation showed a difference of only 9% in terms of simulated yield compared to that achieved (Table 2). Referring to the results of EL Ansari (2018), we can

conclude that our model is well validated and could be used to simulate expected strategies.

Table 2
Comparison between the simulated and observed yields

	Achieved yield (qha^{-1})	Simulated yield (qha^{-1})	Difference (%)
Farm 1	40	33	-17
Farm 2	32	32	0
Farm 3	27	28	+3
Farm 4	40	35	-12
Farm 5	39	36	-8
Average	35.6	32.8	-9

Under the analysis of the farmers' practices in terms of the amount of Nitogen and the applied water volume, we propose three strategies, of varied mix in terms of irrigation water and fertilizer doses in order to improve the wheat production and the water productivity. Indeed, these strategies aim to generate simulations with CROPSYST by the combination of three doses of irrigation (0%, + 15%, +25%) and three doses of fertilization (0%, + 10%, +15%) taking into account theoretical needs for growing DW (Mellouli et al.2007; Bhouri et al.2015) during the cropping years 2015, 2016, 2017.The obtained results showed that the average yields of DW increase by applying various combinations of water supply and nitrogen fertilization (Table 3). Indeed, the analysis of the first strategy showed that the average of yield increases by 3% with an increase of nitrogen dose of 10%. However even we increase by increasing nitrogen dose of 15% we obtained the same simulated yield (Figure 6).While for the second strategy, results showed that the average yield will be increased by 6% from 34 q ha^{-1} to 36 qha^{-1}by increasing the irrigation dose of 15% and by applying the same amount of nitrogen initially used (S21). Whereas increasing the Nitrogen quantity by 10% and 15% (S22 and S23) might increase the average yield by 7%. For the third strategy,the results presented in Figure 6 showed an improvement of average yield by 8% in for an increase in irrigation dose of 25% (S31) while it is 9% for a both increase in irrigation dose of 25% and the Nitrogen of 10% and 15% (S32, S33).

In the light of these results, we found out that there is a significant interaction between wheat yield, applied water volume and fertilization. Thus the best yield of DW (37.5 qha^{-1}) was obtained by applying an irrigation dose of 1440 mm (+ 25% compared to the dose initially applied) and a fertilization dose of 127.6 KgNha^{-1} (+ 10%) and 133.4 kgNha^{-1} (+ 15%). Analysis of simulations showed also a both increase in water productivity and the gross margin of irrigated DW. Thus, results presented in Table 3 showed an improvement of the water productivity up to 8.2 kgha^{-1}mm^{-1}. In terms of Gross margins, the results showed a high increase, ranged between 2 and 3% for the first strategy, 6 and 8% for the second strategy and 9 and 11% for the third strategy (Table 3). An analysis of figure 7 showed that it is possible to obtain an overall gross margin of about 1850 TNDha^{-1} (+ 11%) with a simultaneous increase in the irrigation dose of 25% and nitrogen fertilization 10%.

Table 3
Results of differents simulations in term of yield, water productivity and Gross margin

Strategy		Definition	Yield (qha^{-1})	Water productivity (Kgha^{-1}mm^{-1})	Gross Margin (TNDha^{-1})
Baseline	S00	E0= 115 mm; N0 =116 kg N ha^{-1}	34	7.8	1650.6
	S11	E1=E0; N1= N0+10%*N0	35	8	1701.9
Strategy 1	S12	E1=E0; N1= N0+15%*N0	35	8	1695
	S21	E1=E0+15%*E0; N1= N0	36	8	1772.9
Strategy 2	S22	E1=E0+ 15%*E0 ; N1= N0+10%*N0	36.4	8.1	1784.6
	S23	E1=E0+ 15%*E0 ; N1= N0+15%*N0	36.4	8.1	1778.3
	S31	E1=E0+25%*E0; N1= N0	37	8	1829.8
Strategy 3	S32	E1=E0+ 25%*E0 ; N1= N0+10%*N0	37.5	8.2	1850
	S33	E1=E0+ 25%*E0 ; N1= N0+15%*N0	37.5	8.2	1841.8

Figure6
Simulation of durum wheat yields

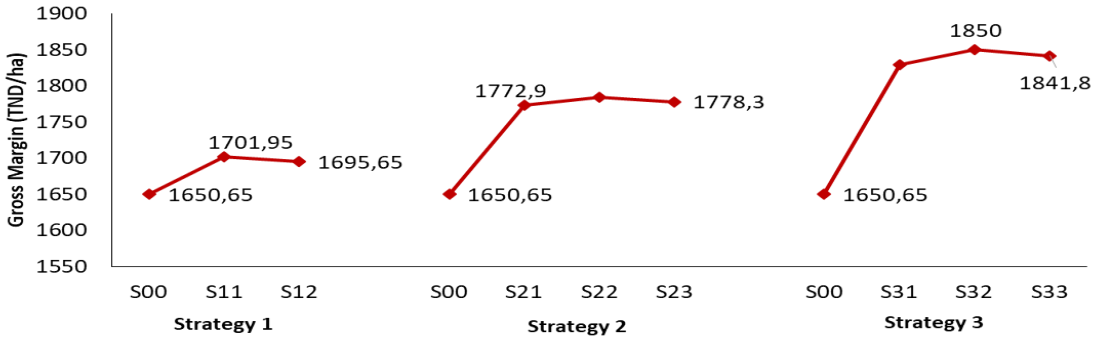

Figure7
Simulation of durum wheat Gross margin

4. Conclusion

The results of this work showed that modeling irrigation and nitrogen fertilization practices by the CROPSYST model are satisfactory. Thus the results from this model have approved that the best match between irrigation water volume and nitrogen fertilization is an essential alternative not only to increase durum yield and water productivity of irrigated DW but also to improve the economic performance of the activity.However, these strategies could be tested and validated by experimental protocols at the farms' level in order to be dissminated and adopted by wider farmers.

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Research Article

Irrigation Water Quality Assessments for Irrigated Lands of Konya – Sarayönü Gözlü Agricultural Enterprise

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ABSTRACT

This study was conducted to assess the irrigation water quality parameters of the water resources in irrigated lands of Konya- Sarayönü Gözlü Agricultural Enterprise. Water samples were taken from deep wells of the research site and soil samples were taken (0-30, 30-60 and 60-90 cm depths) from different sections of the research site. Water quality parameters and soil physico-chemical characteristics were investigated.Soil texture of the research site was identified as clay and clay-loam. Soil pH values varied between 7.11 – 7.90, EC values varied between 696 – 803 µmhos/cm. Irrigation water pH values varied between 6.08 – 7.45 and EC values varied between 1071 - 1989 µmhos/cm. Water samples were classified as C_3S_1(highly saline) according to US Salinity Lab classification system. Despite high salinity levels of irrigation waters, a salinity problem was not encountered in soils of the research site. However, that does not necessarily mean that there won't be a salinity problem in the future since irrigation practices of the region are quite new and sufficient time has not elapsed yet for salt accumulation in soils.Relevant cultural measures should be taken to prevent possible future salinity problems and farmers should be trained about water quality and salinity problems.

1. Introduction

Soil and water resources are the most important sources of wealth of the countries. Today, majority of these sources are under the threat of extinction, thus identification of available potentials and preservation of such potential are quite a significant issue. Water is an essential component of human life. Together with developing technologies, unconscious uses and rapid pollution, ever-increasing populations and rapid depletion of fresh and clean water resources have brought the water into the first place in world agenda. Agriculture is the greatest water user sector (about 70% of freshwater resources are used in agriculture) and it is respectively followed by industrial and domestic uses. Efficient use and recycle are the primary ways to be followed for sustainability of water resources. ***Irrigation***; is defined as the artificial supply of partial quantity of water needed by the plants, but not fully met by natural precipitations to root zones of the plants in a controlled fashion (Kara 2005).

Water and soil quality (salinity) are the primary issues to be considered for sustainability of agriculture. Ongoing climate changes and increasing water use exert serious threats on water resources. Groundwater resources are more influenced by such threats and under qualitative and quantitative degradation. Such a degradation is more prominent in "Konya Closed Basin" without any replenishment from outside and with large irrigated fields. Various salts re transferred to soils through irrigation water. Then, salinity problems emerge based on quality parameters of water resources. Poor-quality water may terminate agricultural production if the relevant measures were not taken (Taş et al 2013).

Type and quantity of dissolved substances in water influence irrigation water quality.With the analyses conducted on irrigation waters, total concentrations of salts and quantity of different elements are identified. Drought and salinity stress are the primary limiting factors in front of agricultural production. Especially the salinity levels of greater than 15 dS/m may result in serious yields losses (Husain et al 2003).

Total salt concentration of irrigation waters is expressed as electrical conductivity (EC x 10^6) (µmhos/cm; 1000µmhos/cm= 1mmhos/cm= 1dS/m).

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Irrigation waters successfully used in irrigated farming usually have a total salt concentration lower than 2250 µmhos/cm. However, water with an electrical conductivity of less than 750 µmhos/cm are recommended to be used in irrigated farming. The waters with electrical conductivity values of between 750 - 2250 µmhos/cm are also largely used without a significant lose in yield under proper drainage and operational conditions, but in case of insufficient or poor drainage conditions, such waters may result in serious salinity problems in irrigated lands (Ayyıldız 1983).

Anlıatamer (2007), conducted a study to investigate soil salinity in irrigation district of Ankara Haymana Türkşerefli Earth-fill Dam and reported increased salinity levels in Babayakup Stream jointing with a tributary of Şerefli Creek within the research site. Researcher indicated that measures should be taken while using this water in irrigated farming and high salinity levels in some sections of the research site were mainly attributed to unconscious irrigation practices and excessive water application rates in surface irrigations of the farmers.

Yeter & Yurtseven (2015) conducted a study to investigate the effects of different quality irrigation waters on alfalfa and reported a recess in plant growth, significant decreases in yield and quality with saline water irrigations. On the other hand, plant growth and development returned to normal levels when the leaching was performed. It was concluded that for high yield levels in alfalfa, irrigation water salinity should be less than 1.5 dSm^{-1}.

Salts generate osmatic pressure in soil solution and influence plant water use accordingly. Plant water use decreases under high osmotic pressure and such a case then ends up with plant die up. Therefore, total salt concentration of irrigation waters is generally used as classification criterion for irrigation water quality (Yurtseven 2016).

Gürcan (2016) conducted a study in irrigation district of irrigation cooperative of Soğulca village of Haymana, Ankara about quality of water resources and classified irrigation waters as C_3 (highly saline) and indicated that this quality irrigation water should not be used in poorly-drained sections. It was also indicated that salinity problem was not observed in irrigated lands of the study area despite the salinity problems of irrigation waters, then recommended the construction of closed or open drainage facilities to prevent potential salinity problems in the future.

Minareci & Öztürk (2012), investigated boron concentrations of water samples taken from the reservoirs of Sevişler Dam, Demirköprü Dam, Avşar Dam and Gölmarmara Dam in Manisa province and reported boron concentrations as between 0.008 – 3.066 mg/L.

Korkmaz et al (2016) conducted a study in Right Bank Irrigation district of Menemen and indicated that improper irrigation methods and low irrigatino water application efficiency raised groundwater levels. High groundwater tables negatively influence plant cultivation, so they recommended the construction of proper drainage facilitiesor improvement of already existing facilities.

Dorak & Çelik (2017) conducted a study to determine the effects of domestic and industrial wastewaters on water quality of Nilüfer Stream. Researchers took water samples from effluent discharge points of 5 wastewater treatment plants in 4 periods between August 2013 and May 2014. Wastewater quality parameters varied based on sampling periods, watersamples were classified as between C_2S_1- C_4S_4 based on EC and SAR values. Water samples taken before and after the discharge points revealed that treatment plant effluents negatively influenced pH, EC, ammonia, phosphorus, sulphate, boron and chlorine values of Nilüfer Stream.

2. Materials and Methods

Water samples were taken from 20 deep wells selected from irrigated fields of Konya – Sarayönü Gözlü Agricultural Enterprise in intensive irrigation periods (May – September) and soil samples were taken from irrigated fields.

Konya province is located between 36^{o} $41^{'}$and 39^{o} $16^{'}$ north latitudes and between 31^{o} $14^{'}$ and 34^{o} $26^{'}$ east longitudes. Average altitude is 1.016 m. Konya is surrounded by Ankara and Eskişehir from the north, Isparta and Afyonkarahisar from the west, Antalya, Karaman and Mersin from the south and Niğde and Aksaray provinces from the east. Total surface area of the province is 41.001 km^2 (Anonymous 2016).

Gözlü Agricultural Enterprise is located 78 km from Konya and 28 km from Sarayönü town. The enterprise is surrounded by Özkent district from the east, Gözlü district from the West, Kolukısa district from the South, Çeşmelisebil District from the north and Başkuyu district from the northwest. There is a stabilized rood connection of 34 km to Altınova Agricultural Enterprise and there is about 7-8 km distance from the fields of Konuklar Agricultural Enterprise. Location of the research site is presented in Figure 1.

Figure 1
Location of study area

The research site has a terrestrial climate with cold and precipitated winters and hot and dry summers.

Precipitations are mostly observed in winter and spring months. Wind speed may reach to 100 – 120 km/h in March and April. Such high wind speeds accelerate wind erosion process. Therefore, 225 km forest line was constructed for erosion prevention.

Konya province with a surface area of 41.001 km^2 has the largest fields of the country. Cereals (wheat, barley, oat, rye) are cultivated over the majority of these lands. Edible legumes (dry bean, lentils, chick-pea), oil crops (sunflower, opium), industrial crops (sugar beet, potato) and feed crops (alfalfa, vetch, silage maize) are also cultivated in the region (Anonymous 2013).

Apart from these crops, fruits (pear, apple, plum, apricot, cherry, peach, melon, watermelon, sour cherry, walnut, strawberry, grape) and vegetables (tomato, cucumber, pepper, fresh bean, eggplant, cabbage, lettuce, spinach, carrot) are also cultivated in the region.

Gözlü Agricultural Enterprise has 288.303,5 da lands and irrigated farming is practiced over 35.129 da of these lands. Wheat, barley, alfalfa, vetch, maize and sunflower are cultivated over the agricultural fields of Gözlü Agricultural Enterprise.

There are 93 deep wells over 35.129 da irrigated fields of Gözlü Agricultural Enterprise and irrigation water is supplied from these wells. Wells were started to be opened in 2006 and continued until 2013.

Irrigations are performed with sprinkler irrigation, drip irrigation and self-propelled irrigation systems. There aren't any drainage canals around the irrigated fields of the enterprise. Sprinkler irrigation is used over the majority of irrigated lands and the rest is irrigated with drip irrigation, linear-move and center-pivot self-propelled irrigation systems.

Water samples were taken from 20 deep wells selected among 93 wells opened by the enterprise and actively operating through purposeful sampling procedure during the intensive irrigation season (May – September). Water samples were taken in accordance with the principles specified in Sağlam (1978).

Samples were brought to laboratory, filtered, placed into clean glass bottles and preserved in a fridge until the time of analysis. Well depths varied between 160 – 260 m and well discharges varied between 20 – 53.2 l/s.

Soil samples were taken from the fields irrigated from the selected wells in a season with the most intensive irrigation and the greatest capillary salt transport (July). Disturbed and undisturbed soil samples were taken from 6 different points with a bucket auger at 3 different depth segments (0-30, 30-60 and 60-90 cm). Samples were brought to laboratory, air dried and passed through 2 mm sieve, placed into nylon bags and preserved in a fridge until the time of analysis. Water and soil sampling locations are presented in Figure 2.

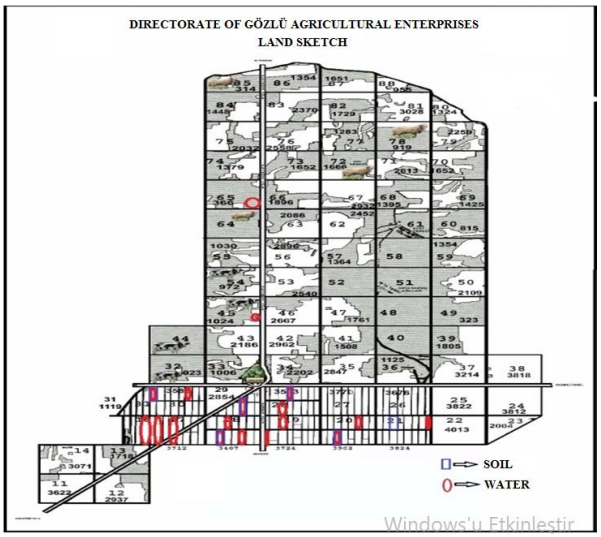

Figure 2
Water and soil sampling locations

3. Results and Discussion

Water samples were taken throughout the irrigation season in May, June, July, August and September. Irrigation water chemical analysis results for May are provided in Table 1. Irrigation water pH values varied between 6.80 – 7.37, Ec values varied between 1158 – 1490 µmhos/cm. Considering the water-soluble anion and cations, Ca^{+2} was the dominant cation and SO_4^{-2} was the dominant anion. There were no residual sodium carbonate (RSC) in irrigation waters. Sodium adsorption ratios (SAR) varied between 1.04 – 1.40, % Na values varied between 18.1 – 24.5 and boron concentrations varied between 0.15 – 0.23 ppm. Water samples taken in May was classified as C_3S_1 according to US Salinity Lab classification system.EC values of irrigation water samples based on well numbers are presented in Figure 3. The greatest salinity values were observed in 10, 14 and 4-numbered wells and all water samples had an EC value of greater than allowable limit value (750 µmhos/cm).

Boron concentrations of water samples are presented in Figure 4. All samples had a boron concentration of lower than allowable limit value (0.7 ppm) and there were not any problems with regard to boron concentrations in May.

Table 1
Irrigation water chemical analysis results for May

Well No	pH	EC x 10^6 µmhos/cm 25 °C	WATER SOLUBLE										RSC	SAR	%Na	Irrigation water class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Total					
1	6,80	1220	2,69	0,19	6,59	3,18	12,65	-	4,34	1,50	5,89	11,73	-	1,21	21,2	C_3S_1	0,15
2	7,10	1405	2,80	3,23	5,59	3,31	14,93	-	4,76	1,65	6,75	13,16	-	1,32	18,7	C_3S_1	0,20
3	6,85	1428	2,90	4,30	5,21	3,31	15,72	-	4,42	1,55	6,79	12,76	-	1,40	18,4	C_3S_1	0,20
4	7,37	1470	3,18	0,21	7,35	3,47	14,21	-	5,62	2,55	6,91	15,08	-	1,36	22,3	C_3S_1	0,21
5	7,01	1231	2,65	0,19	5,84	3,42	12,10	-	4,30	1,70	6,51	12,51	-	1,23	21,9	C_3S_1	0,20
6	7,03	1230	2,79	0,19	5,05	3,36	11,39	-	4,33	1,60	6,94	12,87	-	1,36	24,4	C_3S_1	0,19
7	6,89	1402	2,76	0,20	6,97	3,47	13,40	-	6,05	1,45	6,85	14,35	-	1,20	20,5	C_3S_1	0,20
8	6,95	1415	2,75	0,19	7,83	3,33	14,10	-	5,32	1,45	7,35	14,12	-	1,16	19,5	C_3S_1	0,19
9	7,30	1445	2,89	0,20	7,32	3,38	13,79	-	5,72	1,55	7,36	14,62	-	1,24	20,9	C_3S_1	0,21
10	7,03	1490	2,87	0,21	8,05	3,43	14,56	-	6,29	1,60	7,11	15,00	-	1,19	19,7	C_3S_1	0,22
11	7,05	1410	2,86	0,21	7,48	3,46	14,01	-	4,75	1,30	8,32	14,37	-	1,22	20,4	C_3S_1	0,22
12	6,96	1278	2,86	0,20	5,96	3,41	12,43	-	4,46	1,20	7,47	13,13	-	1,32	23,0	C_3S_1	0,22
13	6,91	1355	2,87	0,21	6,76	3,46	13,30	-	4,20	1,60	7,99	13,79	-	1,26	21,5	C_3S_1	0,23
14	6,88	1485	2,89	0,21	8,15	3,40	14,65	-	5,72	1,55	7,78	15,05	-	1,20	19,7	C_3S_1	0,22
15	7,13	1392	2,41	0,20	7,25	3,40	13,26	-	5,01	1,45	7,70	14,16	-	1,04	18,1	C_3S_1	0,22
16	7,01	1255	2,93	0,21	5,42	3,45	12,01	-	4,54	1,00	7,36	12,90	-	1,39	24,3	C_3S_1	0,23
17	7,13	1374	2,90	0,20	6,92	3,41	13,43	-	5,15	1,30	7,40	13,85	-	1,27	21,5	C_3S_1	0,22
18	7,18	1260	2,87	0,24	5,94	3,49	12,54	-	4,35	1,20	7,19	12,74	-	1,32	22,8	C_3S_1	0,23
19	7,11	1232	2,85	0,20	5,72	3,41	12,18	-	3,60	1,40	7,51	12,51	-	1,33	23,3	C_3S_1	0,21
20	7,35	1158	2,72	0,19	4,83	3,36	11,10	-	3,80	1,35	7,03	12,18	-	1,34	24,5	C_3S_1	0,20

Irrigation water chemical analysis results for June are provided in Table 2. Irrigation water pH values varied between 6.87 – 7.45, EC values varied between 1071 - 1711 µmhos/cm. Considering the water-soluble anion and cations, Ca^{+2} was the dominant cation and SO_4^{-2} was the dominant anion. There were no residual sodium carbonate (RSC) in irrigation waters. Sodium adsorption ratios (SAR) varied between 1.05 – 1.34, % Na values varied between 16.9 – 25.0 and boron concentrations varied between 0.15 – 0.23 ppm. Water samples taken in May was classified as C_3S_1 according to US Salinity Lab classification system.

The greatest salinity values were observed in 4, 17 and 16-numbered wells and all water samples had an EC value of greater than allowable limit value (750 µmhos/cm).

All samples had a boron concentration of lower than allowable limit value (0.7 ppm) and there were not any problems with regard to boron concentrations in June.

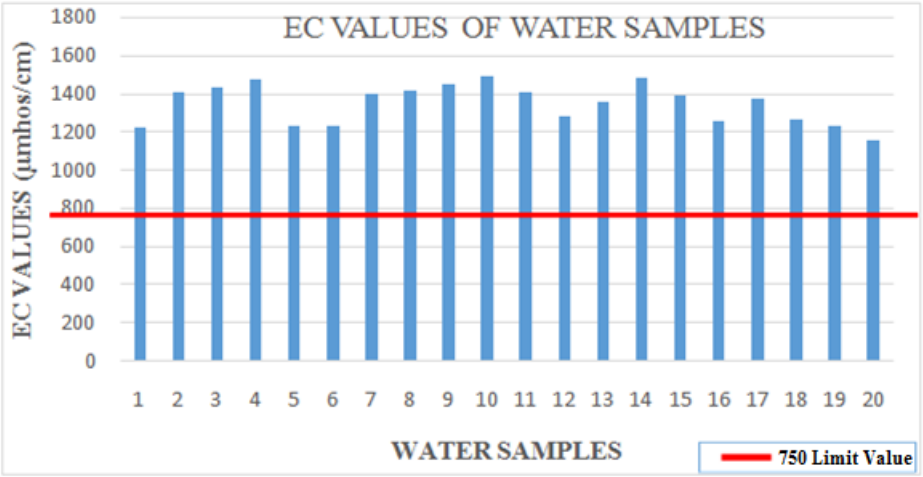

Figure 3
EC values of water samples in May

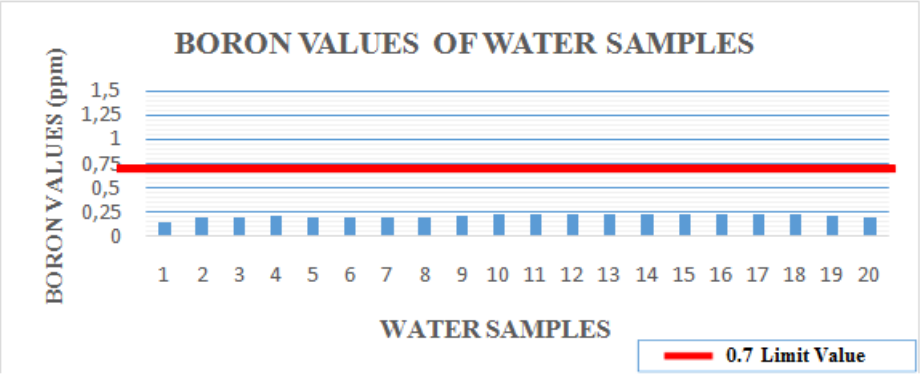

Figure 4
Boron concentrations of water samples in May

Irrigation water chemical analysis results for July are provided in Table 3. Irrigation water pH values varied between 6.86 – 7.39, EC values varied between 1440 – 1771 µmhos/cm. Considering the water-soluble anion and cations, Ca^{+2} was the dominant cation and HCO_3^- and SO_4^{-2} were the dominant anion. There were no residual sodium carbonate (RSC) in irrigation waters. Sodium adsorption ratios (SAR) varied between 1.17 – 1.36, % Na values varied between 17.7 – 21.9 and boron concentrations varied between 0.28 – 0.35 ppm. Water samples taken in May was classified as C_3S_1 according to US Salinity Lab classification system.

EC values of irrigation water samples based on well numbers are presented in Figure 5. The greatest salinity values were observed in 9, 12, 11-numbered wells and all water samples had an EC value of greater than allowable limit value (750 µmhos/cm).

Boron concentrations of water samples are presented in Figure 6. All samples had a boron concentration of lower than allowable limit value (0.7 ppm) and there were not any problems with regard to boron concentrations in May.

Table 2
Irrigation water chemical analysis results for June

WellNo	pH	EC x 10^6 µmhos/cm 25 °C	WATER SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Σ	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Σ					
1	7,34	1117	2,62	0,17	4,96	3,24	10,99	-	4,00	1,85	5,38	11,23	-	1,29	23,8	C_3S_1	0,19
2	7,25	1460	2,83	0,24	8,06	3,33	14,46	-	6,14	1,80	6,94	14,88	-	1,18	19,5	C_3S_1	0,21
3	7,19	1259	2,80	0,20	5,98	3,34	12,32	-	4,75	1,90	6,15	12,80	-	1,29	22,7	C_3S_1	0,20
4	6,88	1711	3,34	0,23	10,08	3,49	17,14	-	7,77	2,35	7,08	17,20	-	1,28	19,4	C_3S_1	0,23
5	7,02	1539	2,73	0,18	9,80	3,28	15,99	-	7,70	1,60	6,59	15,89	-	1,06	17,0	C_3S_1	0,19
6	6,89	1404	2,80	0,20	6,81	3,33	13,14	-	5,60	1,70	6,77	14,07	-	1,24	21,3	C_3S_1	0,19
7	7,03	1189	2,71	0,20	5,35	3,46	11,72	-	5,11	1,65	5,15	11,91	-	1,29	23,1	C_3S_1	0,20
8	6,93	1547	2,81	0,19	9,01	3,31	15,32	-	6,99	1,85	7,13	15,97	-	1,13	18,3	C_3S_1	0,19
9	7,14	1296	2,80	0,20	5,37	3,31	11,68	-	4,65	1,70	5,97	12,32	-	1,34	23,9	C_3S_1	0,19
10	6,97	1184	2,73	0,20	5,28	3,36	11,57	-	4,65	1,40	6,60	12,65	-	1,31	22,6	C_3S_1	0,19
11	6,90	1210	2,75	0,19	5,58	3,40	11,92	-	4,20	1,90	6,42	12,52	-	1,29	23,0	C_3S_1	0,20
12	6,91	1398	2,79	0,20	6,85	3,35	13,19	-	5,44	1,60	7,07	14,11	-	1,23	21,1	C_3S_1	0,20
13	6,88	1225	2,75	0,20	5,76	3,32	12,03	-	4,54	1,55	6,72	12,81	-	1,29	22,8	C_3S_1	0,19
14	6,87	1425	2,71	0,20	7,36	3,29	13,56	-	5,45	1,90	7,06	14,41	-	1,17	19,9	C_3S_1	0,18
15	6,99	1313	2,61	0,19	7,23	3,25	13,28	-	5,63	1,45	6,83	13,91	-	1,14	19,6	C_3S_1	0,17
16	6,94	1612	2,92	0,21	10,15	3,39	16,67	-	8,00	1,55	7,20	16,75	-	1,12	17,5	C_3S_1	0,21
17	7,01	1614	2,71	0,19	9,81	3,28	15,99	-	8,16	1,80	6,73	16,69	-	1,05	16,9	C_3S_1	0,17
18	7,06	1071	2,59	0,20	4,20	3,33	10,32	-	4,41	1,95	5,17	11,53	-	1,33	25,0	C_3S_1	0,17
19	7,14	1406	2,55	0,17	8,10	3,20	14,02	-	6,60	1,90	6,49	14,99	-	1,07	18,1	C_3S_1	0,15
20	7,45	1266	2,49	0,18	6,97	3,19	12,83	-	5,86	1,85	5,32	13,03	-	1,10	19,4	C_3S_1	0,15

Table 3
Irrigation water chemical analysis results for July

Well No	pH	EC x 10^6 µmhos/cm 25 °C	WATER SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Σ	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Σ					
1	7,22	1440	2,91	0,12	8,75	3,18	14,96	-	6,02	2,05	5,98	14,05	-	1,19	19,4	C_3S_1	0,28
2	6,99	1598	3,05	0,14	9,69	3,28	16,16	-	7,71	1,60	6,66	15,97	-	1,19	18,8	C_3S_1	0,32
3	7,39	1553	3,02	0,13	9,34	3,27	15,76	-	6,90	2,45	6,53	15,88	-	1,20	19,1	C_3S_1	0,31
4	7,27	1574	3,47	0,17	9,49	3,38	16,51	-	6,62	2,50	6,78	15,90	-	1,36	21,0	C_3S_1	0,35
5	6,97	1585	3,00	0,13	9,89	3,25	16,27	-	7,06	1,70	6,98	15,74	-	1,17	18,4	C_3S_1	0,31
6	6,88	1603	3,18	0,15	10,18	3,32	16,83	-	7,81	2,10	6,72	16,63	-	1,22	18,8	C_3S_1	0,32
7	7,00	1596	3,19	0,17	8,95	3,45	15,76	-	7,31	2,25	6,74	16,30	-	1,28	20,2	C_3S_1	0,35
8	6,93	1644	3,22	0,16	10,62	3,32	17,32	-	7,39	2,25	7,33	16,97	-	1,21	18,5	C_3S_1	0,33
9	6,98	1771	3,22	0,17	11,10	3,31	17,80	-	8,58	2,55	6,93	18,06	-	1,19	18,0	C_3S_1	0,33
10	6,97	1622	3,20	0,17	9,69	3,40	16,46	-	7,69	1,90	6,78	16,37	-	1,25	19,4	C_3S_1	0,34
11	6,91	1701	3,16	0,16	11,06	3,38	17,76	-	7,50	1,85	7,82	17,17	-	1,17	17,7	C_3S_1	0,32
12	6,89	1710	3,16	0,16	10,64	3,32	17,28	-	7,26	1,65	7,90	16,81	-	1,19	18,2	C_3S_1	0,32
13	6,86	1697	3,22	0,17	10,30	3,36	17,05	-	6,98	1,55	8,35	16,88	-	1,23	18,8	C_3S_1	0,33
14	6,90	1630	3,16	0,16	9,91	3,31	16,54	-	6,80	2,35	6,98	16,13	-	1,22	19,1	C_3S_1	0,31
15	7,10	1654	3,21	0,16	10,33	3,32	17,02	-	6,92	1,80	7,74	16,46	-	1,22	18,8	C_3S_1	0,31
16	6,95	1615	3,26	0,18	9,72	3,37	16,53	-	6,86	1,50	7,40	15,76	-	1,27	19,7	C_3S_1	0,32
17	7,04	1513	3,23	0,18	8,49	3,40	15,30	-	6,30	2,10	6,45	14,85	-	1,32	21,1	C_3S_1	0,32
18	7,26	1503	3,24	0,18	7,82	3,51	14,75	-	6,90	2,05	6,32	15,27	-	1,36	21,9	C_3S_1	0,33
19	7,06	1616	3,15	0,15	10,73	3,31	17,34	-	6,10	1,75	8,48	16,33	-	1,18	18,1	C_3S_1	0,30
20	7,29	1573	3,08	0,14	9,68	3,31	16,21	-	7,30	1,55	6,65	15,50	-	1,20	19,0	C_3S_1	0,30

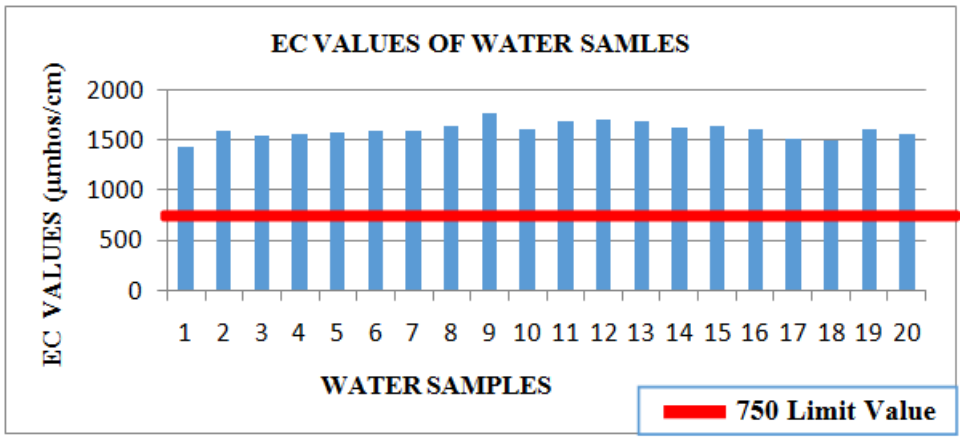

Figure 5
EC values of water samples in July

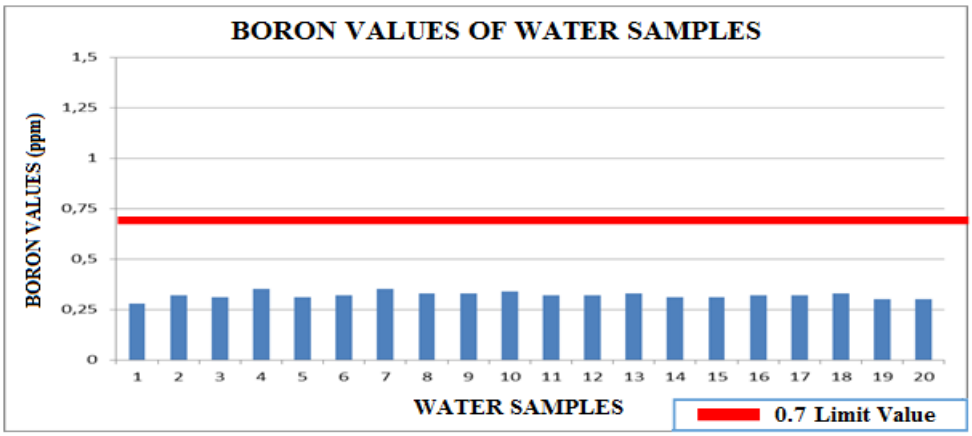

Figure 6
Boron concentrations of water samples in July

Irrigation water chemical analysis results for August are provided in Table 4. Irrigation water pH values varied between 6.08 – 7.30, EC values varied between 1692 - 1989 µmhos/cm. Considering the water-soluble anion and cations, Ca^{+2} was the dominant cation and HCO_3^- was the dominant anion. There were no residual sodium carbonate (RSC) in irrigation waters. Sodium adsorption ratios (SAR) varied between 1.00 – 1.16, % Na values varied between 15.1 – 17.8 and boron concentrations varied between 0.27 – 0.36 ppm. Water samples taken in May was classified as C_3S_1 according to US Salinity Lab classification system.

The greatest salinity values were observed in 11, 14 and 4-numbered wells and all water samples had an EC value of greater than allowable limit value (750 µmhos/cm).

All samples had a boron concentration of lower than allowable limit value (0.7 ppm) and there were not any problems with regard to boron concentrations in August.

Irrigation water chemical analysis results for September are provided in Table 5. Irrigation water pH values varied between 6.84 – 7.26, EC values varied between 1474 – 1946 µmhos/cm. Considering the water-soluble anion and cations, Ca^{+2} was the dominant cation and HCO_3^- was the dominant anion. There were no residual sodium carbonate (RSC) in irrigation waters. Sodium adsorption ratios (SAR) varied between 1.04 – 1.21, % Na values varied between 15.1 – 19.7 and boron concentrations varied between 0.21 – 0.33 ppm. Water samples taken in May was classified as C_3S_1 according to US Salinity Lab classification system.EC values of irrigation water samples based on well numbers are presented in Figure 7. The greatest salinity values were observed in 8, 11 and 15-numbered wells and all water samples had an EC value of greater than allowable limit value (750 µmhos/cm).

Boron concentrations of water samples are presented in Figure 8. All samples had a boron concentration of lower than allowable limit value (0.7 ppm) and there were not any problems with regard to boron concentrations in August.

Table 4
Irrigation water chemical analysis results for August

Well No	pH	EC x 10^6 µmhos/cm 25 °C	WATER SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Σ	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Σ					
1	7,30	1741	2,85	0,11	9,73	4,45	17,14	-	8,31	3,00	6,48	17,79	-	1,07	16,6	C_3S_1	0,27
2	6,97	1865	3,02	0,14	10,99	4,61	18,76	-	9,37	2,40	6,92	18,69	-	1,08	16,0	C_3S_1	0,31
3	7,06	1767	2,92	0,13	10,79	4,63	18,47	-	8,54	1,20	7,95	17,69	-	1,05	15,8	C_3S_1	0,29
4	7,03	1924	3,10	0,14	11,06	4,71	19,01	-	9,78	1,50	7,13	18,41	-	1,10	16,3	C_3S_1	0,31
5	7,10	1725	2,71	0,15	8,50	5,09	16,45	-	9,35	2,00	6,22	17,57	-	1,03	16,4	C_3S_1	0,34
6	6,82	1809	3,03	0,13	10,69	4,68	18,53	-	9,19	2,30	6,59	18,08	-	1,09	16,3	C_3S_1	0,31
7	6,92	1821	2,97	0,14	10,33	4,86	18,30	-	9,91	2,00	6,73	18,64	-	1,07	16,2	C_3S_1	0,33
8	6,82	1909	2,95	0,13	11,55	4,68	19,31	-	9,26	3,00	6,93	19,19	-	1,03	15,2	C_3S_1	0,31
9	6,92	1827	3,02	0,14	10,96	4,65	18,77	-	8,72	1,50	8,32	18,54	-	1,08	16,0	C_3S_1	0,32
10	6,86	1784	2,93	0,14	10,44	4,81	18,32	-	8,41	2,30	6,87	17,58	-	1,06	15,9	C_3S_1	0,36
11	6,89	1989	3,03	0,14	12,09	4,79	20,05	-	9,53	2,60	7,21	19,34	-	1,04	15,1	C_3S_1	0,30
12	6,98	1906	3,04	0,14	11,04	4,68	18,90	-	8,75	3,80	6,52	19,07	-	1,08	16,0	C_3S_1	0,32
13	6,75	1871	3,01	0,14	11,19	4,70	19,04	-	8,04	2,50	7,85	18,39	-	1,06	15,8	C_3S_1	0,32
14	6,80	1937	3,00	0,14	11,50	4,71	19,35	-	8,94	3,50	7,22	19,66	-	1,05	15,5	C_3S_1	0,32
15	6,98	1860	2,97	0,14	11,36	4,59	19,06	-	9,52	2,90	5,81	18,23	-	1,05	15,5	C_3S_1	0,29
16	6,99	1810	3,14	0,17	9,80	4,85	17,96	-	8,80	2,30	7,20	18,30	-	1,16	17,4	C_3S_1	0,27
17	7,01	1692	3,03	0,15	9,09	4,74	17,01	-	8,21	2,00	6,65	16,86	-	1,15	17,8	C_3S_1	0,32
18	6,08	1807	3,05	0,15	9,09	4,86	17,15	-	8,90	2,60	7,28	18,78	-	1,15	17,7	C_3S_1	0,31
19	7,01	1823	2,81	0,12	10,90	4,63	18,46	-	8,58	1,70	7,49	17,77	-	1,00	15,2	C_3S_1	0,29
20	6,78	1879	2,97	0,14	11,08	4,64	18,83	-	8,81	2,60	7,16	18,57	-	1,05	15,7	C_3S_1	0,31

Table 5
Irrigation water chemical analysis results for September

Well No	pH	EC x 10^6 µmhos/cm 25 °C	WATER SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Total					
1	7,26	1549	2,75	0,10	8,69	4,40	15,94	-	7,02	1,70	6,67	15,39	-	1,07	17,2	C_3S_1	0,21
2	7,17	1775	2,98	0,13	10,79	4,63	18,53	-	7,98	2,90	6,77	17,65	-	1,07	16,0	C_3S_1	0,27
3	7,24	1864	2,90	0,12	10,50	4,59	18,11	-	9,61	3,20	6,02	18,83	-	1,05	16,0	C_3S_1	0,26
4	7,04	1894	3,11	0,14	11,06	4,70	19,01	-	8,46	2,20	8,08	18,74	-	1,10	16,3	C_3S_1	0,29
5	7,08	1672	2,74	0,15	8,33	5,09	16,31	-	8,03	1,40	7,65	17,08	-	1,05	16,7	C_3S_1	0,32
6	6,87	1795	3,05	0,14	10,56	4,68	18,43	-	8,36	2,30	6,89	17,55	-	1,10	16,5	C_3S_1	0,28
7	7,24	1474	2,95	0,16	6,58	5,26	14,95	-	7,60	1,20	6,22	15,02	-	1,21	19,7	C_3S_1	0,33
8	6,93	1946	3,08	0,14	11,53	4,67	19,42	-	8,83	2,70	8,53	20,06	-	1,08	15,8	C_3S_1	0,28
9	6,95	1854	3,03	0,14	11,41	4,74	19,32	-	8,48	3,20	6,85	18,53	-	1,06	15,6	C_3S_1	0,29
10	6,97	1895	3,03	0,15	10,26	4,79	18,23	-	9,09	3,30	6,68	19,07	-	1,10	16,6	C_3S_1	0,30
11	6,84	1921	3,03	0,14	12,04	4,82	20,03	-	8,88	2,70	8,25	19,83	-	1,04	15,1	C_3S_1	0,31
12	7,00	1789	3,04	0,14	10,82	4,68	18,68	-	8,20	1,20	7,99	17,39	-	1,09	16,2	C_3S_1	0,30
13	6,92	1840	3,05	0,15	10,83	4,76	18,79	-	8,73	3,40	6,92	19,05	-	1,09	16,2	C_3S_1	0,29
14	6,92	1833	3,00	0,14	11,08	4,67	18,89	-	8,53	2,80	7,76	19,09	-	1,06	15,8	C_3S_1	0,28
15	6,96	1896	3,10	0,14	11,85	4,69	19,78	-	8,17	2,40	7,98	18,55	-	1,07	15,6	C_3S_1	0,30
16	6,97	1774	3,13	0,16	9,53	4,88	17,70	-	9,25	2,00	7,50	18,75	-	1,16	17,6	C_3S_1	0,31
17	6,92	1688	3,05	0,16	9,09	4,78	17,08	-	7,54	1,20	7,82	16,56	-	1,15	17,8	C_3S_1	0,31
18	7,04	1776	3,02	0,16	9,85	4,86	17,89	-	9,36	2,50	6,63	18,49	-	1,11	16,8	C_3S_1	0,31
19	7,08	1805	2,97	0,13	11,01	4,63	18,74	-	8,34	1,90	7,60	17,84	-	1,06	15,8	C_3S_1	0,28
20	6,87	1869	2,96	0,13	10,91	4,63	18,63	-	8,36	2,70	7,72	18,78	-	1,06	15,8	C_3S_1	0,28

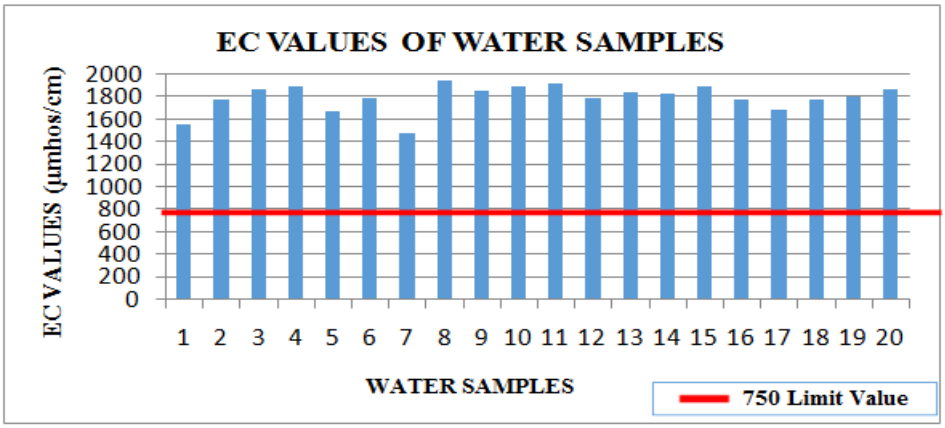

Figure 7
EC values of water samples in September

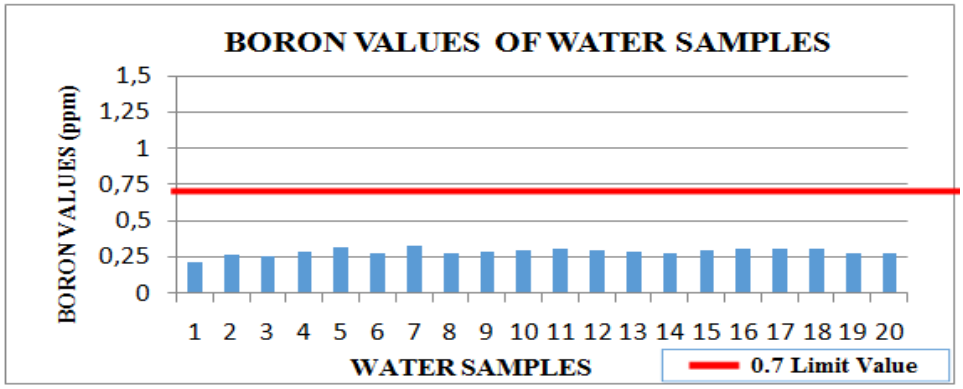

Figure 8
Boron concentrations of water samples in September

Results of physical analyses conducted on disturbed and undisturbed soil samples taken from 0-30 cm, 30-60 cm and 60-90 cm depths are provided in Table 6.Degree of saturation values varied between 46.2 – 57.4%, field capacity (FC) values varied between 26.1 – 38.7%, permanent wilting point (PWP) values varied between 14.2 – 21.3%and unit weights varied between 1.36 – 1.49 g/cm^3, soil texture was clay (C) and clay-loam (CL).

Results of chemical analyses conducted on soil samples are provided in Table 7. Soil pH values varied between 7.11 – 7.90, salinity values varied between 696 – 803 µmhos/cm. Salinity values all layers were below the soil salinity threshold value (4000 µmhos/cm). With regard to water soluble cations and anions, $Na^{+}$and Ca^{+2} were the dominant cations and SO_4^{-2} was the dominant anion. Cation Exchange capacity (CEC) of soil samples varied between 15.19 – 17.23 me/100g. Exchangeable sodium percentages (ESP) varied between 6.60 – 7.49%and all values were below the threshold ESP value (15%). Lime contents varied between 1.58 – 12.94% and boron concentrations varied between 0.08 – 0.85 ppm and all values were below the threshold boron concentration (4 ppm).

Considering the values provided in Table 7, it was observed that current soils were appropriate for almost all crops including boron-sensitive cereals. Since boron toxicity does not exist in the region, there were no treats of boron for majority of crops cultivated within the region.

EC – Depth relationships based on the values provided in Table 7 are presented in Figure 9 and ESP – Depth relationships are presented in Figure 10.EC values of soil layers did not change much, and values generally varied between 600-800 µmhos/cm (Figure 9). Considering the water EC values of greater than limit value, it can be stated that salt accumulation in soils has not started, yet or salt leaching was well. However, such a case may generate a problem in the future.

It possible to state that ESP values also did not change much with the depths (Figure 10). ESP values of experimental soils were all below the threshold ESP value (15%).

Table 6
Soil physical characteristics

Soil Sample		Degree of Saturation (%)	Field Capacity (%)	Permanent Wilting Point (%)	Unit Weight (g/cm^3)	Soil Texture			
Plot No	Depth					Sand %	Clay %	Silt %	Texture
	0-30	51,2	33,9	18,7	1,42	26,3	46,9	26,8	C
1	30-60	52,0	38,7	20,3	1,46	36,4	35,7	27,9	CL
	60-90	47,6	37,8	20,5	1,41	38,2	45,9	15,9	C
	0-30	57,4	28,7	19,2	1,42	29,2	45,7	25,1	C
2	30-60	46,2	33,6	21,3	1,39	38,6	36,5	24,9	CL
	60-90	47,4	36,9	20,6	1,37	25,5	53,4	21,1	C
	0-30	46,4	26,1	14,2	1,45	30,7	48,0	21,3	C
3	30-60	48,8	27,9	14,9	1,44	37,6	45,0	17,4	C
	60-90	49,6	28,7	15,3	1,41	42,8	45,5	11,7	C
	0-30	52,4	30,2	17,6	1,49	26,3	49,8	23,9	C
4	30-60	49,6	30,8	17,2	1,48	34,9	46,0	19,1	C
	60-90	53,0	31,1	18,4	1,45	26,9	51,3	21,8	C
	0-30	57,2	31,2	19,7	1,37	42,5	34,7	22,8	CL
5	30-60	56,8	35,6	19,4	1,39	38,7	36,4	24,9	CL
	60-90	54,8	37,9	20,2	1,38	38,8	38,1	23,1	CL
	0-30	47,4	26,4	16,8	1,41	31,9	44,4	23,7	C
6	30-60	47,4	27,9	15,9	1,36	36,9	34,4	28,7	CL
	60-90	49,8	31,1	18,7	1,39	32,8	49,8	17,4	C

Table 7
Soil chemical characteristics

Soil Sample		pH	EC x 10^6 µmhos/cm 25°C	Water Soluble										CEC (me/100g)	Exchangeable Cations			ESP (%)	Lime (%)	Boron (ppm)
				Cations (me/l)					Anions (me/l)											
Plot No	Depth			Na^{+}	K^{+}	Ca^{+2}	Mg^{+2}	Σ	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{-2}	Σ		Na^{+}	K^{+}	$Ca^{+2}+Mg^{+2}$			
	0-30	7,11	734	2,57	0,61	3,83	0,93	7,94	-	0,89	2,2	3,95	7,04	16,52	0,94	4,76	9,21	7,18	2,22	0,20
1	30-60	7,25	734	2,57	0,81	3,21	0,47	7,06	-	0,97	2,1	3,85	6,92	16,21	1,03	3,62	12,54	7,05	1,89	0,80
	60-90	7,22	750	2,67	0,72	3,11	0,96	7,46	-	0,79	1,9	4,45	7,14	16,01	1,43	4,20	10,07	6,96	2,21	0,85
	0-30	7,45	696	2,67	0,21	3,21	0,45	6,54	-	1,20	1,8	3,69	6,69	15,40	1,99	5,51	8,40	6,69	8,52	0,12
2	30-60	7,57	727	2,57	0,82	3,20	0,55	7,14	-	1,40	2,0	3,76	7,16	15,50	1,38	4,13	10,65	6,74	9,62	0,49
	60-90	7,65	731	2,97	0,73	2,99	0,85	7,54	-	0,88	1,5	4,80	7,18	15,40	1,01	3,76	10,21	6,69	11,99	0,33
	0-30	7,81	771	2,10	0,83	4,21	0,24	7,38	-	1,20	3,7	2,84	7,74	17,23	0,43	3,70	9,82	7,49	4,10	0,26
3	30-60	7,90	736	2,52	0,95	3,21	0,65	7,33	-	0,99	3,2	2,96	7,15	15,50	0,75	3,63	11,99	6,74	10,57	0,23
	60-90	7,80	731	2,43	0,73	3,82	0,53	7,51	-	0,77	1,7	5,03	7,50	15,19	1,94	3,54	9,25	6,60	12,94	0,41
	0-30	7,56	765	3,52	0,23	3,30	0,71	7,76	-	1,49	1,2	4,95	7,64	16,32	1,92	3,66	8,35	7,09	2,37	0,08
4	30-60	7,60	762	3,60	0,12	3,53	0,21	7,46	-	1,60	1,0	4,69	7,29	16,72	1,62	3,23	11,89	7,27	1,58	0,14
	60-90	7,63	803	3,80	0,61	3,50	0,40	8,31	-	1,66	1,8	4,57	8,03	16,93	0,72	3,58	9,09	7,36	1,74	0,16
	0-30	7,36	753	3,43	0,21	3,67	0,27	7,58	-	1,22	2,1	4,34	7,66	17,13	0,70	4,42	9,67	7,45	2,21	0,32
5	30-60	7,44	775	3,53	0,51	3,41	0,47	7,92	-	0,69	2,3	4,14	7,13	16,32	1,20	4,65	10,29	7,09	2,21	0,17
	60-90	7,50	718	3,48	0,41	3,29	0,56	7,74	-	1,00	2,0	4,25	7,15	16,83	2,31	4,36	8,40	7,31	3,00	0,24
6	0-30	7,60	730	1,56	0,21	4,57	0,89	7,23	-	1,21	2,9	3,16	7,27	17,13	1,99	5,42	6,92	7,45	5,68	0,19
	30-60	7,61	752	1,84	0,70	4,40	0,89	7,83	-	1,17	1,9	4,34	7,41	16,72	1,81	3,42	9,42	7,27	5,99	0,32

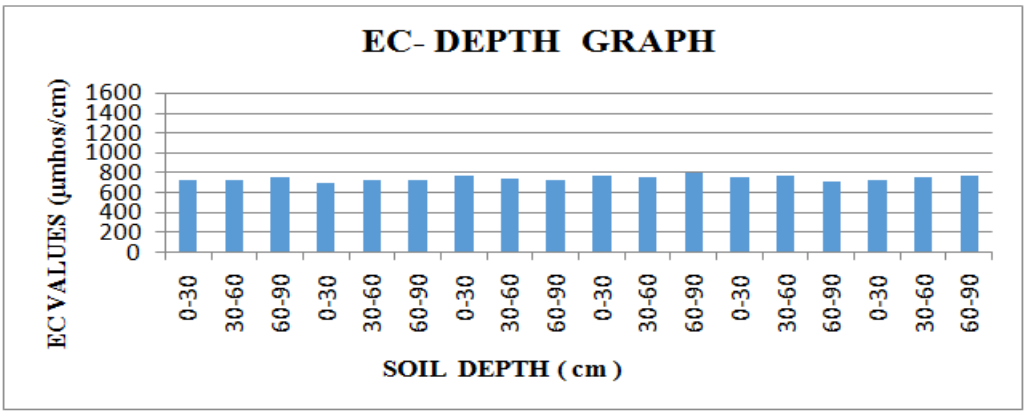

Figure 9
Soil EC – Depth relationships

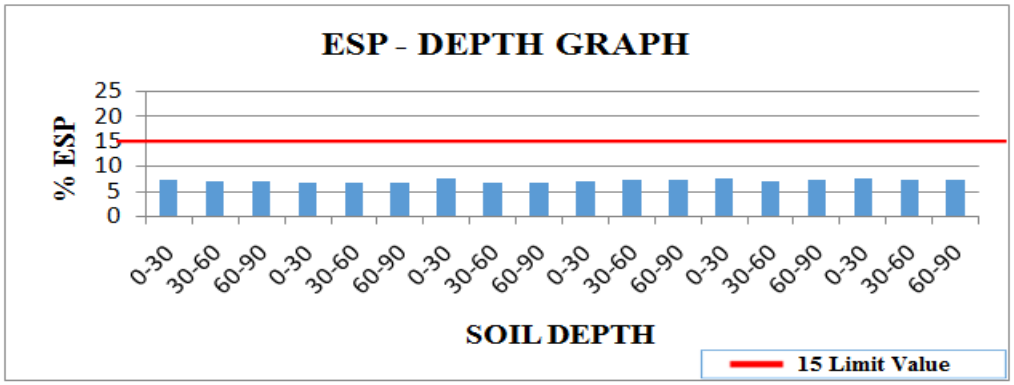

Figure 10
Soil ESP – depth relationships

Following conclusions were drawn based on present findings;

1) Considering irrigation water quality values in May, June, July, August and September all together, it was observed that water pH values varied between 6.08 – 7.45 and EC values varied between 1071-1989 µmhos/cm. Considering the EC values of the months, it was observed that EC values relatively increased from May to September and such increases were attributed to increasing plant water consumptions in summer season, consequent excessive water use and resultant decrease in well water levels and continuous use of saline waters. However, such increases did not change irrigation water class. With regard to water soluble cations and anions, it was observed that Ca^{+2} was the dominant cation and HCO_3^- and SO_4^{-2} were the dominant anions. Sodium Adsorption Ratios (SAR) varied between 1.00 – 1.40, % Na values varied between 15.1 – 25.0% and boron concentrations varied between 0.15 – 0.36 ppm. Based on these values with regard to salinity and alkalinity, irrigation waters were classified as C_3S_1 according to US Salinity Lab classification system. These waters could be used in pervious soils without any drainage problems. However, these waters should be avoided in clay soils with drainage problems or measures should be taken in case of use of these waters.

2) Boron concentrations all water samples were below the threshold boron concentration of 0.7 ppm. Such a case also reflected in soil samples and boron toxicity (<4ppm) was not observed in soils.

3) Despite high salinity of well waters within the research site, salinity was observed in irrigated lands of the research site. Such a case was attributed to well-leaching or recent opening of the fields to irrigation. But, measures should be taken to prevent possible salinity problems in the future.

4) All of the water samples had greater salinity values than the threshold salinity level, thus it is possible to state that these waters should not be used in irrigations.

5) Soil degree of saturation values varied between 46.2 – 57.4% and unit weights varied between 1.36 – 1.49 g/cm^3. Soils were mostly clay and clay-loam in texture.

6) Soil pH values varied between 7.11 – 7.90, EC values varied between 696-803 µmhos/cm, cation exchange capacity (CEC) values varied between 15.19 – 17.23 me/100gr, exchangeable sodium percentage (ESP) values varied between 6.60 – 7.49%, lime contents varied between 1.58 – 12.94% and boron concentrations varied between 0.08 – 0.85 ppm.

7) Exchangeable sodium percentage of all samples taken from the research site was below the threshold ESP value of 15%.

8) Significant salt and boron accumulations haven't been reached, yet since sufficient time has not

been elapsed for salt accumulation in soils by irrigations. Agricultural fields of the research site have been irrigated with groundwater resources for about 10 years. Common use of sprinkler irrigation might have prevented salt accumulation in soils.

Recommendations

1) According to present findings, irrigation water resources of the research site had salinity problems, however, salinity problem was not encountered in fields irrigated with these waters. That does not mean that salinity problem will not be encountered in near future since irrigation history of these fields are quite new. Quality of water resources of the region should be improved, and quality water should be delivered to fields as soon as possible.

2) Despite inexistence of salinity – alkalinity problems and considering the salinity problem of available water resources, it is recommended that drainage facilities should be constructed and land leveling should be performed in required places to prevent future salinity problems. Cultivation of salt-tolerant crops (barley, sugar beet) may also delay the emergence of a salinity problem.

3) Besides agricultural practices, reclamation practices should also be implemented over the agricultural fields of the region. Soil organic matter contents should be improved, and proper cropping patterns should be practiced.

4) Since the water resources of the region are replenished from the same reservoirs, farmers around the research site should be trained about water quality and salinity problems, significance and use of appropriate irrigation methods by Gözlü Agricultural Enterprise, agricultural organizations and universities.

5) While performing irrigations with saline waters, a certain leaching water fraction should be added to irrigationwater under appropriate drainage conditions. Local farmers should be informed about this issue.

6) There is a high possibility of soil salinity in near future since saline irrigation waters are still being used in irrigations. Therefore, either quality of water resources should be improved, or appropriate drainage facilities should be constructed.

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Research Article

The Change of Wear Element in Engine Lubricating Oil in Diesel Engines Using Biofuel

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ABSTRACT

In this study, terebinth methyl ester (biodiesel), diesel and bioethanol fuels were mixed in different ratios volumetrically. The obtained fuel mixtures, EB_1D_1 (2.5% bioethanol + 2.5% biodiesel + 95% diesel), EB_2D_2 (2.5% bioethanol + 5% biodiesel + 92.5% diesel), EB_3D_3 (2.5% bioethanol + 7.5% biodiesel + 90% diesel), and D_{100} (diesel) fuel were tested in a four-stroke and single cylinder diesel engine. Engine tests were performed in 100 hours for each fuel type and samples were taken from the engine lubricating oil at different time periods during the tests (0, 20, 40, 60, 80 and 100 hours). Wear element (Al, Fe, Pb, Cu, Cr) analyzes were performed on the samples. Wear element data of fuel mixtures lubricating oil were compared to diesel fuel. Wear element changes in lubricating oil were investigated.

As a result of the study, the best result was obtained from EB_3D_3 fuel in the change of wear element in the engine lubricating oil compared to diesel fuel.

1. Introduction

In general, the materials used to separate the two solids from each other and to facilitate the movement by minimizing the friction force is called “lubricant” or “oil“. The work carried out by the substance between these two soilds is called lubricating (Anonymous, 2011b).

The task of the engine oil is to prevent mechanical wear and reduce power loss by forming a thin film between moving surfaces. In addition, apart from the lubrication of moving parts of the machine; lubricating oil has functions such as reducing friction losses, ensuring the cooling of the surface by absorbing the heat generated by the friction in moving parts like pistons, neutralizing acids formed during combustion and preventing deposits on the surface. Engine oil analysis is performed to check the condition of used engine oil. Various oil analysis techniques determine how far away the engine oil is from its initial state (Müjdeci, 2009).

The oil put into the crankcase starts to get dirty and lose its lubrication ability from the moment it begins to circulate in the system. The loss of lubricating property of the oil depends on the proportion of foreign wastes collected in it. Carbon deposits occur on the combustion chamber surfaces during the running of the engine. These carbon deposits break down and mix into oil and then cause gum formation. Gummy residues, acids and resinous residues from fuel combustion can also be seen in engine oil operating under high temperature. Although the engine is equipped with an oil filter, some of the impurities will get into engine oil without being filtered, so the oil can no longer be used safely. Therefore, the engine oil and oil filter should be changed periodically (Anonymous, 2011a).

By determining the concentration of metals resulting from the wear in the engine, it is possible to determine the amount of the wear, which part of the engine is worn and whether the filter can function or not. By means of oil analysis, it is possible to take preventive measures by detecting worn products before the damage. Wear metals to be analyzed in lubricating oil are Al, B, Cr, Cu, Fe, Pb, Mg, Mo, Ni, Si, Ag, Na, Sn, Ti and Zn. (Gökalp et al., 2007).

If successive analyzes performed at the end of the same operating times show an increase in the number of metal particles, wear is accelerated on a particular

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piece of equipment. Wear metals and source of wear are given in Table 1.

Table 1
Wear metals and source points (Anonymous 2017b)

Wear metal and Contaminants	Source
Iron	Cylinder, gear, bearing, body, rust, piston ring, crank, liner
Silicon	contamination, clutch discs, gaskets
Sodium	Antifreeze
Potassium	Antifreeze
Chrome	Piston rings, bearings, shafts, coatings, hydraulic shafts
Molibden	Piston rings, gaskets
Copper	Bearings, bushings, thrust washers, oil radiator, clutch discs, turbo and cooler
Lead	Bearing surfaces, fuel additives
Zinc	Bearings, pistons, coatings
Nickel	Compressor cylinder, steel parts, valves
Silver	Bearings, coatings
Vanadium	Fuel, steel parts, valves
Phosphorus	Phosphor bronze alloys
Boron	Antifreeze
Lithium	Grease
Aluminium	Contamination, piston / bearing, pumps, thrust washers
Titanium	Contamination and paint
Manganese	Casting metal, steel parts, rings, liners

We examined the studies of some researchers about the change in engine lubricating oil when biodiesel was used in engine up to a certain mixing ratio. In their study, Agarwal et al (2003) used linseed oil methyl ester, diesel mixtures and diesel fuel in two similar engines respectively and they tested the engines in terms long-term durability in optimum conditions. ICP elements (Fe, Cr, Mg, Cu, Co, Zn, Pb) were analyzed at both engines by taking lubricating oil samples at fixed intervals. They determined that wear metals were lower in the biodiesel engine system.

Aydın and Öğüt (2017), in their study, mixed safflower oil methyl ester and diesel oil with the addition of 2.5% and 5% bioethanol at inverse proportion volumetrically and they obtained $E_{2.5}B_{2.5}$ D_{95}, $E_5B_5D_{90}$, $E_5B_{2.5}$ $D_{92.5}$ and $E_{2.5}B_5D_{92.5}$ mixture fuels. They tried mixture fuels and D100 fuel under partial load in a single cylinder diesel engine for 100 hours. They took samples from engine oil at certain times and examined the wear elements. As a result, they found that the most suitable fuel in terms of lubricating oil is $E_{2.5}B_5D_{92.5}$ compared to other fuels.

Kurre et al. (2017) stated in their study that the thinning (dilution) and oxidation of the oil were effective in engine oil contamination and in deterioration and wear of the engine parts. They stated that the degradation and useful life of the lubricating oil varies due to differences in the chemical composition of biodiesel and diesel.

In a study by Temizer and Eskici (2019), KYME10 and diesel fuel were subjected to 150 hours of work. They examined the effect of different fuels and combustion on engine lubricating oil and engine parts. As a result, compared to the study with KYME10 fuel, they found in the analyses that the engine running with M100 fuel had more metal elements in the lubricating oil.

In this study, mixture fuels were obtained by blending terebinth biodiesel, bioethanol and diesel oil in certain ratios. The obtained fuel mixtures EB_1D_1, EB_2D_2, EB_3D_3 and diesel fuel were used on single cylinder diesel engine. The engine running time for each fuel was 100 hours and samples were taken from the lubricating oil every 20 hours during the trial period. Wear element analysis was performed on the lubricating oil samples and the results were evaluated.

2. Materials and Methods

2.1. Material

Terebinth biodiesel used in the research was obtained by applying transesterification method to the oil from terebint fruit. To produce biodiesel from terebint oil, "PLC Assisted Pilot Production Plant" was used, which was established with the project support numbered DPT 2004/7 within the Faculty of Agriculture at Selçuk University. Methyl alcohol was used in the transesterification reaction and sodium hydroxide was used as catalyst. A schematic view of the pilot plant is shown in Figure 1.

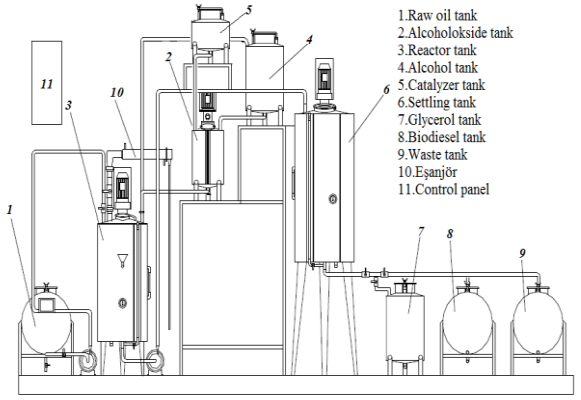

Figure 1
Schematic view of pilot production facility (Balcı, 2017)

Diesel fuel (euro diesel) and 20W50 engine oil, suitable for single cylinder diesel engine, were provided from the market. Bioethanol was obtained from Konya Sugar Industry and Trade Inc.

The engine tests were carried out in the engine testup within the Department of Agricultural Machinery and Technology Engineering, Faculty of Agriculture at Selçuk University. Schematic view of the engine test and test setup is given in Figure 2.

The setup consists of hydraulic dynamometer, magnetic pick-up, S type loadcell, mass fuel consumption meter, dynamometer control unit and exhaust emission meter.

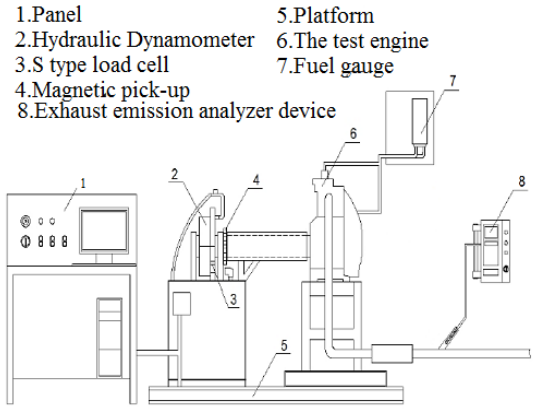

Figure 2
Schematic view of the engine test set up (Balcı, 2017)

The technical characteristics of Super Star brand single cylinder diesel test engine used in the research are given in Table 2.

Table 2
Technical specifications of the test engine (Anonim, 2009)

Technical specifications	Unit	Value
Working principle	-	4 stroke direct injection diesel engine
Cylinder bore	mm	108
Stroke	mm	100
Number of cylinders	number	1
Cylinder volume	l	0.92
Compression ratio	-	17:1
Maximum power	hp	15
Maximum torque	Nm	60
Cooling system	-	Water-cooling

Perkin Elmer Elan DRC-e brand ICP device, which was at Selçuk University Advanced Technology Research and Application Center laboratory, was used in the analysis of the wear elements in the engine lubricating oil. The ICP-MS device allows fast, precise and accurate measurement of a large number of elements in solid and liquid samples. Thus, 76 elements in solid or liquid samples can be analyzed simultaneously and at very low concentrations (ng-pg / l) precisely and quickly. Analysis of about 35 elements in a single sample can be measured by ICP-MS in less than three minutes (Anonymous, 2017a).

2.2. Method

Four types of fuels were used in the study. They are D_{100}, EB_1D_1, EB_2D_2, and EB3D3. To prepare fuel mixtures consisting of terebinth biodiesel, bioethanol and diesel fuel, each type of fuel was blended volumetrically in a certain proportion. Mixing was carried out in the form of diesel, terebinth biodiesel and bioethanol respectively. The bioethanol content of all mixture fuels was kept constant at 2.5% and the terenbinth biodiesel and diesel ratios were variable. Table 3 gives the name of the mixture and the amounts of the mixture as % for each fuel type. As can be seen in Table 3, D_{100} fuel is composed of 100% diesel fuel, EB_1D_1 fuel is composed of homogeneous mixture of 2.5% bioethanol, 2.5% terenbinth biodiesel and 95% diesel fuel, EB_2D_2 fuel is composed of homogeneous mixture of 2.5% bioethanol, 5% terenbinth biodiesel and 92.5% diesel fuel and EB_3D_3 fuel is composed of homogeneous mixture of 2.5% bioethanol, 7.5% terenbinth biodiesel and 90% diesel fuel.

Table 3
The names and amounts of the mixtures

Mixture name	Bioethanol *(%)*	Terebinth biodiesel *(%)*	Diesel fuel *(%)*
D_{100}	-	-	100
EB_1D_1	2.5	2.5	95
EB_2D_2	2.5	5	92.5
EB_3D_3	2.5	7.5	90

Analysis results of fuel properties of terebinth oil, terebinth biodiesel, bioethanol, Diesel, EB_1D_1, EB_2D_2 and EB_3D_3 fuels and standard values were given in Table 4.

Table 4
Fuel analysis results (Balcı, 2017)

Analysis name	Unit	Terebinth oil	Terebinth Biodiesel	TS EN 14214	Bioethanol	D_{100}	EB_1D_1	EB_2D_2	EB_3D_3	TS 3082 EN 590
Kinematic Viscosity (40°C)	mm^2/s	39.18	4.71	max.5.0	1.28	3.17	2.90	3.01	3.12	max.4.5
Density (15 °C)	g/cm^3	0.91	0.88	max.0.90	0.79	0.84	0.84	0.84	0.84	max.0.84
Water content	ppm	438.78	303.12	max.500	690.56	24.37	227.59	286.02	307.45	max. 200
Flash point	°C	-	98	min.01	-	67	-	-	-	min.55
Calorific Value	Mj/kg	-	41.44	-	28.59	45.89	43.40	42.70	41.14	-
Cetane number	-	57.94	53.47	min.51	13.91	55.84	51.03	51.19	51.31	min.51
Cloud point	°C	-	7	-	-	-4.40	-5.45	-4.48	-3.90	-

Table 4 (Continuation)
Fuel analysis results (Balcı, 2017)

Pour point	°C	-	1	-	-	-25.90	-26.88	-25.26	-24.02	-
CFPP	°C	-	5	-20	< -30	-7	-7	-7	-7	-20
Ash	%	0.02	0.02	max.0.02	-	-	-	-	-	max.0.01
Acid number	mg KOH/g	0.56	0.11	max.0.50	-	-	-	-	-	-
İodine number	giodine/ 100g	70.91	70.91	max.120	-	-	-	-	-	-
Copper strip corro-sion	degree	1a	1a	Class 1	1a	1a	1a	1a	1a	1

Each of D_{100}, EB_1D_1, EB_2D_2 and EB_3D_3 fuels were operated under partial load for 100 hours and samples were taken from the lubricating oil during engine tests. 5 samples were collected at the end of 100 hours of operation with 20 hours intervals for each fuel, and totally 20 oil samples were taken from all fuels. Analyzes of Fe, Cu, Al, Pb, Cr elements in unused engine oil and 20 oil samples were performed by ICP (Inductively Coupled Plasma) device at Selçuk University, Advanced Technology Research and Application Center Laboratory.

3. Results and Discussion

3.1. Aluminium (Al)

Aluminum element originates from pistons, piston head and rings and bearings. It can be detected at high rates especially in the samples taken as a result of the first operating hours after the machine production and revision. When this metallic formation is high in the analysis results, it is thought that there is oil filter contamination and there are problems in air intake circuit, valve caps and crankcase. In addition, excessive oil consumption, loss of performance, abnormal machine noise may occur in later stages of this formation (Lukas and Anderson, 1998; Müjdeci, 2009).

The amount of aluminum element in the engine lubricating oil depending on the operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels is given in Table 5 and the graphical expression of these values is given in Figure 3.

Table 5
The amount of aluminum element

Wear element	Operating time	D_{100} (ppb)	EB_1D_1 (ppb)	EB_2D_2 (ppb)	EB_3D_3 (ppb)
Aluminum (Al)	20. h	3147.81	2792.66	2353.44	961.58
	40. h	3060.93	2948.72	2588.64	913.36
	60. h	3459.32	3285.45	2765.13	1005.54
	80. h	3857.70	3572.91	2982.25	1158.16
	100. h	4174.86	3827.65	3227.20	1306.78
	0.h **	1529.77			
Limit values*		15-40 ppm (15000-40000 ppb)			

*Özçelik (2011)

**Clean oil

When the amount of Al element in engine lubricating oil is examined in Figure 3, it is observed that there are certain increases in D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels from the 20 th hour to the end of the 100 th hour.

At the same time, in addition to bioethanol (2.5%) which was a constant value in the mixture fuels, it was determined that the amount of Al element decreased compared to D_{100} fuel according to the increasing amount of biodiesel (2.5%, 5% and 7.5%). As can be seen in Table 5, the highest increase compared to clean oil (0.h) was realized as 172.90% at 100th hours in D100 fuel. The amount of aluminum elements remained within the limit values. Compared to D_{100} fuel, the increase rate of Al element in EB_1D_1, EB_2D_2, EB_3D_3 fuels from the 20th hour to the 100th hour was 3.58%, 13.78%, 10.02% respectively.

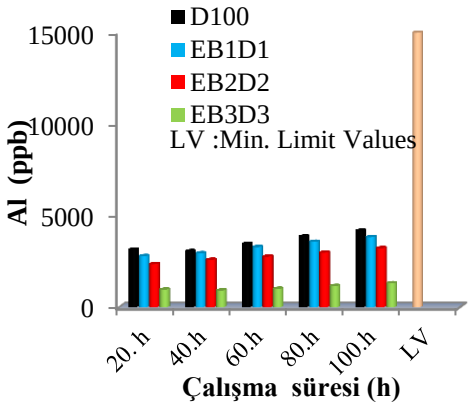

Figure 3
Aluminum element

3.2. Iron (Fe)

Iron element is the most important metallic particle that determines the changing period of lubricating oil. The presence of an excess of metallic formation causes problems such as excessive oil consumption, abnormal

machine noise, performance problems, abnormal oil pressure and operating temperatures, defective piston rings and rust formation in the system (Lukas ve Anderson, 1998; Müjdeci, 2009).

Table 6 shows the amount of iron element in the engine lubricating oil depending on the operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels. The graphical expression of these data is also shown in Figure 4.

According to the results of the study, as the operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels increased, Fe element amount increased as well. In addition, as a result of the evaluations made from the 20th hour to the 100th hour of the operation time, Fe element amounts

of EB_1D_1, EB_2D_2, EB_3D_3 fuels increased at the rate of 65.56%, 29.04%, 23.55% respectively compared to D_{100} fuel. In addition, the highest amount of iron elements was found in E-B_1-D_1 fuel. The amount of Fe element in all fuels did not exceed the limit values. Compared to clean oil, the highest increase rate was 254.05% in EB_1D_1 fuel at 100 th hour.

Table 6
The amount of iron element

Wear elements	Operation time	D_{100} (ppb)	EB_1D_1 (ppb)	EB_2D_2 (ppb)	EB_3D_3 (ppb)
Iron (Fe)	20. h	38088.06	41904.58	23177.38	20808.04
	40. h	37041.94	44749.97	22429.68	21719.81
	60. h	41741.64	43757.09	23760.63	23999.65
	80. h	50546.47	59982.01	27961.58	23140.08
	100. h	51983.76	67215.83	34089.58	30187.35
	0.h**	18984.4			
Limit values*		40-200 ppm (40000 – 200000 ppb)			

*Özçelik (2011)
**Clean oil

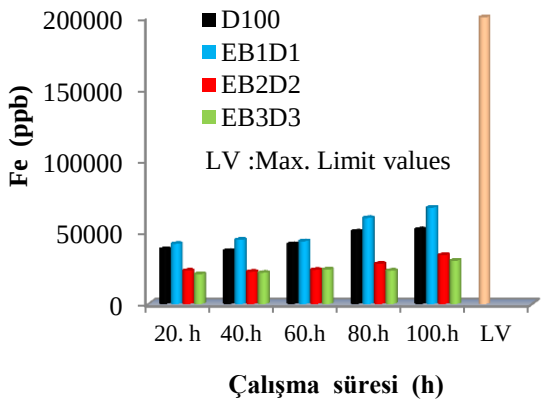

Figure 4
Iron Element

3.3. Lead (Pb)

The lead element may be caused by wear of plain bearings or tin-lead mixture soldering joints and some sealing elements. However, the lead element can result from fuel as well as from gear system clutches and brake friction plates (Lukas and Anderson, 1998; Müjdeci, 2009).

The amount of lead element in the engine lubricating oil, depending on the operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels, is given in Table 7 and the graph of these values is given in Figure 5.

When Table 7 is examined, it is seen that Pb values increased as operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels increased and all data remained within the limit values. Compared to D_{100} fuel, the amount of Pb element in the engine lubricating oil from the 20th to the 100th hours increased by 47.61%, 97.69%, 38.57% respectively in EB_1D_1, EB_2D_2, EB_3D_3 fuels.The highest increase compared to clean oil (0.h) was 144.46% in D_{100} fuel at 100th hour.

Table 7
The amount of iron element

Wear element	Operation time	D_{100} (ppb)	EB_1D_1 (ppb)	EB_2D_2 (ppb)	EB_3D_3 (ppb)
Lead (Pb)	20. h	1284.88	948.79	940.91	612.66
	40.h	1195.44	936.75	987.05	675.98
	60.h	1402.66	745.03	879.54	689.09
	80.h	1489.06	832.16	979.62	616.37
	100.h	1584.05	1274.90	1374.03	810.36
	0.h**	647.96			
Limit values*		5-40 ppm (5000 – 40000 ppb)			

*Özçelik (2011)
**Clean oil

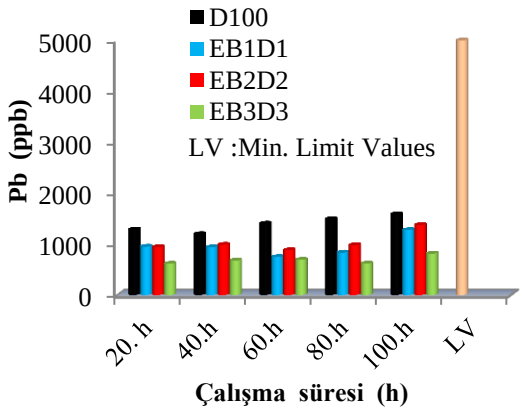

Figure 5
Lead Element

3.4. Copper (Cu)

Copper element can be realized in gear and valve plates, gear types, turbocharger bearings, cam bearings and piston pin bearings, many gear systems with high copper content and in brake plates containing sintered bronze. In addition, corrosion formation in oil cooling system should be considered in case of high copper level (Avcı, 2009).

The copper values of lubricating oil depending on operating time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels are given in Table 8 and graph of values is given in Figure 6.

Table 8
The amount of copper element

When Table 8 is	Operation time	D_{100} (ppb)	EB_1D_1 (ppb)	EB_2D_2 (ppb)	EB_3D_3 (ppb)
Copper (Cu)	20. h	5497.82	1436.64	1536.28	1458.80
	40. h	6193.84	1339.02	1576.59	1811.56
	60. h	5050.20	1490.36	1743.97	1976.00
	80. h	6579.55	1393.94	1845.01	1708.88
	100. h	6797.30	1878.96	2099.43	1738.60
	0.h **	2909.48			
Limit values *		5-40 ppm (5000 – 40000 ppb)			

*Özçelik (2011)
**Clean oil

Compared to D_{100} fuel, Cu element amount increased by 30.25%, 55.08% in EB_1D_1, EB_2D_2 fuels; and decreased by 18.85% in EB_3D_3 fuel compared to diesel. According to the evaluation made according to clean oil (0.h), the highest increase was seen in D_{100} fuel at 100th hour with 133.62% value.

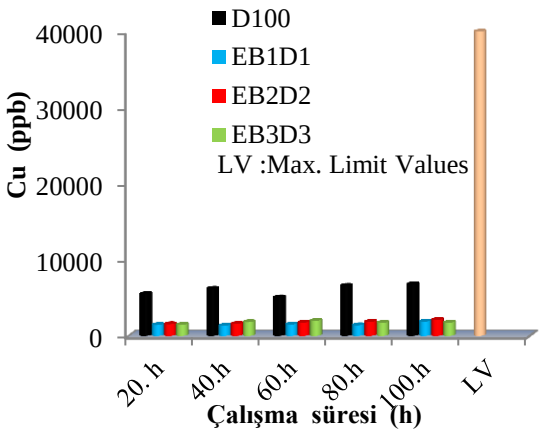

Figure 6
Copper element

3.5. Chrome (Cr)

Chrome element is generally used as coating material of machine elements. Piston rings coated with chrome, chrome and chrome alloy machine parts form the source of this metal. It can also be caused by gasket, cylinder and some bearing elements. Increased pollution of air in the cylinder and defective segments increase the proportion of this metal. Cr increase is an indication of excessive oil consumption, leakage in the machine or deterioration of oil quality (Lukas and Anderson, 1998; Avcı, 2009).

Chrome element values of engine lubricating oil and the gragh of these values depending on the operation time of D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels are given in Table 9 and Figure 7 respectively.

Table 9
The amount of chrome element

Wear element	Operation Time	D_{100} (ppb)	EB_1D_1 (ppb)	EB_2D_2 (ppb)	EB_3D_3 (ppb)
Chrome (Cr)	20. h	5009.61	5370.07	5452.19	4572.14
	40. h	5926.42	5614.76	5825.16	4919.46
	60. h	6075.83	5574.89	5927.10	4892.23
	80. h	6057.48	5345.96	6145.07	5320.77
	100. h	5777.12	5755.07	6234.69	5758.55
	0. h**	5747.15			
Limit values*		10-30 ppm (10000 – 30000 ppb)			

*Özçelik (2011)
**Clean oil

When Table 9 is examined, as engine running time increased in D_{100}, EB_1D_1, EB_2D_2, EB_3D_3 fuels, the amount of chrome increased as well. It is seen that the amount of chrome element in all fuel types is within the limit values.

Compared to D_{100} fuel, the amount of Cr element in EB_1D_1 ve EB_2D_2 fuels from 20th to 100th hours decreased by 53.20%, 7.68% respectively; but in EB_3D_3 fuel it increased by 69.36% compared to diesel fuel. According to the evaluation of clean oil, the highest increase was in EB_2D_2 fuel with 8.48% at 100th hour.

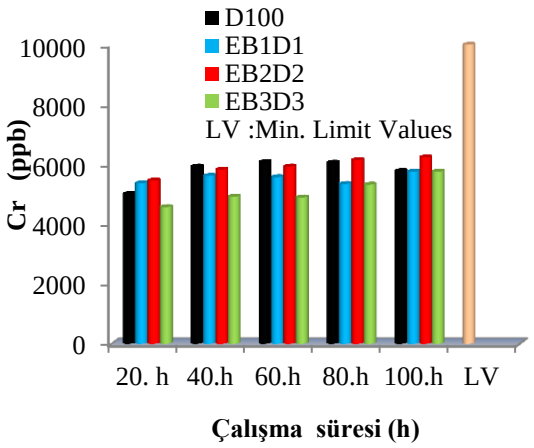

Figure 7
Chrome element

4. Conclusion

When the wear element analysis data of the engine lubricating oil were evaluated in the samples taken from all fuel types, it was found that the wear element amount increased as the engine operating time increased. Compared to D_{100} fuel, there was a decrease in wear elements in EB_1D_1, EB_2D_2, EB_3D_3 fuels. The effect of lubricating of biodiesel confirms these results. Only in EB_1D_1 fuel, iron content is higher than D_{100} fuel. The amount of wear elements in all mixtures remained within the limit values.

When the increase rate of wear element analysis from 20th hour to 100th hour is evaluated according to D_{100}, the lowest ratios were obtained in EB_3D_3 fuel

among fuel mixtures in element analysis results except Cr element. The amount of Cr element in EB_3D_3 fuel is within the limit values.

According to the results of the study, the best results were obtained from EB_3D_3 fuel when the engine lubricating oil data were evaluated compared to D_{100} fuel.

Symbol & abbreviations

Ag	:	Silver
Al	:	Aluminium
B	:	Boron
CFPP	:	Cold filter plugging point
Cr	:	Choreme
Cu	:	Copper
Co	:	Cobalt
D_{100}	:	Diesel
DPT	:	State planning organisation
DRC	:	Dynamic Reaction Cell
EB_1D_1	:	2.5% bioethanol + 2.5% biodiesel + 95% diesel
EB_2D_2	:	2.5% bioethanol + 5% biodiesel + 92.5% diesel
EB_3D_3	:	2.5% bioethanol + 7.5% biodiesel + 90% diesel
Fe	:	Iron
ICP	:	Inductively Coupled Plasma
KOH	:	Potassium hydroxide
KYME10	:	Canalo oil methly ester %10 + %90 diesel
Mg	:	Magnesium
Mo	:	Molibden
Na	:	Sodium
Ni	:	Nickel
Pb	:	Lead
PLC	:	Programmable logic controller
ppb	:	part per billion
ppm	:	part per million
Si	:	Silicon
Sn	:	Tin
Ti	:	Titanium
Zn	:	Zinc

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Research Article

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Detection of Some Virus Diseases of Edible Seed Squash (*Cucurbita pepo* L.) in Nevşehir Province, Turkey

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ABSTRACT

Squash is a member of Cucurbitaceae family. It is grown for fresh consuming and its seeds are used as a snack in Turkey like some Mediterranean countries and Germany, Hungary, Austria and China. *Cucurbita pepo* L. is mostly used for cultivating squash seeds in Turkey. Also, a small amount of seeds obtain from *Cucurbita moschata* Duch (Butternut squash or pumpkin). Virus diseases are one of the most destructive diseases on squash which is grown for seeds in Nevşehir province. In this study, it was aimed to determine the virus infections in major squash growing areas in Nevşehir province. Totally 134 plant samples with common virus symptoms like mosaic, curling, blistering, mottling, distortion, shoestring, stunting and vine decline were collected from squash plants during 2018. In this study. Double-Antibody Sandwich Enzyme-Linked Immunosorbent Assay (DAS-ELISA) method is used for identifying the virus infections on the plant samples. According to the results of the DAS-ELISA, 97.76 % of plant samples were infected with *Zucchini yellow mosaic potyvirus* (ZYMV), *Watermelon mosaic potyvirus-2* (WMV), *Cucurbit aphid borne yellow virus* (CABYV), *Cucumber mosaic cucumovirus* (CMV), *Papaya ringspot potyvirus*-watermelon strain (PRSV-W) and *Squash mosaic comovirus* (SqMV). WMV was predominant in the research area with the ratio of 89.55 %. ZYMV was the second important virus disease in the surveyed area and it was detected on the samples at the ratio of 57.46 %. Also, mixed infections of those virus infections were detected commonly in squash. Especially, ZYMV+WMV (40.29 %) and WMV+ZYMV+PRSV-W (8.20 %) mixed infections were common.

1. Introduction

Squash seeds are one of the most nutritionally rich vegetable by-products out there, having a high content of unsaturated fat, protein, beta carotene, vitamin C, vitamin B1, fiber, iron, calcium, and potassium. These seeds were originally a main food for countries like China, United States, India, and Mexico and recently whole world has realized to the health benefits of these seeds. Although edible seed squash has been grown in Turkey for many years, there has been a rapid increase in the production area and quantity since 2004. As a result, in the year of 2018, edible seed squash production has reached 55.043 tons in about 73.789 ha. production area (TÜİK 2019). In our country, the most important reason for the increase in the production of edible seed squash is that this plant can be grown in both arid and irrigated field conditions. This plant is seen as an economic alternative product that can grow especially in arid conditions. For squash growing, one of the most important problems is virus diseases. It's hard to estimate or calculate the amount of yield losses in crops due to virus diseases. According to the different calculations, 3-5% of overall cultivated vegetable crops are lost because of virus diseases, but these losses can be sometimes very high, where pest control is inadequate, particularly in developing countries (Caciagli 2010). Viruses can cause important economic losses in the world for cucurbit growing. Indeed, on cucurbits, more than 35 different species have been determined as pathogen (Provvidenti 1996). These pathogens cause complicated and dynamically varying problems (Nameth et al 1986). Edible seed squash is one of the most common vegetable crops which is grown in Nevşehir province in Turkey. It occupied 21.165 ha in Nevşehir in 2018, with a predicted production of 16.403 tons (Anonymous 2019). Previous studies from different parts of Turkey have reported different viruses such as *Zucchini yellow mosaic potyvirus* (ZYMV), *Squash mosaic comovirus* (SqMV) and *Cucumber mosaic cucumovirus* (CMV, *Cucurbit aphid borne yellows polerovirus* (CABYV), *Papaya ring spot potyvirus - watermelon strain* (PRSV-W),

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Watermelon mosaic potyvirus - 2 (WMV), *Cucumber vein yellowing ipomovirus* (CVYV), *Tomato ring spot nepovirus* (TRSV), *Melon mosaic virus* (MMV), and *Tomato black ring nepovirus* (TBRV) in the plants of family Cucurbitaceae. (Kurcman 1977; Davis & Yılmaz 1984; Nogay & Yorgancı 1984; Erdiller & Ertunç 1988; Yılmaz et al 1991; Yılmaz et al 1992; Fidan 1995; Gümüş et al 2001; Çağlar et al 2004).

ZYMV, WMV, and PRSV-W are typical members of *Potyvirus* genus (Potyviridae), so they have flexuous filamentous particles, and single stranded positive sense RNA genome. Potyviruses can be transmitted efficiently by mechanical inoculation and vector aphid species. ZYMV can be transmitted with seed to a low level, while PRSV-W and WMV are not transmitted with seeds (Lisa & Lecoq 1984; Purcifull et al 1984a; Purcifull et al. 1984b). CMV is a polyhedral shaped virus that is member of the genus *Cucumovirus* in the Bromoviridae family and has a three-part genome consisting of ssRNA with positive polarity. This virus can be transmitted by seeds of some hosts, aphids and mechanically (Francki et al 1979). SqMV, which has a positive sense ssRNA genome, belongs to the genus *Comovirus* (Secoviridae). The particle of the virus is hexagonal formed of isometric subunits and can be transmitted by insect vectors, seed and mechanically (Campbell 1971). CABYV belongs to the genus *Polerovirus* in the family Luteoviridae (King et al 2012) and was first reported in France in 1992 (Lecoq et al 1992). The virus causes yellowing and thickening of the older leaves in cucurbit plants and is often mistakenly attributed as a nutrient deficiency. Although the major veins of younger leaves would remain green after the infection, plant yield may be reduced (Lecoq et al 1992). The virus is transmitted primarily by *Aphis gossypii* Glover and *Myzus persicae* Sulzer, and the transmission could be circulative, persistent, and nonpropagative (Dogimont et al 1996; Gray et al 2014). CABYV has been reported from cucurbit crops across different climatic regions of the world such as temperate, Mediterranean, and subtropical (Lecoq 1999), and no mechanical transmission has been reported (D'Arcy & Domier 2005). The main constraint for the management of diseases caused by members of Luteoviridae is that no effective strategy exists to cure plants after virus infection (Michelle & Veronique 2018).

In this study, one year of surveys were carried out for determining the incidence and distribution of viruses (CABYV, CMV, PRSV-W, WMV, SqMV, ZYMV) infecting edible seed squash crops grown in Nevşehir province.

2. Materials and Methods

2.1. Collecting of virus infected squash leaves

Surveys were conducted by collecting symptomatic squash leaf samples from main squash growing fields in 6 different districts (Center, Acıgöl, Avanos, Derinkuyu, Gülşehir and Ürgüp) of Nevşehir province during July through September in 2018 (Table 1). In order to samples to represent Nevşehir province, more than % 1 of total edible seed squash growing areas (2 130 da) of the province were surveyed. For this purpose, 24 edible seed squash fields were visited in the province. In these studies, the number of collected samples from each field was determined according to the amount of surface area of the field. So that, at least 5 samples were collected from the fields which have up to 50 da and 8 samples were collected from the fields which have more than 50 da growing areas. The samples were picked from plants which showed virus diseases symptoms like blistering-distortion, mottling, vein clearing, mosaic, yellowing, shoe-string, or stunting and fruit discoloration and deformation. In each field, it was tried to take samples from plants with different symptoms. Five different leaves from each plant showing symptoms of virus diseases were taken as a sample. The samples were tested to determine for the infections of CMV, ZYMV, WMV, SqMV, CABYV and PRSV-W. They were put in plastic bags, and kept in a deep-freezer (-20°C) until diagnostic tests.

2.2. Testing by DAS-ELISA

For determining the virus infections (CABYV, PRSV-W, CMV, WMV, SqMV, and ZYMV) on the squash leaf samples, Double-Antibody Sandwich Enzyme-Linked Immunosorbent Assay (DAS-ELISA) test method was used (Clark and Adams 1977). The antibodies were provided from commercial companies and utilized with respect to the instructions of them. Before the homogenization of the leaf samples, microplates were coated with virus IgG that were diluted in carbonate buffer (pH 9.6), and incubated for 4 h at 37°C. The squash leaf samples were grinded in a mortar with the addition of the sample extraction phosphate buffer solution at a ratio of 1:10 (PBS, pH 7.4). After washing the microplates with washing buffer (PBST) thrice, the extracted samples were added to wells and incubated overnight in a refrigerator (+4°C). Alkaline phosphatase (APP) conjugated antibody diluted in conjugate buffer (pH 7.4) was added after washing the plates, and incubated for 4 h at 37°C. Substrate buffer (pH 9.8) with *Para*-nitrophenylphosphate (*P*-NPP) was added to each well and then, incubated for 30 to 90 min. at dark and room temperature (Fig. 1). Absorbance values were determined at 405 nm by Anthos 2010 Microplate Reader (Biochrom Ltd., Cambridge, UK). Test was assessed as positive when the average absorbance value of tested sample was greater than two times of healthy (uninfected) control (Abou-Jawdah et al 2000; Yeşil & Ertunç 2012).

2.3. Determining infection rates of the viruses

Numbers of infected plant samples for each virus were determined by DAS-ELISA tests. Infection rates of each virus were calculated by simple proportion. Therefore, for each virus, numbers of sum of single,

double and multiple virus infected plant samples were divided to numbers of total tested samples then the results were multiplied with 100. In this way, infection rates of each virus were calculated as percentage.

Table 1
Surveyed districts and number of collected plant samples

Districts	Number of collected samples	Number of surveyed fields	Total areas of the fields (da)
Nevşehir (Center district)	15	3	130
Acıgöl	20	4	400
Avanos	53	7	855
Derinkuyu	11	3	195
Gülşehir	19	4	250
Ürgüp	16	3	300
Total	134	24	2 130

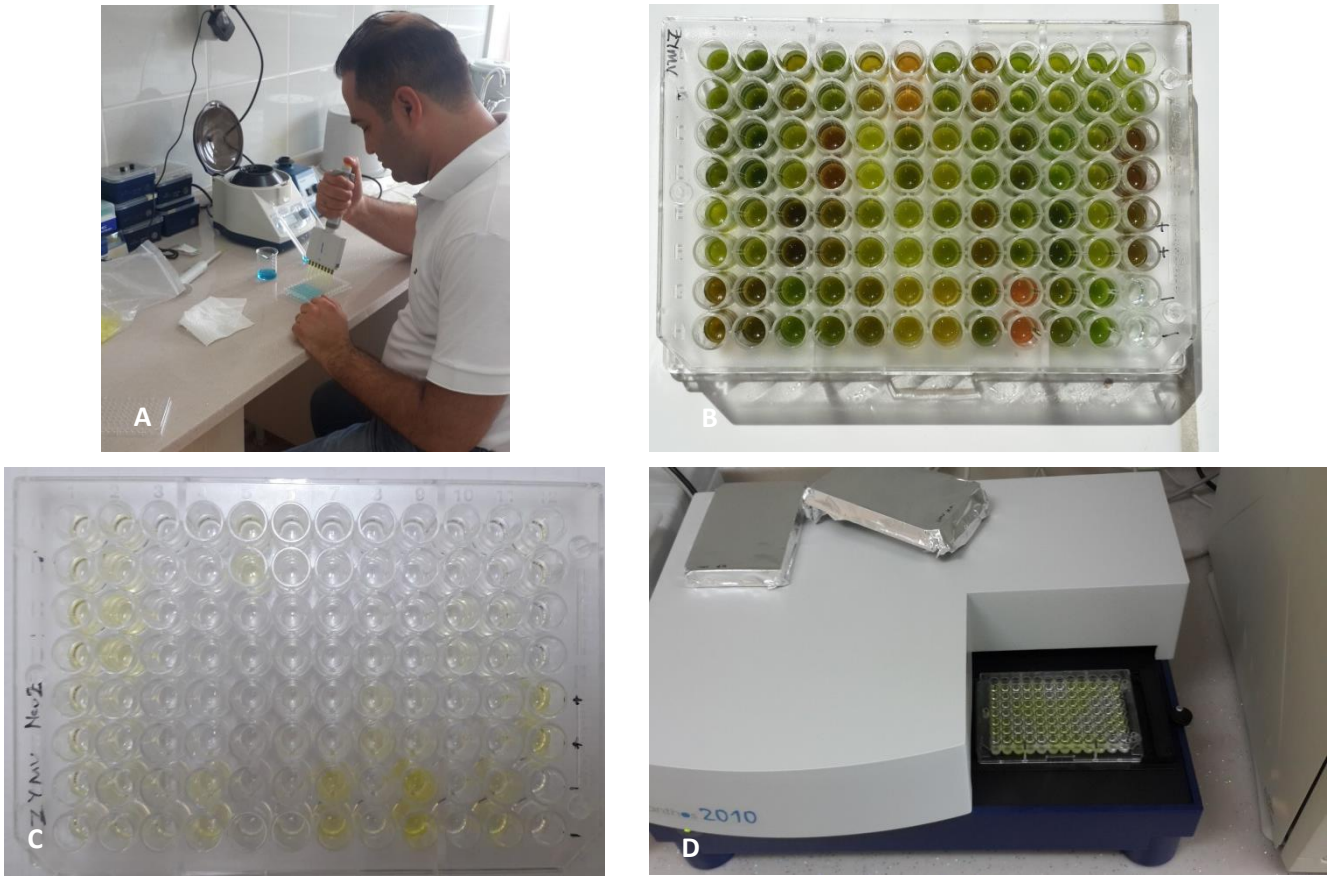

Figure 1
Steps of DAS-ELISA tests. A: Coating wells with virus IgG. B: Extracted samples were added to wells and incubated overnight in a refrigerator (+4°C). C: Substrate (*P*-NPP) added microplates, incubated for 30 to 90 min. at dark and room temperature. D: End of the incubation, the positive wells got yellow and absorbance values were determined by ELISA reader.

3. Results and Discussion

In this study, totally 134 edible seed squash leaf samples were tested by DAS-ELISA. The incidences of the different viruses which infect squash are given in Tables 2 and 3. They obviously show that WMV and ZYMV are the most common squash viruses in the survey area. According to the results of the DAS-ELISA 97.76 % of the samples were infected with CABYV, PRSV-W, ZYMV, CMV, WMV, and SqMV. WMV was the most common virus in the survey area with the ratio of 89.55 %. The second important virus disease in the research area was ZYMV; it was detected on the samples at the ratio of 57.46 %. They are followed by PRSV-W, SqMV, CABYV and CMV 14.18, 2.99, 2.23 and 0.75% in all tested samples, respectively (Table 2). On 82 of all the samples were determined mixed virus infections. Mixed infections of WMV + ZYMV were the most frequently detected ones in the samples with the ratio 40.29 % (Table 3). Double infections with WMV + PRSV-W, WMV + SqMV and ZYMV + PRSV-W were detected as 5.22, 2.98 and 1.49 %, respectively. Triple infections of WMV + ZYMV + PRSV-W (8.20%) and WMV + ZYMV + CABYV (1.49%) were detected in 11 and 2 samples, respectively. According to the DAS-ELISA

test results, all of the samples which were collected from Nevşehir Center, Acıgöl, Derinkuyu and Ürgüp were determined as virus infected. WMV was the most commonly detected in samples from Ürgüp (100%), Acıgöl (95%), Gülşehir (94.74%) and Derinkuyu (90.91%). As for ZYMV, PRSV-W, SqMV, and CABYV were frequently detected in samples from Nevşehir Center (80%), Gülşehir (47.37%), Ürgüp (25%), and Avanos (5.66%), respectively. CMV infection was only determined on one sample from Acıgöl (5%).

Table 2
According to DAS-ELISA tests results, the number of single virus infections

District	No. Tested	Healthy	CMV	SqMV	WMV	PRSV-W	ZYMV	CABYV
Nevşehir (Center)	15	0	0	0	3	0	2	0
Acıgöl	20	0	0	0	5	0	0	0
Avanos	53	2	0	0	15	0	6	0
Derinkuyu	11	0	0	0	6	0	0	0
Gülşehir	19	1	0	0	7	0	0	0
Ürgüp	16	0	0	0	5	0	0	0
Total	134	3	0	0	41	0	8	0

Table 3
According to DAS-ELISA tests results, the number of multiple virus infections

District	Double virus infections						Triple virus infections	
	WMV +ZYMV	WMV+ PRSV-W	WMV +SqMV	ZYMV+ PRSV- W	ZYMV+ CMV	WMV+ CABYV	ZYMV+ WMV + PRSV- W	ZYMV+ WMV+ CABYV
Nevşehir (Center)	9	0	0	0	0	0	1	0
Acıgöl	11	0	0	0	1	0	3	0
Avanos	23	2	0	1	0	1	1	2
Derinkuyu	2	2	0	1	0	0	0	0
Gülşehir	2	3	0	0	0	0	6	0
Ürgüp	7	0	4	0	0	0	0	0
Total	54	7	4	2	1	1	11	2

Edible seed squash is economically important in Nevşehir province, but have a high incidence of virus-like symptoms. During the surveys, different symptoms were observed such as leaf deformations (crinkle, blistering, shoe-string, etc.), different chlorotic patterns on leaves (mosaic, ring spot, oak leaf, etc.), fruit deformations and growth reductions on squash plants (Fig.2). Also, symptoms of mineral deficiencies like growth reductions, wilting and yellowing were observed in some fields. The observed diseases symptoms in this study were similar to the symptoms previously reported from virus-infected cucurbits fields worldwide (Makkouk & Lesemann 1980; Lecoq et al 1981; Sammons et al 1989; Provvidenti 1996; Luis-Arteaga et al 1998; Yuki et al 2000; Davis et al 2002; Massumi et al 2007; Malandraki et al 2014). The occurrence and incidence of viruses on cucurbit plants have been determined in different parts of Turkey. The infection of CMV, CABYV, ZYMV, PRSV-W, WMV, SqMV, and ToMV has been reported in previous studies (Çağlar et al 2004; Davis & Yılmaz 1984; Erdiller and Ertunç 1988; Fidan 1995; Korkmaz et al 2018; Köklü & Yılmaz 2006; Nogay & Yorgancı 1984; Şevik & Balkaya 2015; Topkaya & Ertunç 2012; Yeşil & Ertunç 2012; Yeşil 2014; Yılmaz et al. 1991). But there are a few reports on virus diseases of edible seed squash plants (Yeşil and Ertunç, 2012; Yeşil 2014; 2019a; b). With this study, WMV and ZYMV were determined as the most prevalent viruses in research area. They are effectively transmitted by either infected sap or vector aphids. These two viruses have been accepted as the most common viruses of cucurbits in the world (Al-Ali et al 2013). Similarly, in a study which was carried out in different provinces of Turkey by Yılmaz et al (1992) WMV and ZYMV were the most widespread viruses among the tested viruses (ZYMV, WMV, CMV, CABYV and PRSV-W). The similar results were reported by Kızmaz et al (2016). These researchers were conducted a survey in cucurbit fields of Mardin and Diyarbakır provinces and they reported that the incidences of WMV (60.00%), CMV (43.13%), ZYMV (39.38%), PRSV-W (21.25%) and CABYV (16.25%). Also, a survey was carried out in Konya province, 334 edible seed squash leaf samples were tested by DAS-ELISA, and ZYMV, WMV and CMV were determined on the samples with the ratios of 60.18%, 52.99% and 13.77%, respectively (Yeşil 2014). The similar results were reported by the Özaslan et al (2006); they carried out a survey study to determine infections of cucurbit viruses in Gaziantep province of Turkey. They reported that ZYMV was the most common virus species on cucurbit plants and, also, the infections of CMV and *Potato potyvirus Y* (PVY) on cucurbits are common. To reveal viruses of cucurbits in Tokat province, a survey performed by Korkmaz et al (2018). Totally 146 squash plant samples were tested by DAS-ELISA and they found WMV (38.35%), ZYMV (26.71%), ToMV (*Tomato mosaic tobamovirus*) (22.53%), CMV (13.01) and PRSV-W (5.47%) infections on the samples. Also,

they didn't determine any infection of TMV (*Tobacco mosaic tobamovirus*), SqMV and PVY.

Also, mixed virus infections were determined on 82 of the plant samples with this study (Table 3). In previous studies, mixed virus infections on cucurbits were reported (Kaya & Erkan 2011; Topkaya et al 2019; Yeşil & Ertunç 2012; Yeşil 2014; 2019a;b; Yuki et al 2000).

Some of the cucurbit viruses can be transmitted by seeds such as CMV, ZYMV, SqMV, TRSV, and CGMMV. A research was performed to detect the presence of seed borne viruses in pumpkin seed lots collected from Samsun, Sinop, and Bolu provinces during 2013-2014. According to the results of this research, the seed samples were only infected with ZYMV (12.5%) and CMV (4.1%). Moreover, any infection wasn't determined on the seeds of SqMV, TRSV, and CGMMV. With another study about determining seed infections of some viruses in major cucurbit growing areas in Konya, Karaman and Aksaray provinces of Turkey during 2009 and 2010. The results of this study showed that 8,7% of seed samples were infected with ZYMV (4,3%), WMV (3,3%) and CMV (1,1%). PRSV-W, SqMV and CGMMV were not determined in any of the tested samples and were not present in the tested cucurbit seeds lots (Yeşil & Ertunç 2016). As can be seen in the above mentioned studies, the reason of occurring frequently infections on cucurbits by the viruses such as ZYMV, WMV and CMV may be infected seeds.

In the present study, WMV and ZYMV were detected as most common viruses. In previous studies, similar viruses were detected in different incidences (Erdiller & Ertunç 1988; Fidan 1995; Korkmaz et al 2018; Köklü & Yılmaz 2006; Nogay & Yorgancı 1984; Şevik & Balkaya, 2015; Yeşil & Ertunç, 2012; Yeşil 2014; 2019a; b; Yılmaz et al 1991). It may be two main reasons for this. Firstly, although other cucurbit crops are grown only in irrigated fields, edible seed squash plant can be grown in either irrigated or semi-arid conditions. The second reason is regional differences. It's normal that, different viruses infect to the same plant species in different environmental conditions. Because differentiations in environmental conditions determine significantly some factors which effect virus epidemiology. These factors are populations and varieties of weed and vector species in or near fields, plant species which are grown in adjacent fields and plant vitality.

Figure 2
Virus diseases symptoms on edible seed squash plants. A: Mosaic symptoms on the leaf caused by WMV. B: Severely leaf deformations and blisters on the leaf because of ZYMV+WMV double infection. C: Shoestring symptoms on

squash leaves because of ZYMV+CMV double infections and (D) blisters on fruit because of ZYMV+WMV double infections.

4. Conclusions

The presences of CABYV, CMV, PRSV-W, WMV, ZYMV, and SqMV on edible seed squash were firstly detected in Nevşehir with the study. The results showed that one of the most important problems in squash growing in the province is virus infections. Because, during the survey studies, symptoms of virus diseases were observed almost each edible seed squash fields in the province. According to the results of this study, for reducing or eradication of virus diseases in squash production areas in Nevşehir province and can be produced more yielded and more quality edible squash seeds the following suggestions must be regarded.

First of all, healthy, non-infected, pathogen-free and certified seed should be used.

For controlling virus diseases efficiently, it is very important to know about transmission ways and infection sources of the viruses. It's known that, except of SqMV, all viruses detected in our study were spread by mechanical inoculation and aphids (Kaper & Waterworth 1981). Unfortunately, squash growers in the province neither know symptoms of virus diseases nor know transmission ways of the viruses from plant to plant. Therefore, they are not able to efficiently control virus diseases as they can't prevent the spread of viruses via vector aphid species.

Also, some of the common weed species in squash growing areas have a great importance in the epidemiology of virus diseases because they role as reservoir plants for virus diseases (Zitter 2002; Yeşil & Ertunç 2015). For preventing virus infection of cucurbits, weeds must be controlled.

As well in other plant crops production, in squash production cultural practices are very important. If all conditions which are necessary for growing healthy plant can be obtained, possibility of chance of phytopathological problems occurrence will be minimum. Therefore, cultural practices such as tilling, planting, fertilizing and irrigation should be done properly.

The plants which show virus diseases symptoms should be eradicated as soon as seen. Since, they act as infection sources for later infections.

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Determining Some Structural Characteristics and Mechanization Potential of Dairy Cattle Farms in Karacabey District of Bursa Province

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ABSTRACT

In this study, is aimed to determine some structural characteristics and mechanization potential of dairy cattle farms in Karacabey District of Bursa province and data were obtained with 59 questionnaires, which were made by one-on-one interviews with cattle farms, selected by random sampling method. The enterprises owners, visited in Karacabey District, educational levels as follows; 74.5% primary school, 15.6% secondary schools, 3.3% high school, 3.3% universities and 3.3% postgraduate level. While 86.4% of the owners are involved in agricultural activities in addition to dairy cattle, 13.6% are only involved in dairy cattle. Of 51 enterprises, engaged in agricultural production, 74.5% grow silage corn, 56.8% barley, 11.8% vetch and 19.6% alfalfa. Holstein Hybrid is grown intentionally in the region with 86.4%, while Simmental is preferred with 11.9% and Montofon with 1.7%. It was determined that 52.5% of the enterprises consisted of closed and 47.5% of semi-open barns, 98% of which were concrete and 1.7% were soil. 42.4% of barns have a ventilation pipe, while 57.6% do not. 84.7% of the enterprises have separate sections for calves and 52.5% have separate sections for cows, will give birth. Average daily milk yield quantity is detected as 18.6 kg in the region. 62.7% of the enterprises use mobile machines, while 37.3% of the them use milking system to milking process.

1. Introductıon

The Agricultural sector has increased its importance in improvement and industrialization process of developed and developing countries day by day. Even for developed countries, that are more focused on the industry and services., agriculture is still very important in economic and social terms (Demir and Sancar., 2012). The agricultural sector plays a very important role in the economy of the country, it does not only supply the population with food but also contributes with raw material for industrial sector, creates demand for industrial product, helps the national income as well as foreign currency for the country in terms of exportation (Tunç., 2018).

Agricultural Production is the activity of producing, storing and processing animal goods and vegetables under proper circumstances as well as the marketing and permanent improvement of those mentioned before. (Doğan et al. 2015; Güzel 2016).

Husbandry sector supports important economical activities like supplying raw materials for several production lines, added value, increasing the income of the logistic sector and retailing, helping rural development, besides its contributions to the nutrition of the nationals. (Anonymous 2019).

About 90% of the production in the dairy sector, which is one of the most important components of the food sector, is obtained from milk cows, in Turkey, as is the case with worldwide. (Akman et al., 2010, Güzel 2016).

Dairy cattle production is an important branch of the livestock sector in our country and contributes to development of the country in various ways. Considering the producers, a big part of the population, which living in rural areas, in Turkey is to live off dairy cattle. Dairy cattle farming is managed as both in large-scale commercial enterprises and in several dairy cows as family businesses, especially in areas close to the provinces, that with large populations. Livestock activities require intensive labor force because of that, the large

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* This study is summarized from Hilmi TUTAR's Master's thesis.

scale enterprises make significant contributions to employment in their provinces. Family businesses, which are more then other enterprises in number, contribute to the on site development of agrarian populations in every region. (Boz, 2013).

A healthy database is needed for forward-looking rational policies in the livestock sector. (Cenan, Gürcan 2011). In Turkey, there are many studies, aimed at determining the structural status of cattle raising enterprises in different provinces. Repetition of theses type of studies more commonly and at regular, is important in order to update the data in the sector, determine the current situation, keep track of changes over the years and determine the problems of the sector and produce solutions for these problems and finally to make rational planning for the future (Şeker et al., 2012; Güzel, 2016).

Some of the problems of the sector affect the entire sector on the country basis and others may differ from region to area or province. Therefore, working on the local level and searching the issue in depth are important, in order to develop consistent solution proposals. (Boz, 2013).

In this study, it is aimed to that, determine and evaluate the some structural and mechanization potential characteristics of dairy cattle farms in Karacabey District of Bursa province and to shed light on the regional policies to be implemented.

2. Material And Method

2.1. Material

The main material of this study, which examined some structural characteristics and mechanization potential of dairy cattle breeding enterprises in Karacabey district of Bursa province, where dairy cattle farms are concentrated, is the data obtained from one-to-one questionnaires conducted with owners or authorized persons in January-March 2019 period.

2.2. Method

2.2.1. Detecting the enterprises will be searched on and preparing survey form

Stratified random sampling method was used in the selection of the enterprises to be surveyed and the sample volume was calculated according to the following formula (Yamane, 2001).

$$n = \frac{N.\Sigma_h S^2_h}{N^2 D^2 + N_h S^2_h}$$

In formula;

n: Sample volume,

N: Enterprise quantity in population

Nh: Enterprise quantity in "h" stratify

Sh2: Variance of "h" stratify

D2: Permissible fault amount from population average (D2 = (e/t)2),

e: Permissible fault lot from population average,

t: The value is,on distribution table, detected according to fault rate.

The number of sample farms, to be surveyed, was determined, by stratified random sampling method and considering the number of dairy cows in the farms, as 59 pcs with 1% error margin and 99% confidence limit.

The enterprises that make up the population are divided into 4 layers (1-3, 4-11, 12-35, 36+ of the 4 size group) by taking into consideration the distribution of cows. The enterprises in the sample were distributed to the layers by using modulating distribution method nh = (Nh / N) n. By this way, the surveys were conducted with the enterprises from the first layer 4pcs., the second layer 17 pcs., the third layer 18 pcs., the fourth layer 20 pcs., so the enterprises to be sampled, determined randomly from each layer. Besides, substitute enterprises were determined, as 10% of the sample volume, in cases that the responsibles of sample enterprises, can't be found at places (Güzel and Aybek 2017).

You can see at following table, the number of enterprises and the number of milking animals, for each group, in the enterprises, that divided into four layers

Table 1
Enterprise and Animal Quantity in Groups

Enterprises Groups	Animal Qty.	Enterprises Qty
1. Group	1-3	4
2. Group	4-11	17
3. Group	12-35	18
4. Group	36+	20
Total		59

In 59 questionnaires, conducted in Karacabey district, comprises the information about the characteristics of proprietor and employees (experience, education, training, etc.), general and structural characteristics of enterprises (land size, area of activity, animal species and numbers, animal milk yields, Shelter type and characteristics, time consumption of daily work on animals, forage crops grown and fed in the Enterprise, etc.), mechanization characteristics of the enterprises (machine type, number and characteristics, etc.), provision of machinery conditions and their expectations. The questionnaire consists of closed and open-ended questions.

3. Results and Discussion

The work experiences of the operators, in 59 dairy cattle enterprises, that are the subject of our research are divided according to the groups determined by the number of animals, in Table 2. Among the farms with 1-3 animal, the average period of husbandry is 42.5 years according to groups of operators experience as to this study. This value has been determined respectively as 26.5, 27.7 and 25.5 years for enterprises with 4-11,

12-35 and lastly 36 + animals. In general, average of the experience of 59 business owners was calculated as 27.5 years (Table 2). Özyürek et al., (2014), The study, conducted in the District of Erzincan province, reported that the average time of the experience of operators in cattle farming is 22 years.

Table 2
Experience of Enterprise Owners

Experience of Enterprise Owners	Enterprise Groups			
	1-3 animal	4-11 animal	12-35 animal	36+ animal
Cattle Breeding Duration (Average year)	42.5	26.5	27.7	25.5

The education level of producers in Karacabey district is given in Table 3. When the educational level of business owners is examined in, it is observed that there are no uneducated business owners. When the education level of the operators is examined, emergent results are follows; in 1-3 groups; 3 of them primary schools graduate (75%), 1 of them secondary school graduate (25%), in 4-11 group; 17 of them primary schools graduate (100%), in 12-35 group; 11 of them primary school graduate (61.1%), 5 of them secondary school graduate (27.7%), 2 of them high school graduate(11.2%), among 36+ groups; 13 of them primary school graduate(65%), 3 of them secondary school graduate (15%), 2 of them university graduate (10%) and 2 of them postgraduate (10%) . As to the general average, 74.5% of enterprise owners elementary school graduate, 15.6% of them secondary school graduate, 3.3% of them high school graduate, 3.3% of them university graduate, and 3.3% of them postgraduate. (Table 3). (Gençoğlan, 2017), According to the study, conducted in Kahramanmaraş province, enterprise owners educational levels are follows; 46.4% of them primary school graduate, 21.5% of them high school graduate and 32.1% of them university graduate. (Avsever, 2016), Moreover the study, conducted in Ereğli District of Konya province, determined that; 74.83% of enterprise owners graduated from primary and secondary school.

Table 3
Education Level of Enterprises Owner

Groups	Education Level Of Operator					
	Primary school	Secondary	High School	University	Postgradu-	Total
1-3 animal	3 (75%)	1 (25%)	-	-	-	4
4-11 animal	17 (100%)	-	-	-	-	17
12-35 animal	11 (61.1%)	5 (27.7%)	2 (11.2%)	-	-	18
36+ animal	13 (65%)	3 (15%)	-	2 (10%)	2 (10%)	20
General	44 (74.5%)	9 (15.6%)	2 (3.3%)	2 (3.3%)	2 (3.3%)	59
χ^2=19.206; SD=12; p=0.084						

Table 4 shows the land sizes of the enterprise groups. Considering the land sizes; among the groups with 1-3,4-11,12-35,36 + animals, total dry land sizes are 78, 291, 455, 799 respectively. And total sizes of irrigated land are 74, 464, 1701, 4223 respectively. (Güzel, and Aybek, 2017) In the study, done in Kahramanmaras province; determined average land sizes are, irrigated ones 8.2 hectares, dry ones 7.3 hectares and this research detected that, minimum irrigated land size is 1 hectare, maximum 100 hectares, and minimum dry land size is 1 hectare, maximum 30 hectares.

Table 4
Land Sizes at Enterprises

Sizes of Land Belong to Enter-	Enterprise Groups				
	1-3 animal	4-11 animal	12-35 animal	36+ animal	Total
Dry Land (da)	78 (51.3%)	291 (38%)	455 (21.1%)	799 (15.9%)	1623 (20%)
Irrigated Land (da)	74 (49.7%)	464 (62%)	1701 (78.9%)	4223 (84.1%)	6462 (80%)
Total (da)	152 (100%)	755 (100%)	2156 (100%)	5022 (100%)	8085 (100%)
χ^2=131.840; SD=102; p=0.025					

86.4% of dairy cattle farms are active in agriculture additively, while 13.6% are only engaged in dairy cattle. (Table 5). As to the results of (Özyürek et al., 2014), found in Çayırlı District of Erzincan province; 26.3% of the operators are only active in dairy cattle farming, while 62.6% of the rest also engaged in other branches of agriculture.

Table 5
Enterprises that are engaged in Other Activities

Other activity area of enterprise	Enterprise Groups				
	1-3 animal	4-11 animal	12-35 animal	36+ animal	Total
Available	4 (100%)	15 (88.2%)	17 (94.4%)	15 (75%)	51 (86.4%)
Not	0	2 (11.8%)	1 (5.6%)	5 (25%)	8 (13.6%)

The distribution of 51 enterprises, that are interested in other branches of agriculture, with dairy cattle breeding, and their products are given in Table 6. As it can be seen from the table, corn (74.5%) is produced by 38 enterprises. The group, which has the most corn production (88.8%), is the 12-35 group, with 16 quantity. Barley is produced by 29 of the enterprises (56.8%). The highest barley production (66.6%) is realized in 12 enterprises, which are at 12-35 group. 11.8% of enterprises in total, produce vetch. In each 1-3,4-11,36 +groups, 2 producer grows vetch. Vetch is not produced in 12-35 group. There are no rye producers among the enterprises. Clover production is realized by 10 of the enterprises (19.6%). The highest clover production (23.5%) was detected at 4-11 group (Table 6)

Table 6
Products, are grown at Enterprises

Agricultural Products	Enterprise Groups				Total
	1-3 animal	4-11 animal	12-35 animal	36+ animal	
Maize	4 (100%)	8 (47%)	16 (88.8%)	10 (50%)	38 (74.5%)
Barley	4 (100%)	6 (35.2%)	12 (66.6%)	7 (35%)	29 (56.8%)
Vetch	2 (50%)	2 (11.7%)	-	2 (10%)	6 (11.8%)
Clover	3 (75%)	4 (23.5%)	1 (5.5%)	2 (10%)	10 (19.6%)

The data of the dairy cows, which are the basis for the formation of the research groups and farm numbers, are evaluated as follows. The total quantity of dairy cows, in 1-3 group, is 8. In this group, dairy cow quantities are as follows; Holstein and Holstein hybrid is (50%) 4 and (50%) Simmental and Simmental Hybrid is also 4. In 4-11 group, dairy cow quantities are; Holstein and Holstein hybrid is 111 (85.38%), Simmental and Simmental hybrid is 10 (7.69%), Montofon is 9 (6.93%). The breed distribution of 12-35 Group, which has 396 cows in total, is, Holstein and Holstein hybrid is 361 (91.16%) Simmental and Simmental hybrids is 35 (8.84%). Lastly, in 36+ group, the total quantity is detected as 1111, and distribution of them is; 891 (80.20%) Holstein and Holstein hybrid, (19.80%) 220 Simmental and Simmental hybrid

Among the four different enterprise groups, the Holstein and its hybrid are the most common breed and covering 86.4% of the total number. The Simmental and its hybrid are the most common breed after the Holstein and its hybrid, with 11.9% rate. Among enterprises, the least common dairy cow breed is the Montofon, with 1.7% rate. The study conducted by (Öztürk, 2009) in Mardin province, reported that among the current breeds Holstein (44.3%) was the most common breed and second one is Simmental (20.13%), on the other side the ranges of domestic breed and the brunet breed are (38.58%), (4.97%) respectively. This situation is in parallel with the results obtained. On the other hand (Özyürek et al., 2014) presented that, in the Erzincan region with 45.4% rate Brown and with 47.8% rate Yellow breed are dominant culture breed, while Black Holstein breed preferred less.

Table7
Animal Specifications

Animal Specifications			Enterprise Groups			
			1-3 animal	4-11 animal	12-35 animal	36+ animal
Cow	Quantity		8	130	396	1111
	Race (%)	Holstein and Hybrid	75%	85.3%	91.1%	80.2%
		Simmental and Hybrid	25%	7.8%	8.9%	19.8%
		Montofon	-	6.9%	-	-

The barn types, used in the 59 enterprises, were found to that, among 1-3 group all of them are closed (100%), in 4-11 group (5.9%) one of them is half-open, (94.1%) 16pcs are closed, in 12-35 group, (44.4%) 8 pcs are half-open, (55.6%) 10 pcs are closed, and in 36+ group (95%) 19 barns are half-open, and 1(5%) of them is closed (Table 8). When the farm groups are examined, an increasing in semi-open system among the group, which the animal quantity is at rise and using semi-open system in 36+ groups commonly indicate that modern barn types become common as the farms grow.

According to this; the study conducted in Kars by (Tilki et al., 2013), 79.1% of enterprises, the study conducted, in Kayseri by (Uğurlu, and Şahin, 2010), 75.0% of enterprises, the study is conducted in Ağrı, by (Bakan, 2014) 97.2% of them are from closed; in case the study conducted by (Yener et al., 2013) shows that, in South East Anatolia Region, 17.5% of barns are closed and 8.5% of barns are semi-open.

Table 8
Barn Types

Barn Types	Enterprise Groups			
	1-3 animal	4-11 animal	12-35 animal	36+ animal
Closed System	100%	94.1%	55.6%	5%
Semi-open Sytems	-	5.9%	44.4%	95%
χ^2=33.592; SD=3; p=0.000				

The floor material used in the barns are detected that; is in 1-3 group; (75%) 3 barns are concrete, (25%) 1 barn is soil, in 4-11 group; 17 barns (100%) are concrete, in 12-35groupp, 18 barns (100%) are concrete and in 36+ groups 20 barsn are (100%) concrete.

As the size of the barns increasing, the use of concrete as a base material becomes inevitable This can be interpreted as a necessity considering requirements such as cleaning, animal control and animal traffic. Table 9 shows the base material information of the enterprise groups.

(Mundan et al., 2018), in their study conducted in Şanlıurfa province, it was reported that 85.2% of operators preferred concrete structure and 14.8% preferred compressed soil as shelter ground in dairy cattle enterprises. On the other hand, (Şeker et al., 2012) determined that breeders generally used concrete (59%), then Stone (20.5%), soil (16.4%) and wood (4.1%) for base of the barn.

Table 9
Barn Floor Material

Barn Floor Material	Enterprise Groups			
	1-3 animal	4-11 animal	12-35 animal	36+ animal
Concrete	75%	100%	100%	100%
Soil	25%	-	-	-
χ 2 = 33.592; SD=3; p=0.576				

Barn size averages, which differ by business groups, have been discussed. In the light of the data, among the enterprise groups, the highest average barn size is 936 m2 in 36+ group. When looking at the groups; 12- 35 group values, the average barn size is 356 m2, in 4-11 group the it is 104 m2, and among 1-3 group it is 42 m2. (Table 9).

In Table 10, the status of the barns ventilation chimneys, which were important in the enterprises, were given. The situations of chimney, according to groups as follow; in 1-3 group, 2 (50%) enterprises have, two of them (50%) do not, in 4-11group, 8 enterprises have (47.1%) ,9 of the (52.9%) do not, in 12-35 group; 10 enterprises (55.6%) have and 8 of them (44.4%) do not and in 36+ group 5 (25%) enterprises have and 15 of them (75%) do not. In addition, when we looked at enterprises in general, 42.4% of the enterprises have ventilation chimneys and 57.6% of them do not.

(Özyürek et al. 2014), the study examined in the region, 86.3% of the barns have ventilation chimneys, 13.7% of them do not have. Also in the study conducted by (Öztürk, 2009) in Mardin province 5.17% of of existing barns have ventilation chimneys, while 44.83% of them do not.

Table 10
Barn Size and Ventilation

Changeable Factors		Enterprise Groups			
		1-3 animal	4-11 animal	12-35 animal	36+ animal
Barn Size (m²)		42	104	356	936
Barn Ventilation Pipe	Available	50%	47.1%	55.6%	25%
	Not	50%	52.9%	44.4%	75%
χ^2=138.738; SD=135; p=0.395					

Calf partitions form in enterprises, are seen as; in 1-3 group 2 (50%) of them has separate partition at same barn,1 of them (25%) has no separate partition and 1 of them (25%) separate partition at different barns. 4-11 group has the most diversity in this subject. Accordingly, calves are raised, in separate partitions in the same barn at 8 enterprises (47.1%), at 6 enterprises (35.3%), at same barn with mother, at 1 enterprise (5.9%) at individual calf cage and at 2 enterprises (11.8%) in separate partition at different barns. In 12-35 group, calves are grown in separate partition in the same barn in 7 of the businesses (38.9%), in 5 of them (27.8%) individual calf cage is used and in 6 enterprises (33.3%) use separate partition at different barns. In 36 +group, calves are grown in separate partition in the same barn in 5 of the enterprises (25%), in individual calf cages in 10 enterprises (55%), and in separate partitions in different barns in 3 enterprises (20%). The rate of usage separate partitions for calves, among businesses, is 84.7% (Table 11).

Özyürek et al., (2014) in their study, 59% of businesses found calves to be free in a separate partitions, while 41% said they grown them in a separate partitions, (Öztürk, 2009) and in the study, 93.9% of the businesses observed that calf partitions were located in the barn.

Table 11
Calf Partition Forms

Calf Partition Forms	Enterprise Groups			
	1-3 animal	4-11 animal	12-35 animal	36+ animal
Separate Partition at the same barn	50%	47.1%	38.9%	25%
At the same barn with mother	25%	35.3%	-	-
Individual Calf Cage	-	5.9%	27.8%	55%
Separate Partitions at different	25%	11.7%	33.3%	20%
$\chi 2$=25.318; SD=9; p=0.003				

In 4 enterprises of 1-3 group (100%), cows that give birth have no separate places. Among 4-11 group; 5 enterprises (29.4%) have separate places for cows to give birth, in 12 businesses, it is not available. In 12-35 group, 10 enterprises (55.6%) have separate places for the cow for birth, 8 enterprises (44.4%) do not. The group with the highest number of separate places for cows to give birth, is the 36+ Group. Accordingly, 16 enterprises (80%) have separate places while 4 enterprises (20%) do not (Table 12). In general, it is determined that, 52.5% of enterprises have separate places for cows to give birth. Here under, as the size of enterprises increases, it is observed that there are more individual places needed for animals. In similar studies have been conducted by; (Öztürk, 2009) and (Özyürek et al., 2014) it is detected that, respectively 45.5% and 6.6% of enterprises have separate places for cows to give birth. When studies examined it is seen that, similar results were found with (Öztürk, 2009), while results is seen to be different with (Özyürek et al., 2014).

Table 12
Separate Place for Birth

Separate Place for Birth	Enterprise Groups			
	1-3 animal	4-11 animal	12-35 animal	36+ animal
Available	-	29.4%	55.6%	80%
Not	100%	70.6%	44.4%	20%
$\chi 2$=14.189; SD=3; p=0.003				

In Table 13, the average milk yields of 59 business groups that are the subject of research, are observed. As can be seen from the examination of the table, average milk yields were determined as 16.2 kg in 1-3 group, 17.3 kg in 4-11 group, 18.8 kg in 12-35 group and 20.1 kg in 36+ group. In general, the results were found to be 18.1 kg day-1.

Şeker et al., (2012), reported that, the proportion of whom reported getting an average of 15 kg and more milk per day in the study was 3.2% and 78.4% of business reported having an average daily milk yield of 7 kg and less.

Elmaz et al., (2010), in the study of, Burdur province dairy cattle production and its characteristics, they reported that the average of the milk yield is 18.7

Table 13
Milk Yield

Milk Yield	Enterprises Groups			
	1-3	4-11	12-35	36+
Average Milk Yield (kg day-1)	16.2	17.3	18.8	20.1

Milking in enterprises in the region,1-3 group (100%) with milking machine in the 3 businesses,4-11 group (88.2%)with Mobile machine in 15 businesses, (11.8%) 2 milking systems in 12-35 group(77.8%),14 Mobile machine(22.2%), 4 milking systems and finally; in 36+ group(20%) 4 enterprises mobile machine (80%), 16 operation milking systems was found be carried out.Looking at the overall to 59 businesses(62.7%),the part of 37 , the milking process with Mobile machine(37.3%),and the part of 22 was found to be carried out bu milking systems.(Table 14). In addition, it was found out that; the enterprises, which have big quantity animals, (36+ heads) (80%) preferred milking systems.

Akar, (2015) stated in the study conducted in Muş plain that; 75% of the 73 farms have milking machines and 10 of these milking machines; are pipeline milking systems and 47 of them are mobile machines. (Öztürk, 2009), In the study carried out in Mardin province, 95.24% of the operators milked by hand and 4.76% by machine. (Demir, Sancar, 2012), Gümüşhane province Kelkit, Köse and Şiran districts of 37.3% of businesses by hand, 62.7% of mobile machine milking highlights. (Akbaş, et al., 2015), The results he encountered in his work in 39 provinces were that 93% of the visited businesses milked in the milking room while 7% milked in the barn.

When the types of milking systems used in the enterprises that are the subject research are evaluated; in 4-11 group enterprises 2 pipeline milking system (11.8%), in 12-35 group 1 herringbone milking system (5.6%), 3 pipeline milking system (16.6%) and in 36+ group; 7 herringbone milking system (35%), 9 pipeline milking system (45%) is used (Table 15).

Gençoğlan, (2017), in the study carried out in Kahramanmaraş province, 65.5% of the enterprises have a milking parlor, while 17.2% of the enterprises have a parallel milking system, 48.3% used a herringbone milking system.

Table 14
Enterprises Milking Types

Milking Type	Enterprise Groups				Total
	1-3 animal	4-11 animal	12-35 animal	36+ animal	
By Mobile Machine	4 (100%)	15 (88.2%)	14 (77.8%)	4 (20%)	37 (62.7%)
By Milking System	-	2 (11.8%)	4 (22.2%)	16 (80%)	22 (37.3%)
$\chi 2$=24.464; SD=3; p=0.000					

Table 15
Milking Systems Types at Enterprises

Milking System Types	Enterprise Groups				Total
	1-3 animal	4-11 animal	12-35 animal	36+ animal	
Herringbone Milking System	-	-	1(5.60%)	7 (35%)	8 (36.3%)
Pipeline Milking System	-	2 (11.8%)	3 (16.6%)	9 (45%)	14 (63.7%)
General	-	2 (9.3%)	4 (18.3%)	16 (72.3%)	22 (100%)

4. Conclusion and Recommendations

It has been found that the work experience of the breeders in the enterprises decreases as the number of animals increases and this shows that the new generations started animal husbandry in high numbers. In parallel with this, it is determined that the education level is high in the enterprises with high number of animals. Regular training can be provided for small enterprises (1-3 heads, 4-11 heads) in order to benefit from this.

The big part of dairy cattle enterprises are involved in other agricultural activities with dairy cattle. Enterprises in different area of business will be beneficial to the business economy and will respond to various needs. To increase such activities and to encourage business owners, various facilities such as low-interest credit can be provided.

Among the enterprises engaged in agricultural activities, mainly forage corn is grown although barley, alfalfa, vetch.

According to the research data, the average land size of enterprises, with large numbers of animals, was seen to be greater than. This can be related to the economy and the need for forage crops in the farm compared to the number of animals.

According to the results of the study in Karacabey region, the dominant race, density was determined as Holstein, Simmental and Montofon respectively.

The barn types in the area are two varieties, closed and semi-open. Among these, it is seen that closed barns stand out and open barns are in enterprises with more animals. Barn type selection is very important for both

animal welfare and business owner workload. According to this, modern projects can be developed for business owners to minimize animal welfare and keep animal welfare at the highest level and business owners can be informed and encouraged in this regard.

Generally used in barns, the floor material is concrete. Concrete is preferred in livestock farms due to its strength and ease of cleaning.

Barn sizes vary from 42 m² to 936 m². Considering the cow and calf factors that will give birth in most 1-3 enterprises group, it is thought to be insufficient. Ventilation in enterprises is not sufficient. Generally, ventilation is provided by using fan or ridge suitable for barn structure, in large scale enterprises.

A separate place for cows to give birth is never found in small businesses, it is has seen in half of medium-sized businesses and close to all large-sized businesses. Calves have special importance in business economics. Based on this, hygiene and optimum conditions should be ensured for healthy calves and space must be reserved for cows to give birth in the farms.

Milk averages, which are the main source of income in enterprises, were seen as 16.25 kg day-1 in small enterprises and 20.1 kg day-1 in large enterprises. Considering this in detail, it can be based on the differences between enterprises. They are; care, hygiene, animal welfare etc.

Statistically significance was determined between enterprise size and land size, barn type, calf partitions, delivery room status, milking system type.

The main aim of dairy cattle production enterprises is to obtain high quality, healthy, hygienic and high yield milk, but the study shows that many enterprises have deficiencies in this regard. In the scope of the study, no milking enterprises, which milk by hand were found, while many of the enterprises use mobile milking machines. It is seen that mobile machines are more primitive and simple than milking systems and milking systems are more developed in terms of hygiene.

In the light of the data obtained, we consider that the study will be beneficial for the sector-related planning in the district.

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Seed Vigor Changes of Forage Pea Cultivars Based on Seed Color

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ABSTRACT

This study aimed to determine whether there were the differences for germination performance and seed vigor among the seed colors (Brown, green and army green) in forage pea cultivars (Özkaynak, Töre and Taşkent) after harvest. Second day germination percentage, final germination percentage (FGP), mean germination time (MGT), shoot length (SL), root length (RL), seedling fresh (SFW) and dry weight (SDW) were measured. The seed vigor tests, electrical conductivity (EC) and accelerated ageing (AA) conducted at 42°C for 48 h were used for distinguishing the vigor of seed colors in forage pea cultivars. The results showed that the final germination percentage was not significantly changed with seed color and cultivar while 2nd day germination was recorded in cv. Töre and army green seeds. Army green colored seeds germinated faster than brown ones. Among three genotypes, cv. Töre had the highest final germination percentage, shoot length, seedling fresh and dry weights, and the earlier time to germination. There were significant differences among seed colors and army green and green seeds produced more vigorous seedling than brown seeds. The EC and AA tests confirmed that vigorous germination and seedling growth were obtained from green colored seeds in forage pea. Lower EC values and higher germination performance in AA test were recorded in army green and green seeds. It was concluded that the forage pea seeds after harvest should be sorted for seed color and removing of brown seeds may be beneficial for improving seeds quality for their high seed vigor and seedling growth ability.

1. Introduction

Forage pea (*Pisum sativum* subsp. *arvense* (L.), an annual forage legume adapting in the cool season, is used for hay and seed production in feeding ruminants. It might be also cultivated as green manuring to enhance soil fertility. It is a high-quality feed source for livestock as roughage and intensive feeding. The nutritional value of forage pea as roughage and seed is about 18-20% and 20-30% crude protein, respectively (Mishra et al. 2010; Tan et al. 2012; Açıkgöz 2001). Because it fixes nitrogen into the soil between 5-15 kg/da and leaves a clean stubble for subsequent crops, it has a high potential in winter sowing in irrigated and fallow land in the central region of Turkey (Parr et al. 2011; Uzun et al. 2012). Therefore, forage pea sown area (104 377 da) and green production (210 706 tonnes) in Turkey has increased by 3 times in the last 5 years (TUİK 2018).

Variations in seed coat color in forage pea are associated with seed harvest in different development stages of fruit and some genetic differences (Atış et al. 2011). The seed coat color might be different in the same varieties due to different ripening period of pods. In some research, it was reported that different seed coat colors affect water imbibition and seed quality characteristics in various legumes. Dark colored seeds in *Pisum sativum* L. (Atak et al. 2008) and in *Lotus* sp. (Bhatt et al. 2016) indicated that superior seed quality characteristics were observed in dark colored seeds than light ones. In contrary of these findings, light colored seeds had higher germination rate and lower EC values in *Vigna subterranea* L (Mandizvo and Odindo 2019) and in *Cicer arietinum* L. (Anuradha et al. 2009. Also, green colored seeds gave better seed vigor and quality than dark ones (Ertekin and Kırdar 2010; Atış et al. 2011).

Despite the high rate of different seed coat colors in forage pea varieties, no previous studies have been conducted on seed vigor and quality. The aim of this study was to investigate the effect of three seed colors (brown, green and army green) on germination and seed vigor characteristics of three forage pea varieties with purple flowers (Taşkent, Özkaynak and Töre).

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2. Materials and Methods

Forage pea genotypes of Özkaynak, Töre and Taşkent purchased from local seed suppliers were produced at the experimental fields of Eskişehir Osmangazi University, Turkey in 2018. Until the start of the experiment, the seeds were stored at 4°C. The three seed colors were visually screened and separated by previously reported as brown, green and army green by Santos et al. (2019) as shown in Figure 1.

Germination test were performed by four replicates of 50 seeds from each cultivar and seed color. The seeds were germinated in three rolled filter papers with 7 mL of distilled water. To avoid water evaporation, the rolled papers were put into a sealed plastic bag and transferred to incubator arranged at 20 ± 1°C in the dark. A two millimeter of root protrusion was considered as germination criterion. The germinated seeds were daily counted and 2nd day germination expresses two days after the start of germination test. Fnal germination percentage (FGP) was recorded at 8th day of germination (ISTA 2003). The germination speed was evaluated by using mean germination time described by follows: $MGT = \Sigma Dn / \Sigma n$

Where D is the number of newly germinated seeds on each day and n is days of counting.

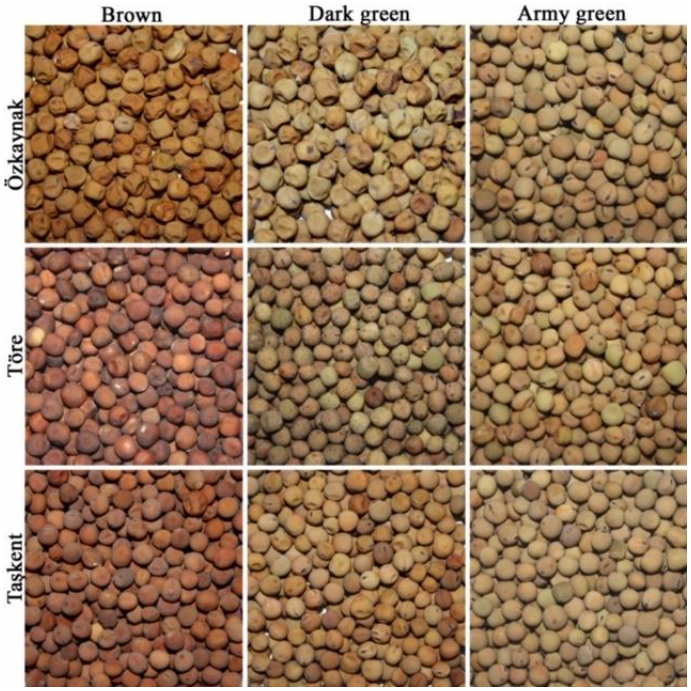

Figure 1
Seed coat colors of forage pea cultivars after visual separation.

Root length (RL), shoot length (SL), seedling fresh weight (SFW) and dry weight (SDW) were measured on the 10th day.

Seed vigor of the seed color of forage pea was determined by two vigor tests. First, the electrical conductivity (EC) test was conducted with two replicates of 50 seeds from each cultivar and seed color. The seeds were firstly weighed and then soaked in 250 mL deionized water at 20°C for 24 h. The EC of soaked water was measured using a conductivity meter (Model WTW Cond 314i, Germany) and the results were expressed in $\mu S\ cm^{-1}\ g^{-1}$ to evaluate the variability in seed weight (ISTA 2003). Second vigor test was accelerated ageing (AA) conducted with four replicates of 50 g seeds. It was performed by using an ageing temperature and time combination of 42°C for 48 h in a dark growth chamber (Atak et al. 2008). After incubation, 4×50 seeds were germinated between filter papers at 20°C in dark growth chamber for 10 days as described in germination test.

The experiment was designed as two factors factorial arranged in completely randomized design with four replications. The first factor was genotypes and the second was seed colors. Data for germination percentage were subjected to arcsine transformation before statistical analysis. Analysis of variance was performed using the MSTAT-C program (Michigan State University, v. 2.10). Significant differences among the mean values were compared by Duncan's Multiple Range test ($p< 0.05$).

3. Results and Discussion

The main effects of forage pea cultivars, seed colors and analysis of variance with their significance levels for all the germination and seedling characteristics were described through Table 1. Among the forage pea cultivars, cv.Töre had the highest 2nd day germination, final germination percentage, SL, SFW while it had the shortest MGT. There were significant differences among seed colors and the lighter colors (green and army green) resulted in the higher SL, RL, SFW and SDW.

Table 1
Germination and seedling characteristics of three seed colors of three forage pea cultivars

Factor	2nd day GP (%)	FGP (%)	MGT (day)	SL (cm)	RL (cm)	SFW (mg/plant)	SDW (mg/plant)	Electrical conductivity (μS cm^{-1} g^{-1})
Cultivar								
Özkaynak	43.0^{b}	96.6^{ab}	2.61^{a}	5.19^{b}	7.03	203^{b†}	19.4	18.0
Töre	67.8^{a}	98.6^{a}	2.32^{b}	7.01^{a}	7.46	243^{a}	20.1	19.3
Taşkent	47.3^{b}	94.3^{b}	2.61^{a}	5.06^{b}	8.00	199^{b}	18.8	18.8
Seed color								
Brown	51.6^{ab}	96.5	2.51^{ab}	5.01^{b}	6.77^{b}	181^{b}	17.9^{b}	25.3^{a}
Green	48.3^{b}	96.3	2.57^{a}	6.04^{a}	8.04^{a}	232^{a}	20.1^{a}	15.0^{b}
Army green	58.1^{a}	96.8	2.45^{b}	6.20^{a}	7.68^{a}	232^{a}	20.2^{a}	15.7^{b}
Analysis of variance								
Cultivar (C)	**	**	**	**	ns	**	ns	ns
Seed color (SC)	*	ns	*	**	**	**	**	**
C × SC	**	ns	**	**	**	ns	ns	ns

*, **: significant at 5% and 1%, respectively. GP: germination percentage, FGP: final germination percentage, MGT: mean germination time, SL: shoot length, RL: root length, SFW: seedling fresh weight, SDW: seedling dry weight

No significant changes in FGP was observed while 2nd day germination was the highest in army green seeds (58.1%). The electrical conductivity values were not affected by genotypes but it was varied by seed colors. Green and army green colored seeds gave lower EC values than brown ones. Similar these findings, Mandizvo and Odindo (2019) and Atıs et al. (2011) reported that brown colored seeds indicated the lowest seed vigor and highest EC values than light ones in Bambara groundnut and red clover, respectively. However, Atak et al. (2005) stated that bleached pea seeds produced the minimum germination and the maximum EC value.

A two-way interaction (cultivar × seed color) was significant for 2nd day GP, MGT, SL and RL ($p<0.01$, Table 1). The army green seeds in Özkaynak and Taşkent gave the highest 2nd day GP while Töre possessed it in brown seeds (Table 2). But, no significant differences between seed colors were determined. Contrarily, previous researches demonstrated that seed colors clearly affected germination percentage in pea (Atak et al. 2005), in guar (Liu et al. 2007) and in red clover (Atıs et al. 2011).

Cv.Taşkent with army green seeds led to a decrease time to germination while the fastest germination was obtained from brown seeds of cv.Töre without significance between seed colors. Similar results were observed by Atak et al. (2005) who determined faster germination in dark green colored pea seeds. Shoot length was significantly changed by seed color and the forage pea cultivars. Green and army green seeds of the cultivars had the longest SL, except for cv.Taşkent with green seeds (Table 2). The highest root length (RL) was recorded in brown seeds of cv. Töre with 9.10 cm and it was gradually decreased when the seed colors were green. However, no significant changes in RL of cv.Taşkent were determined among seed colors and green seeds of cv.Özkaynak gave longer RL than the other colors.

Table 2
Germination and seedling properties as affected by the cultivars and seed colors

Seed color	Özkaynak	Töre	Taşkent
	Cultivar		
	2nd day germination percentage (%)		
Brown	33.5^{f}	73.5^{a}	48.0^{cd}*
Green	41.0^{de}	65.0^{b}	39.0^{ef}
Army green	54.5^{c}	65.0^{b}	55.0^{c}
	Mean germination time (day)		
Brown	2.74^{a}	2.26^{e}	2.55^{b}
Green	2.63^{ab}	2.34^{de}	2.76^{a}
Army green	2.47^{bcd}	2.36^{cde}	2.51^{bc}
	Shoot length (cm)		
Brown	3.82^{e}	6.13^{b}	5.09^{cd}
Green	6.09^{b}	7.23^{a}	4.81^{d}
Army green	5.66^{bc}	7.67^{a}	5.28^{cd}
	Root length (cm)		
Brown	5.96^{d}	9.10^{a}	7.81^{b}
Green	8.01^{b}	8.22^{ab}	7.77^{b}
Army green	6.35^{cd}	7.29^{bc}	7.45^{b}

*: Means followed by same letter(s) are not significant at 5%.

All the investigated parameters after AA test were significantly different (Table 3). Higher 2nd day germination and FGP were recorded in green and army green seeds. Cv.Töre indicated the superiority to the other cultivars in terms of the investigated parameters. Also, its seeds germinated faster than the others did. The seeds colored army green produced more vigorous seedling while mean germination time shortened in green and army green seeds. The study of Mandizvo and Odindo (2019) on structural and imbibitional characteristics of dark and light seed coat colors of *Vigna subterranea* L. landraces was confirmed by these findings. They reported that the light colored seed had the highest germination while the dark colored one had the lowest final germination after 120 hours of seed ageing.

Table 3
Germination and seedling properties as affected by the cultivars and seed colors after AA test

Factor	2nd day GP (%)	FGP (%)	MGT (day)	SL (cm)	RL (cm)	SFW (mg/plant)	SDW (mg/plant)
Cultivar							
Özkaynak	35.0^{b}	93.8^{b}	2.84^{a}	5.21^{b}	6.32	188^{b}	16.8^{b}
Töre	58.6^{a}	98.0^{a}	2.42^{b}	6.40^{a}	6.55	217^{a}	18.1^{a}
Taşkent	49.0^{a}	94.8^{b}	2.59^{b}	4.68^{c}	5.85	176^{b}	15.4^{c}
Seed color							
Brown	37.1^{b}	89.6^{b}	2.77^{a}	4.85^{c}	5.63^{c}	171^{b}	14.7^{c}
Green	51.3^{a}	98.3^{a}	2.51^{b}	5.35^{b}	6.30^{b}	199^{a}	17.0^{b}
Army green	54.1^{a}	98.6^{a}	2.57^{ab}	6.08^{a}	6.78^{a}	210^{a}	18.5^{a}
Analysis of variance							
Cultivar (C)	**	**	**	**	ns	*	*
Seed color (SC)	**	**	*	**	**	**	**
C × SC	**	ns	*	**	ns	**	ns

*, **: significant at 5% and 1%, respectively. GP: germination percentage, FGP: final germination percentage, MGT: mean germination time, SL: shoot length, RL: root length, SFW: seedling fresh weight, SDW: seedling dry weight.

The 2nd day GP after AA test was dissimilar to the germination test because army green seeds of cv. Töre gave the highest value of 74.0% (Table 4). Green colored seeds of Özkaynak and Taşkent germinated better than brown seeds. Also, time to germination retarded in brown seeds of forage pea cultivars and, green and army green seeds gave faster germination than brown seeds. The brown seeds had the lowest shoot length and seedling fresh weight and cv. Taşkent produce the lowest seedling growth.

Table 4
Germination and seedling properties by the cultivars and seed colors after AA test

	Cultivar		
Seed color	Özkaynak	Töre	Taşkent
2nd day germination percentage (%)			
Brown	14.0^{d}	51.5^{b}	46.0^{bc}*
Green	52.0^{b}	50.5^{b}	51.5^{b}
Army green	39.0^{c}	74.0^{a}	49.5^{bc}
Mean germination time (day)			
Brown	3.14^{a}	2.51^{cd}	2.64^{bc}
Green	2.50^{cd}	2.49^{cd}	2.55^{bcd}
Army green	2.88^{ab}	2.27^{d}	2.58^{bcd}
Shoot length (cm)			
Brown	4.34^{d}	6.08^{bc}	4.15^{d}
Green	5.57^{c}	6.37^{ab}	4.10^{d}
Army green	5.72^{c}	6.75^{a}	5.78^{c}
Seedling fresh weight (mg/plant)			
Brown	142^{d}	207^{ab}	165^{c}
Green	209^{ab}	229^{a}	158^{cd}
Army green	212^{ab}	214^{ab}	204^{b}

*: Means followed by same letter(s) are not significant at 5%.

EC values of forage pea cultivars were similar to each other while seed colors gave different EC values. The higher EC value was measured in brown seeds but green and army green seeds gave lower EC values (Figure 2). No significant differences between EC values of green and army green seeds were determined. Moreover, the results of AA test appeared in corroboration with EC test. Brown seeds after AA produced the lowest 2nd day GP, FGP, seedling growth and retarded germination time.

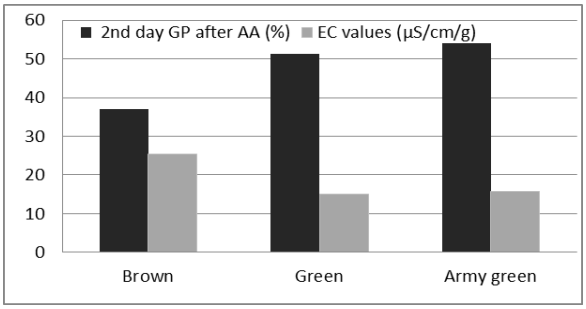

Figure 2
EC values and 2nd day germination percentage after AA test of brown, green and army green seeds of forage pea.

In conclusion, seed color is an indicator of seed vigor in forage pea cultivars and the darker seeds produced a delayed germination and restricted seedling growth. However, forage pea genotypes showed different responses to seed color and cv. Taşkent did not show the sensitivity to seed colors. It should be advised that the seed lots after harvest should be selected for seed color to attain vigorous seeds, better germination performance and seedling growth in forage pea cultivars.

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Research Article

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Maintenance of Physicochemical Qualities of Nectarine Fruits During Cold Storage Using Ultrasonic Treatment with Salicylic Acid

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ABSTRACT

This study was carried out to retain the high quality of nectarine cv. 'Venus' fruits during the cold storage. In the study, fruits were treated with ultrasonic and salicylic acid (1 and 2 mM) separately or in combination as well as water in control and then, they were stored at 0°C and 90±5% relative humidity for 60 days. Fruits were examined for weight loss, fruit firmness, soluble solids content, titratable acidity, ascorbic acid, total flavonoids, total phenolics, antioxidant content and chilling injury at 15 days intervals. The results showed that no significant differences were observed among control and ultrasonic alone treatments in the experiment. However, salicylic acid combined with ultrasonic treatment has more potential than salicylic acid alone in regulation of nectarine fruit ripening. Moreover, combination treatments, in comparison to the control, led to better preservation of firmness, ascorbic acid, total phenols, flavonoids and antioxidant contents, more weight loss control, alleviating the chilling injury symptoms. Synergistic effects between salicylic acid and ultrasonic treatment were observed and the most effective treatment for preserving the quality of nectarine fruits was the combination of 2 mM salicylic acid with ultrasonic treatment. These results demonstrated that the combined treatments of salicylic acid and ultrasonic could provide a useful means of extending nectarine postharvest life during cold storage.

1. Introduction

Peaches and nectarines are similar genetically and horticulturally, but for commercial purposes are regarded as two different fruits. The nectarine is essentially a fuzzless peach (Brown et al 1983). Nectarine is high functional fruits as a consequence of their bioactive compounds and deteriorate rapidity at ambient temperature. Therefore, cold storage of nectarines after harvest is necessary to minimize excessive softening, quality loss and decay and to prolong time for marketing (Celik et al 2006). Nectarines as climacteric stone fruits have a limited post-harvest life and they remain fresh only for 2-6 weeks stored at 0°C and 90-95% relative humidity depending on cultivar (Karen 1991).

After harvest, the nutritional and organoleptic quality of fresh produce start to decline as a result of altered plant metabolism. Quality deterioration of fruits is the result of produce transpiration, senescence, ripening associated processes and development of postharvest disorders (Kader 2001). However, the most important factor that limits the post-harvest life of nectarine is chilling injury (CI) or internal breakdown (Candır et al 2009). Fruits stored between 2.2°C and 7.6°C are more prone to chilling injury than those stored at 0°C or lower (Crisosto et al 1999). Therefore, it is very important to prevent the postharvest losses of nectarine fruit.

Salicylic acid (SA), the plant natural organic compounds which is found in a wide range of plant species, has been reported to play a vital role in regulating plant growth and development. Moreover, this compound have been proven to be photochemical inducing bioactive compounds such as antioxidants and antioxidant enzymes and have been use for maintaining postharvest quality of perishable commodities (Supapvanich&Promyou 2013).

SA induces hydrogen peroxide (H_2O_2) accumulation at high temperatures while reducing H_2O_2 at lower temperatures. During chilling stress, the activities of antioxidant enzymes are decreased, which leads H_2O_2, and other reactive oxygen species. SA is involved in chilling tolerance through H_2O_2 metabolism mediation. (Kang et al 2003). SA has also been reported to reduce spoilage in peach fruit by controlling cell membrane electrolyte leakage, decreasing respiration and ethylene production, maintaining flesh firmness, and increasing antioxidant enzymes activities (Han et al 2003). In recent years, exogenous application of SA has been reported to improve storage life and storage quality

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attributes in many fruit like peach (Tareen et al 2012; Awad 2013), plum (Sabır 2017), apricot (Ezzat et al 2017).

Increasing public demands for improved safety and quality of fruits and vegetables in the fresh market, awaken a growing interest for novel technologies for the preservation of postharvest fruits and vegetables before storage. Ultrasonic technology provides one of the methods that with better treating time, enhanced products quality, reduced chemical hazards, low consumption of energy, and is environmentally friendly (Yuting et al 2013). Ultrasonic is composed of mechanical sound waves that originate from molecular movements that oscillate in a propagation medium (Gallo et al 2018). Postharvest ultrasonic treatments (UT) have been shown to extend shelf life and maintain quality in strawberries (Aday&Caner 2014), litchis (Chen et al 2012), pears (Zhao et al 2007), and plums (Chen&Zhu 2011). In addition, there are various reports indicating that combination of ultrasonic and other chemicals effectively increased postharvest life of horticultural crops (Chen&Zhu 2011; Yang et al 2011, Bal 2013; Bal 2016; Bal et al 2017, Khademi et al 2019). However, there is no study on the combined effects of ultrasonic with SA treatment on quality controlling in postharvest nectarine fruit. Thus the purpose of this study was to investigate the ability of ultrasonic treatment with SA to maintain physicochemical qualities and alleviate CI of nectarine fruits during cold storage.

2. Materials and Methods

Nectarine (*Prunus persica* var. *nectarina*) cv. 'Venus' fruits were harvested manually at firm-ripe stage (firmness was about 75 N; SSC was about 12.7%) from a commercial orchard in Turkey and immediately transported to the postharvest physiology laboratory. Fruits were selected for similar size, uniform maturity and appearance and freedom from defects.

Treatments and Storage Conditions

Ultrasonic treatment was applied in sonicator bath with water (20°C) in the ultrasonic chamber. Fruits were treated with 32 kHz ultrasonic at powers of 60 $W*L^{-1}$ for 10 min in 10 L distilled water. A surfactant Tween 20® at 1 $g*L^{-1}$ was also added to enhance infiltration. SA concentrations of 1 mM and 2 mM were prepared by dissolving SA powder (Sigma Aldrich Co.) in hot distilled water. Fruits were divided into four groups. Treatments and abbreviations can be summarized as follows:

1. Control: Fruits was immersed in distilled water at 20°C for 10 min
2. Ultrasonic treatment (UT): Fruits was immersed (distilled water) in sonicator bath at 20°C for 10 min
3. SA1 treatment: Fruits was immersed in sonicator bath at 1 mM SA and 20°C for 10 min
4. SA2 treatment: Fruits was immersed in sonicator bath at 2 mM SA and 20°C for 10 min
5. Ultrasonic treatment with SA1: Fruits was immersed in sonicator bath at 1 mM SA and 20°C for 10 min
6. Ultrasonic treatment with SA2: Fruits was immersed in sonicator bath at 2 mM SA and 20°C for 10 min

After dipping treatments, fruit placed on craft paper were allowed to dry at room temperature for approximately 60 min. Dried nectarines were placed in plastic boxes and stored at 0°C and 90±5% relative humidity for 60 days. During storage, 10 fruit of each replicate were analyzed at 15 days intervals. Other group of 20 fruit was used for initial analyses.

Analysis of Quality Attributes

Weight loss of nectarines was expressed as the percentage of loss of weight with respect to the initial weight (%). Firmness was determined using a hand penetrometer with an 8 mm long measuring plunger and was expressed as Newton (N).

For the analysis of soluble solids content (SSC) and titratable acidity (TA) of each sample, tissue sap was squeezed out from fresh fruit materials with a press. In this juice, SSC were determined with a hand refractometer (%). TA content was determined by titrating method and calculating the result as grams of malic acid per 100 g fresh weight (%).

Ascorbic acid content of the samples was determined according to the recommended method of A.O.A.C. (2000) using 2,6-dichlorophenol indophenol and expressed as mg kg^{-1}.

The total flavonoid contents were measured by a colorimetric assay (Zhishen et al 1999) and the results were expressed as mg (rutin equivalent) 100 g^{-1}. Total phenolics of the nectarine extract were quantified spectrophotometrically using Folin-Ciocalteu reagent based on the method (Slinkard&Singleton 1977). Results were expressed as mg (gallic acid equivalent) 100 g^{-1}.

Total antioxidants was determined by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical-scavenging method as described by Brand-Williams et al (1995) and was expressed as μmol (trolox equivalent) g^{-1}.

For evaluation of CI, nectarine fruits were longitudinally cut into halves for the evaluation of the occurrence of CI according to the severity of exocarp browning and flesh translucency (Khan et al 2011). CI was estimated visually as the percentage of the affected area compared with the total surface area of each section on a scale where: 0 = no change; 1 = less than 10%; 2 = 10-25%; 3 = 25-50%; 4 = 50-75%; and 5 = more than 75%.

The experiment was set up according to the factorial randomized design with 3 replications (10 fruit per replication). Analysis of Variance was the means for analyzing the difference between means and while LSD test being applied for mean separation at $p< 0.05$. All the analyses were carried out through SPSS as statistical software. Data were expressed as the mean ± SE for all parameters.

3. Results and Discussion

Weight loss

Weight loss is a major factor reflecting the quality of fruit. Weight loss of nectarine fruit constantly increased during whole storage duration due especially to respiration and transpiration process, regardless of the treatments (Figure 1). Ultrasonic treatment alone did not affect weight loss of fruit. However, combined treatment with ultrasonic and SA showed significantly reduced loss of weight, than control. UT + SA1 and UT + SA2 treatments reduced weight loss of fruits. At the end of the storage, the highest weight loss was determined in ultrasonic treated fruits (6.9%) and control fruits (6.6%), while the lowest weight loss was determined in UT + SA2 treatment (5.2%) followed by UT + SA1 treatment (5.3%). The anti-senescent action and maintenance of cellular integrity by SA in the present study might be the reason in lowering weight loss of nectarine (Bal 2016; Ezzat et al 2017). These findings for SA were supported on different fruit crops (Srivastava&Dwivedi 2000; Zheng&Zhang, 2004). Moreover, salicylic acid as an electron donor produces free radicals which prevents normal respiration (Wolucka et al 2005) and can also decrease respiration rate and fruit weight loss by stoma closing (Zheng&Zhang, 2004).

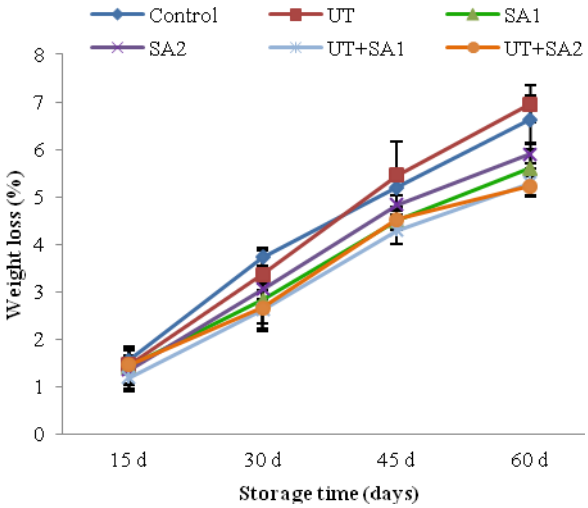

Figure 1
Effect of ultrasonic and salicylic acid treatments on weight loss of nectarine fruit during storage

SSC and TA

SSC and TA were assessed as indicators of the metabolic activity and ripening stage of the fruit. In the study, While TA decreased gradually during storage with no significant differences between the treatments, a significant increase in SSC was observed (Figure 2,3). A similar increase in SSC during storage of nectarine fruit has been previously reported (Ozdemir et al 2006; Bal 2018). Increases in SSC usually accompany with ripening of climacteric fruits. At the end of storage, the highest SSC value was determined in control fruits (15%), while the lowest SSC value was determined in UT + SA2 treatment (13.4%). Comparing with the control fruit, UT + SA2 treatment retarded SSC increase of nectarine fruit, effectively maintaining the initial quality. These results are in accordance with those obtained by Erbas et al (2015) and Sabır (2017) who showed that SSC increased slightly with SA treatments during storage.

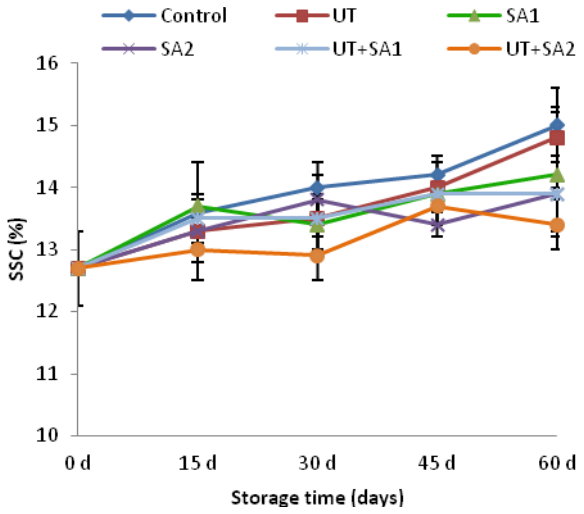

Figure 2
Effect of ultrasonic and salicylic acid treatments on SSC and TA of nectarine fruit during storage

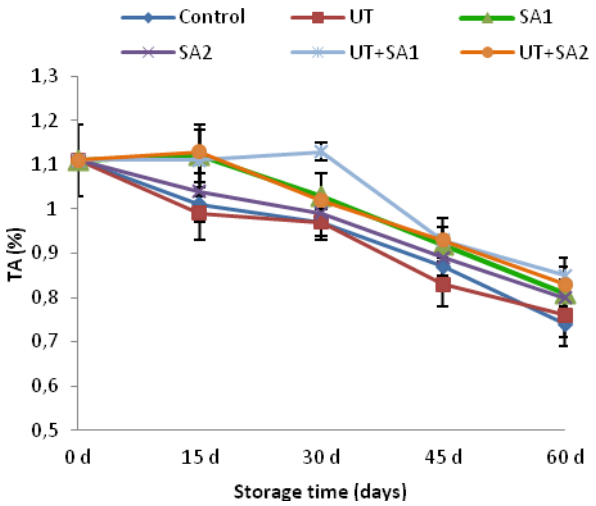

Figure 3
Effect of ultrasonic and salicylic acid treatments on SSC and TA of nectarine fruit during storage

Fruit firmness

Fruit softness occurs as a result of deterioration in cell wall structures and changes in cellulose and pectin components. In the study, nectarine firmness decreased during postharvest storage due to softness of fruit tissues via metabolic changes induced by enzymatic action and respiration (Figure 4). Firmness value of nectarine fruits at harvest time was 75.3 N. In control and ultrasonic treatment, fruit firmness value decreased to 45 N during 60 day cold storage. At the end of the storage, the highest firmness was determined in UT + SA2 treatment (58 N), followed by SA2 (54.6 N), UT + SA1 treatment (53.3 N) and SA1 treatment (50 N),

respectively. Ultrasonic alone had no influence, but when it was combined with SA, it resulted in greater retardation of firmness softening than SA alone. This is in agreement with Yuting et al (2013) and Bal et al (2017) who reported that ultrasonic could facilitate polyamine penetration into the tissue cells of fruits; a quicker and stronger resistance is induced. Moreover, delayed ripening process in SA treated fruits was concentration dependant and 2 mM SA dose maintained the firmness better than 1mM SA. Higher firmness in SA alone or combination treated fruits might be attributed to the reduced hydrolysis of soluble starch. Increased retention of firmness as the result of SA treatment has also been reported in several horticultural crops (Srivastava&Dwivedi 2000; Zhang et al 2003; Asghari&Aghdam 2010).

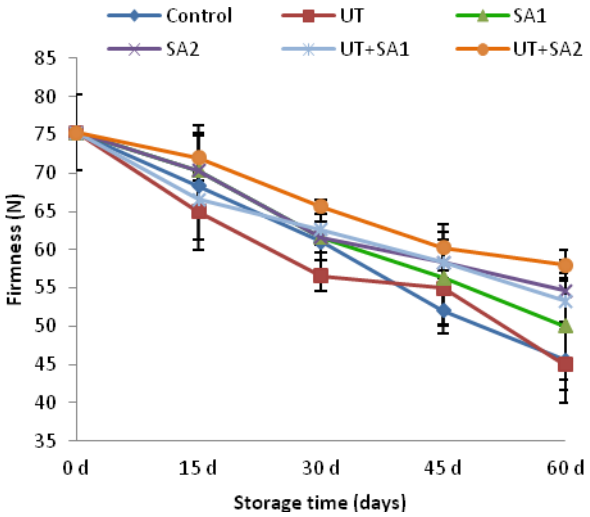

Figure 4
Effect of ultrasonic and salicylic acid treatments on firmness of nectarine fruit during storage

Ascorbic acid

Ascorbic acid is an important nutrient quality parameter and is very sensitive to degradation due to its oxidation compared to other nutrients during food processing and storage (Veltman et al 2000). The variation on ascorbic acid content is indicated in Figure 5. The content of ascorbic acid dropped notably during the storage of 40 days in all the samples. These results are consistent with previous reports showing that the levels of ascorbic acid in peaches, nectarines and apricots increased soon after harvest and decreased during storage (Lee&Kader 2000; Zhao et al 2018). The application of UT + SA2 and SA2 treatment significantly slowed the falling tendency. After 60 days of storage, the lowest ascorbic acid value was determined in ultrasonic treated fruits (161 mg 100 g^{-1}) followed by control fruits (175 mg 100 g^{-1}), while the highest ascorbic acid value was determined in UT + SA2 treated fruits (205 mg 100 g^{-1}) followed by SA2 treated fruits (195 mg 100 g^{-1}). The ascorbic acid degrades during storage period due to oxidative reduction and activity of ascorbate oxidase. The markedly delayed ascorbic acid degradation in UT + SA2 and SA2 treated fruits could possibly be due to its restrained oxidation-induced breakdown and retarding ripening. Similar to these findings, Lu et al (2011) and Awad (2013) reported that SA delayed the decline of ascorbic acid content and prevented the destruction, so high contents of ascorbic acid in treated pineapple and peach fruits could improve the fruit quality.

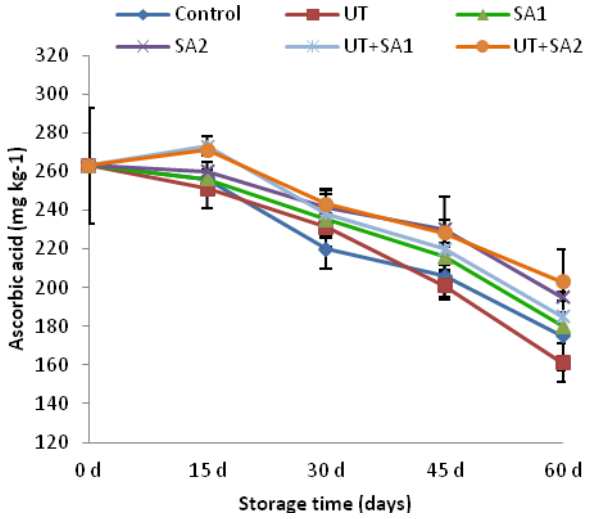

Figure 5
Effect of ultrasonic and salicylic acid treatments on ascorbic acid of nectarine fruit during storage

Total flavonoid and total phenolic content

In stone fruit the most abundant phenolics are flavonols and cinnamic acids, including chlorogenic and neochlorogenic acids (Ramina et al 2008). As shown in Figure 6 and Figure 7, at the beginning of the storage, the amounts of total flavonoid and phenolic contents was 93 mg 100 g^{-1} and 294 mg 100 g^{-1}. In the study, flavonoids followed a pattern very similar to that of phenolics, as also reported by Bal (2016) in SA treated peaches, the contents of total phenols and flavonoids in nectarine fruits fluctuated until 45th day and then decreased in all treatment. Fruits treated with individual SA and combination of SA and UT had higher values of total flavonoid and total phenolic content than the untreated control fruits and UT alone. At the end of the storage, the highest both total flavonoid and total phenolic content were determined in UT + SA2 treated fruits (108 mg 100 g^{-1} and 320 mg 100 g^{-1}, respectively). The results showed that the contents of total phenols and flavonoids of the nectarine fruits treated with UT + SA2 were higher than those treated with UT + SA1, which suggested that the effects of SA on total phenols and flavonoids contents of the nectarine fruits were concentration dependent. According to the results obtained that synergistic effects between salicylic acid and ultrasonic treatment were observed and combined treatment was more effective on enhancing total phenols and flavonoids. Similarly, Chen & Zhu (2011) and Bal et al (2017) reported that ultrasonic treatment with other chemicals had synergistic effect that maintained the biochemical compound of fruits. Moreover, Perez-Balibrea et al (2011) and Razavi et al (2018) have

reported that the total phenols and flavonoids contents in broccoli sprouts and peaches were significantly increased by SA treatment.

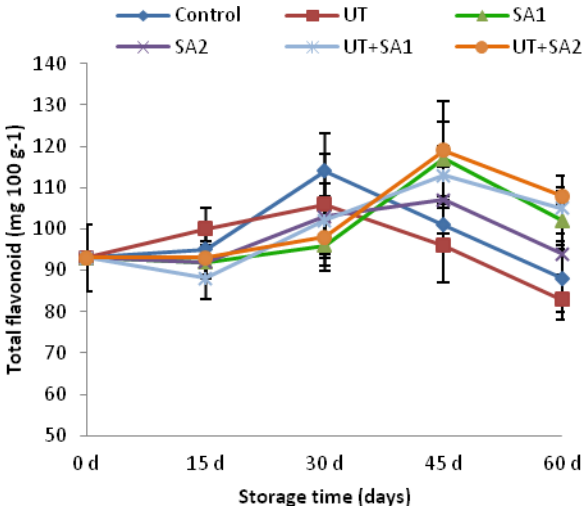

Figure 6
Effect of ultrasonic and salicylic acid treatments on total flavonoid of nectarine fruit during storage

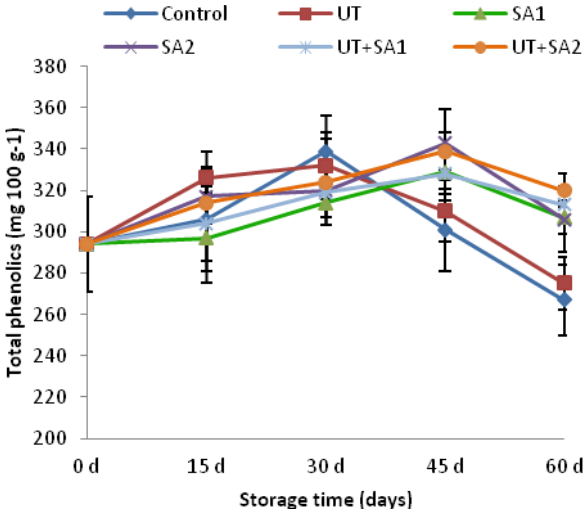

Figure 7
Effect of ultrasonic and salicylic acid treatments on total phenolics of nectarine fruit during storage

Antioxidant content

Nectarines are a good source of natural antioxidants, which provide protection against harmful reactive oxygen species and are associated with a lower incidence of chronic diseases (Shui&Leong 2006). The antioxidant contents showed an initial increase, followed by a decrease during cold storage (Figure 8); this is consistent with previous studies (Xi et al 2017; Zhao et al 2018). The results of antioxidant activity showed that fruits treated with SA and UT and combination of SA and UT had higher antioxidant activity than control fruits after 60 days of storage. At the end of the storage, control fruits had the lowest antioxidant content (13 µmol g^{-1}), while nectarine fruit treated with UT + SA2 (16.7 µmol g^{-1}) had the highest total phenolic content followed by UT + SA1 treatment (16.5 µmol g^{-1}). Accordingly, SA molecules could have had more opportunities to penetrate the fruit tissue by ultrasonic application. Moreover, SA has been reported to regulate antioxidants and maintain dietary value during storage (Huang et al 2008). The regulation of antioxidants as a result of SA application is not clear. It may be due to activation of antioxidant system in response to signaling SA which results in systemic acquired resistance in the cells (Tareen et al 2012). Taking into account the change in UT + SA2 treatment, it could be confirmed that total phenolics, total flavonoids and ascorbic acid are the main compounds contributing to the antioxidant capacity of the nectarine fruits, in agreement with previous reports (Sayyari et al 2011; Gimenez et al 2014; Davarynejad et al 2015).

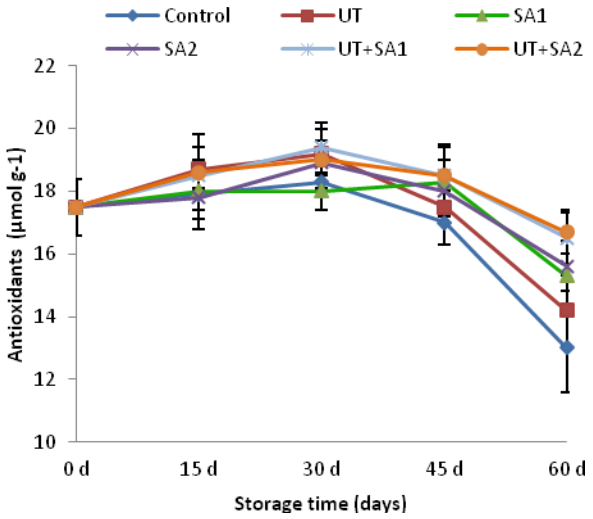

Figure 8
Effect of ultrasonic and salicylic acid treatments on antioxidants of nectarine fruit during storage

Chilling İnjury

CI limits the storage life of peaches and nectarines under low temperature. It has been widely reported that the expression of CI symptoms, especially internal browning, develops faster and more intensely when susceptible fruit are stored at temperatures between 2.2 and 7.6°C than those stored at 0°C or below but above their freezing point (Lurie&Crisosto 2005). As shown in Figure 9, no visible symptoms of CI were observed in the fruit when stored at 0°C for 30 days. In the present study, it was found that salicylic acid and combined treatment with ultrasonic treatment could effectively reduce CI in nectarine fruit, and 2 mM was the most effective concentration. CI symptoms, characterized by exocarp browning and flesh translucency, were observed the highest rate (10-25%) in ultrasonic treated fruit and control fruit after 45 days of storage. At the end of the storage, the lowest CI rate was determined in UT + SA2 treated fruits (1.1) followed by UT + SA2 and SA2 treated fruits (1.5), while the CI rate was determined in UT treated fruits (3.5) followed by control fruits (3). The lower CI symptoms in nectarines treated with SA alone and combined ultrasonic may be due to slower metabolic rates and retention of various

bioactive compounds in fruits. Nowadays, it has been obvious that the CI symptoms are created due to the oxidative stress caused by overproduction of ROS and high values of antioxidant compounds inhibit ROS and contribute to reduce the CI symptoms (Yang et al 2011). Kang et al (2003) also reported that SA is involved in chilling tolerance through H_2O_2 metabolism mediation. Similar to previous studies (Cao et al 2010; Aghdam et al 2014; Khademi et al 2019), we found that SA treatment alleviated the CI symptoms of fruits.

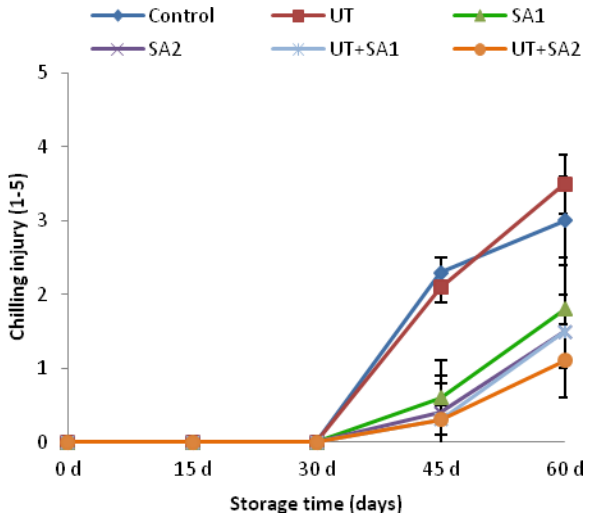

Figure 9
Effect of ultrasonic and salicylic acid treatments on chilling injury of nectarine fruit during storage

Conclusion

In conclusion, ultrasonic combined with SA treatment was more effective in alleviating CI and maintaining quality in nectarine fruit during the cold storage. However, ultrasonic treatment alone had similar effect to control treatment. Among the assayed doses (1 mM and 2 mM), the highest effect were found with SA at 2 mM. The combination of 2 mM SA with ultrasonic treatment was especially successful in preserving quality attributes with a higher nutraceutical value through ascorbic acid, phenolic, flavonoid and antioxidant content. These results suggested that 2 mM SA with ultrasonic treatment might be a powerful strategy to enhance antioxidant potential and quality of nectarine fruits. In further research, the potential benefit of using the combination of ultrasonic technology and other safe chemicals as commercial postharvest treatments to maintain quality in nectarine fruit should be explored.

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The Antibacterial Effects of the Different Extracts of *Oenothera biennis* and *Origanum minutiflorum* O. Schwarz et. P. H. Davis on Food-borne Pathogenic Bacteria

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ABSTRACT

This study aimed to determine the antibacterial effects of *Oenothera biennis* and *Origanum minutiflorum* O. Schwarz et. P. H. the leaves extrats on food-borne pathogenic bacteria. The highest antibacterial effect on bacterial strains, the lowest Minimum Inhibitory Concentration (MIC) and the lowest Bactericidal Concentration (MBC) values of both plants was determined in extracts obtained from the leaves using diethyl ether ($P < 0.05$). Diethyl ether extracts of both plants showed the highest antibacterial activity on *Listeria monocytogenes* (37.23 and 23.98-mm-zone diameters, respectively) ($P < 0.05$). The lowest MIC and MBC effect of the diethyl extract of *Oenothera biennis* on bacterial strains was determined to be 0.011mg/L and 7.81 mg/mL, respectively, on *Bacillus cereus*. However, the highest values were determined to be 0.750 mg/ L and >500 mg/mL, respectively, in acetone extract detected on *Pseudomonas aeroginosa*. The lowest MIC value of the diethyl extract of *Origanum minutiflorum* O. Schwarz et. P. H. Davis was determined to be 0.029 mg/L on *Listeria monocytogenes* and *Bacillus cereus* whereas the lowest MBC was determined to be 7.81 mg/mL on *Bacillus cereus*.

1. Introduction

Oenothera biennis is a biennial plant from the *Convolvulaceae* family. It is commonly known as evening primrose. The plant grows well in sandy, loamy and clayey soils in almost every place such as fields, roadsides and meadows (Morrison and Reekie, 1995). The oil obtained from the seeds of the plant was determined to have various pharmacological properties (Arimura, 2003a). The seed oil of the plant is very rich in γ-linolenic acid content, an important fatty acid found in the composition of prostaglandins and related hormones that are effective in regulating muscle and vascular contractions in human physiology. (Becker, 1983; Shukla et al., 1999). Also, recent studies have shown that ethanol extract obtained from the seeds of the plant shows specific anti-tumor activity (Arimura et al., 2003b; Arimura et al., 2004).

The *Origanum* genus belonging to the *Lamiaceae* family has 24 species in Turkey. Of these species, 16 are endemic (Aslım and Yücel, 2008; Albayrak and Aksoy, 2017). They are widely grown in the Mediterranean region (Azizi et al., 2009; Oke and Aslim, 2010). The species has high-level biological properties and reported to possess antimicrobial, antifungal, antioxidant, antimutagenic, anticarcinogenic, antifungal, antinematodal, antiparasitic and antiemetic activities (Bostancioglu et al., 2012; Chishti et al., 2013; Karaboduk et al., 2014; Sarikurkcu et al., 2015). *Origanum minutiflorum* O. Schwarz et. P. H. Davis (Turkish oregano) is an endemic species that grows in the Sütçüler region of Isparta in Turkey (Baydar, 2005). It is widely used as a spice and herbal tea (Ozen et al., 2014).

This study aimed to determine the antibacterial effects of the extracts obtained from the leaves of *Oenothera biennis* and *Origanum minutiflorum* O. Schwarz et. P. H. on foodborne pathogenic bacteria.

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2. Materials and Methods

2.1. Materials

Oenothera biennis used in the study was obtained from the villages in Antalya while *Origanum minutiflorum* O. Schwarz et. P. H. Davis was obtained from the Sütçüler region in Isparta, Turkey.

2.2. Bacterial Strains Used in This Study

In the study; *Staphylococcus aureus* (ATCC 6538), *Yersinia enterocolitica* (ATCC 9610), *Salmonella Typhimurium* (ATCC 14028), *Listeria monocytogenes* (ATCC 51774), *Escherichia coli* (ATCC 25922) *Enterococcus feacalis* (ATCC 29212), *Enterobacter aerogenes* (ATCC 13048) ve *Shigella flexneri* (ATCC 12022) *Bacillus cereus* (ATCC 14579) *Pseudomonas aeroginosa* (ATCC 15442), *Escherichia coli* (ATCC 25922) species of bacteria were used.

2.3. Preparation of Plant Extracts

Leaves of the plants were cut into small pieces and mixed with 400 mL ethanol (85%: Merck, 100983, Germany), methanol (Merck, 106009 Germany), diethyl ether (Merck, 100921, Germany), acetone (Merck, 100014, Germany) or chloroform (Merck, 102445, Germany) at 1:3 (w/v) ratio. The mixtures were then shaken at 22 °C in a shaker (Wiseshake SHO-2D, Witeg, Germany) at 120 rpm for 24 hours. After the extracts were filtered through sterilized filter paper (Whatman No. 32), the solvents were removed from the extract by rotary evaporator (Heidolph, Germany). The extracts were stored in colored glass bottles (100 ml, glass bottle, Turkey) at 4°C in refrigerator (Arçelik 554271, Turkey).

2.4. Preparation of Discs Containing Plant Extracts

For the preparation of discs containing the plant extracts, 10 µL samples of the extracts of *Oenothera biennis* and *Origanum minutiflorum* O. Schwarz et. P. H. Davis were taken into Petri dishes (Sterile, 90 x 15, Fıratmed, Turkey) using sterile tipped pipettes (Research Plus, Eppendorf) and dropped on 6-mm-diameter empty antibiogram discs (Bio-Disk 316010001). The Petri dishes were kept closed at 4 °C in refrigerator (Arçelik 554271, Turkey) for 60 minutes for the discs to absorb the extracts. The extract-impregnated discs were then dried in a laminar flow cabinet (Cryste, Puricube 1200) at room temperature for 8-10 hours.

2.5. Preparation of the Inocula

The young (24-hour) bacterial strains produced on non-selective media were taken from single growing colonies using a sterile loop and suspended in physiological saline (Merck, 115525, Germany) until homogeneous turbidity occurred. The density of the inoculum suspension was adjusted to 0.5 McFarland standard using a densitometer (Biosen, 1B, Turkey). The inocula were taken using a transport swap (Fıratmed, Turkey) and inoculated on the surface of Mueller Hinton Agar (1.05437, Merck, Germany) (MHA) and spread homogeneously (Bauer et al., 1966; Akarca, 2019).

After waiting for 10 minutes for the medium to absorb the inocula, the antibiogram discs containing plant extracts were placed in the Petri dishes and incubated in an incubator (Incucell, MMM, Germany) as described by Anonymous (2018) and Cruz-Gálvez et al. (2018). The zones formed at the end of the period were measured in mm using a digital caliper (Mitutoyo, 500-181-30, Japan) under sufficient daylight.

2.5. Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) Values

From the extracts of both plants obtained with five different solvents, 1 mL of Nutrient Broth (Merck, 1.05443, Germany) was added to the first tubes. Then, 1 mL of the mixtures formed in the first tubes was taken and transferred to the next tubes. This procedure was applied to all tubes in series. As a result, the mixtures were obtained in equal amounts in each tube but only half of the concentration of the previous tube. Also, positive and negative control tubes were formed.

Of the bacterial strains used in the study, 1 µl (10^6 cfu/mL) were inoculated into all other tubes except for the negative control tube and incubated at the appropriate temperature, time and conditions. At the end of the period, turbidity in the tubes, membrane formation on the surface and sediment at the bottom were regarded as positive. Also, no growth was determined in the negative control tube whereas growth was determined in the positive control tube. The MIC value was determined by taking half of the sum of the concentrations of the first tube evaluated as positive growth and the tubes previously evaluated as negative growth (By Aamer et al., 2015; Chikezie, 2017; Akarca, 2019).

The first tube, which was evaluated as negative growth in MIC analysis, was inoculated into Muller Hinton Agar (Merck, 195437, Germany) by taking 1 µl from all the tubes at the following concentrations and then incubated at the appropriate temperature, time and conditions for each bacterial species. The value of the first concentration with no growth at the end of the period was evaluated as MBC (Dhiman et al., 2011; By Aamer et al., 2015; Akarca, 2019).

2.6. Statistical Analysis

The results of the study were determined by SPSS (V 23.0.0) statistical software and the differences were determined by the Duncan test ($P < 0.05$).

3. Results and Discussion

The antibacterial effect (mm-zone-diameter) of the extracts of *Oenothera biennis* from five different solvents on ten foodborne pathogenic bacteria is shown in Table 1.

It was determined that the diethyl ether extract of *Oenothera biennis* showed the highest antibacterial

effect on *Listeria monocytogenes* with a 37.23-mm-zone-diameter, followed by *Bacillus cereus* with a 32.46-mm-zone diameter ($P < 0.05$). In contrast, the acetone extract exhibited the lowest antibacterial effect ($P < 0.05$). *Pseudomonas aeroginosa* was the bacteria species on which this extract showed the lowest antibacterial effect with a 7.33-mm-zone-diameter ($P < 0.05$).

It was determined that the highest antibacterial effect was determined in the *Origanum minutiflorum* O. Schwarz et. P. H. extract obtained using diethyl ether, followed by extracts obtained using ethanol and chloroform (Table 2; $P < 0.05$).

Table 1
Antibacterial Effects of Different Extracts of *Oenothera biennis* (mm Zone Diameter)

Species of Bacteria	Solvent				
	Ethanol	Methanol	Diethyl ether	Acetone	Chloroform
Staphylococcus aureus	16.02 ± 1.39^{Bde}	15.08 ± 0.65^{Bbc}	20.55 ± 0.93^{Ad}	9.93 ± 0.25^{Cbc}	14.28 ± 1.02^{Bcd}
Yersinia enterecolitica	18.00 ± 1.57^{Ad}	10.29 ± 0.96^{Bef}	18.18 ± 0.54^{Aef}	12.29 ± 1.14^{Bab}	13.79 ± 1.66^{ABcd}
Salmonella Typhimurium	21.85 ± 1.24^{Ac}	14.61 ± 1.12^{Bbc}	23.18 ± 0.34^{Ac}	13.80 ± 2.67^{Ba}	15.87 ± 0.51^{Bbc}
Listeria monocytogenes	35.81 ± 0.62^{Aa}	16.76 ± 1.39^{Bb}	37.23 ± 0.90^{Aa}	15.15 ± 1.03^{Ba}	17.30 ± 0.88^{Bb}
Enterococcus feacalis	17.86 ± 0.38^{Ad}	12.01 ± 0.14^{Bde}	18.43 ± 0.66^{Aef}	9.35 ± 0.67^{Cbc}	10.22 ± 0.30^{Cf}
Enterobacter aerogenes	14.77 ± 0.40^{Ade}	10.02 ± 0.51^{Bef}	16.25 ± 0.11^{Af}	9.16 ± 0.44^{Bbc}	10.71 ± 0.53^{Bf}
Shigella flexneri	16.96 ± 1.28^{ABde}	13.77 ± 0.58^{Bcd}	17.24 ± 0.91^{Aef}	10.08 ± 0.07^{Cbc}	13.94 ± 1.07^{ABcd}
Bacillus cereus	30.65 ± 1.70^{Ab}	19.28 ± 0.80^{Ba}	32.46 ± 0.71^{Ab}	15.28 ± 1.11^{Ca}	20.36 ± 0.78^{Ba}
Pseudomonas aeroginosa	13.36 ± 0.82^{Be}	8.86 ± 0.22^{Cf}	19.23 ± 1.12^{Ade}	7.33 ± 0.21^{Cc}	9.04 ± 0.23^{Cf}
Escherichia coli	17.05 ± 1.34^{ABde}	9.32 ± 0.16^{Cf}	20.12 ± 1.37^{Ad}	15.19 ± 0.96^{Ba}	11.27 ± 1.10^{Cde}

a-f (↓): Values with the same capital letters in the same column for each analysis differ significantly ($P < 0.05$).
A-C (→): Values with the same capital letters in the same rows for each analysis differ significantly ($P < 0.05$).

Table 2
Antibacterial Effects of Different Extracts of *Origanum minutiflorum* O. Schwarz et. P. H. (mm Zone Diameter)

Species of Bacteria	Solvent				
	Ethanol	Methanol	Diethyl Ether	Acetone	Chloroform
Staphylococcus aureus	13.88 ± 0.64^{Bb}	10.99 ± 0.25^{Cb}	16.30 ± 0.83^{Ac}	10.72 ± 0.36^{Cc}	11.33 ± 0.21^{Cbc}
Yersinia enterecolitica	11.09 ± 0.23^{B}	10.01 ± 0.36^{Bb}	12.84 ± 0.32^{Aef}	9.96 ± 0.09^{Bc}d	10.63 ± 0.50^{Bcd}
Salmonella Typhimurium	12.84 ± 0.39^{ABbcd}	10.65 ± 0.97^{BCb}	13.35 ± 0.86^{Ad}	10.25 ± 0.47^{Ccd}	12.07 ± 0.19^{ABCb}
Listeria monocytogenes	20.86 ± 0.32^{Ba}	15.55 ± 0.93^{Ca}	23.98 ± 0.27^{Aa}	13.14 ± 0.52^{Db}	16.77 ± 0.46^{Ca}
Enterococcus feacalis	10.61 ± 0.75^{Ae}	9.45 ± 0.71^{ABb}	10.90 ± 0.53^{Af}	8.13 ± 0.44^{Bf}	10.13 ± 0.21^{ABcd}
Enterobacter aerogenes	11.00 ± 0.33^{Ade}	9.77 ± 0.50^{Ab}	11.56 ± 1.16^{Aef}	9.33 ± 0.30^{Ade}	10.45 ± 0.12^{Acd}
Shigella flexneri	10.97 ± 0.35^{Bde}	9.92 ± 0.37^{Bb}	13.23 ± 0.41^{Aef}	9.84 ± 0.29^{Bcd}	9.78 ± 0.33^{Bd}
Bacillus cereus	19.42 ± 1.04^{ABa}	16.10 ± 0.73^{Ca}	21.56 ± 1.07^{Ab}	14.42 ± 0.24^{Ca}	17.02 ± 0.64^{BCa}
Pseudomonas aeroginosa	13.52 ± 0.82^{Abc}	9.13 ± 0.30^{BCb}	13.80 ± 0.38^{Ad}	8.49 ± 0.04^{Cf}	10.28 ± 0.37^{Bcd}
Escherichia coli	11.67 ± 0.83^{Acde}	11.04 ± 0.35^{ABb}	11.86 ± 0.28^{Aef}	9.16 ± 0.63^{Bde}	10.33 ± 0.60^{ABcd}

a-f (↓): Values with the same capital letters in the same column for each analysis differ significantly ($P < 0.05$).
A-D (→): Values with the same capital letters in the same rows for each analysis differ significantly ($P < 0.05$).

Table 3
Antibacterial Effects of Different Extracts of *Oenothera biennis* and *Origanum minutiflorum* O. Schwarz et. P.

Species of Bacteria	Solvent									
	Ethanol		Methanol		Diethyl Ether		Acetone		Chloroform	
	Ob	*Om*	*Ob*	*Om*	*Ob*	*Om*	*Ob*	*Om*	*Ob*	*Om*
Staphylococcus aureus	++	++	++	+	+++	++	+	+	++	+
Yersinia enterecolitica	++	+	+	+	+++	++	++	+	++	+
Salmonella Typhimurium	+++	++	++	+	+++	++	++	+	++	++
Listeria monocytogenes	+++	+++	++	++	+++	+++	++	++	++	++
Enterococcus feacalis	++	+	++	+	+++	+	+	-	+	+
Enterobacter aerogenes	++	+	+	+	++	+	+	+	+	+
Shigella flexneri	++	+	++	+	+	++	+	+	++	+
Bacillus cereus	+++	+++	+++	++	+++	+++	++	+	+++	++
Pseudomonas aeroginosa	++	++	-	+	+++	++	-	-	+	+
Escherichia coli	++	+	+	+	+++	+	++	+	+	+

7-9 mm zone diameter: -, 9-12 mm zone diameter: +,12-18 mm zone diameter :++, >18 mm zone diameter:+++, *Ob*: *Oenothera biennis*, *Om: Origanum minutiflorum* O. Schwarz et. P. H. Davis

Table 4
MIC (mg/L) and MBC (mg/mL) Values of Different Extracts of *Oenothera biennis*.

Species of Bacteria	Solvent									
	Ethanol		Methanol		Diethyl Ether		Acetone		Chloroform	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
Staphylococcus aureus	0.070±0.023^{Bab}	11.72±3.91^{Aa}	0.093±0.000^{Bab}	15.63±0.00^{Ac}	0.035±0.012^{Ba}	11.72±3.91^{Ab}	0.562±0.188^{Aab}	156.25±93.75^{Ab}	0.139±0.045^{Bab}	39.07±23.44^{Acd}
Yersinia enterecolitica	0.046±0.000^{Bb}	15.63±0.00^{Ba}	0.281±0.094^{Aab}	62.50±0.00^{Ac}	0.070±0.024^{ABa}	11.72±9.91^{Bb}	0.281±0.094^{Abc}	39.07±23.44^{ABb}	0.093±0.000^{ABab}	23.44±7.81^{ABcd}
Salmonella Typhimurium	0.035±0.012^{Aab}	11.72±3.91^{Aa}	0.234±0.141^{Aab}	23.44±7.81^{Ac}	0.023±0.000^{Aa}	19.53±11.72^{Ab}	0.187±0.000^{Ac}	31.25±0.00^{Ab}	0.281±0.094^{Aab}	23.44±7.81^{Acd}
Listeria monocytogenes	0.017±0.06^{Ab}	15.63±0.00^{Aa}	0.070±0.024^{Ab}	19.53±11.72^{Ac}	0.017±0.06^{Aa}	7.81±0.00^{Ab}	0.117±0.071^{Ac}	23.44±7.81^{Ab}	0.035±0.012^{Ab}	15.63±0.00^{Ad}
Enterococcus feacalis	0.035±0.012^{Bab}	11.72±3.91^{Aa}	0.140±0.047^{Bab}	62.50±0.00^{Ac}	0.029±0.018^{Ba}	39.07±23.44^{Ab}	0.562±0.188^{Aab}	312.50±187.5^{Aa}	0.140±0.047^{Bab}	187.50±62.5^{Ab}
Enterobacter aerogenes	0.070±0.024^{Bab}	15.63±0.00^{Aa}	0.281±0.094^{ABab}	93.75±32.25^{Abc}	0.070±0.024^{Ba}	62.50±0.00^{Aab}	0.374±0.000^{Abc}	312.50±187.5^{Aa}	0.105±0.082^{Bab}	156.25±93.75^{Abc}
Shigella flexneri	0.046±0.000^{Ab}	93.75±31.25^{Aa}	0.234±0.141^{Aab}	125.00±0.00^{Abc}	0.035±0.012^{Aa}	46.88±15.63^{Aab}	0.140±0.047^{Ac}	187.50±62.5^{A}b	0.070±0.024^{Ab}	78.13±46.87^{Abcd}
Bacillus cereus	0.017±0.006^{Ab}	11.72±0.00^{Aa}	0.035±0.012^{Ab}	20.03±12.22^{Ac}	0.011±0.000^{Aa}	15.63±0.00^{Ab}	0.093±0.000^{Ac}	15.63±0.00^{Ab}	0.138±0.092^{Aab}	11.72±3.91^{Ad}
Pseudomonas aeroginosa	0.140±0.047^{Ba}	132.82±117.18^{Ba}	0.374±0.000^{ABa}	375.00±125.00^{ABa}	0.035±0.012^{Ba}	93.75±31.25^{Ba}	0.750±0.000^{Aa}	>500.00	0.469±0.282^{ABa}	500.00±0.00^{Aa}
Escherichia coli	0.117±0.071^{Aab}	93.75±31.25^{Aa}	0.281±0.094^{Aab}	312.50±187.50^{Aab}	0.058±0.035^{Aa}	39.07±23.44^{Ab}	0.058±0.035^{Ac}	46.88±15.62^{Ab}	0.105±0.082^{Aab}	125.00±0.00^{Abcd}

a-d (↓): Values with the same capital letters in the same column for each analysis differ significantly (P < 0.05).
A-C (→): Values with the same capital letters in the same rows for each analysis differ significantly (P < 0.05).

Table 5
MIC (mg/L) and MBC (mg/mL) Values of Different Extracts *Origanum minutiflorum* O. Schwarz et. P. H.

Species of Bacteria	Solvent									
	Ethanol		Methanol		Diethyl Ether		Acetone		Chloroform	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
Staphylococcus aureus	0.140±0.047^{ABa}	93.75±31.25^{Aab}	0.187±0.000^{Aba}	187.50±62.50^{Aab}	0.093±0.000^{Bab}	78.13±46.87^{Aa}	0.281±0.094^{Abc}	140.63±109.38^{Aab}	0.187±0.000^{Aba}	62.50±0.00^{Abc}
Yersinia enterecolitica	0.187±0.00^{Aa}	78.13±46.87^{ABab}	0.234±0.140^{Aa}	125.00±0.00A^{Bab}	0.140±0.047^{Aab}	46.88±15.63^{Ba}	0.374±0.000^{Abc}	187.50±62.50^{Aab}	0.281±0.094^{Aa}	125.00±0.00^{ABbc}
Salmonella Typhimurium	0.117±0.071^{Aa}	93.75±31.25^{Aab}	0.281±0.094^{Aa}	156.25±93.75^{Aab}	0.093±0.000^{Aab}	78.13±46.87^{Aa}	0.187±0.000^{Abc}	125.00±0.00^{Aab}	0.140±0.047^{Aa}	93.75±31.25^{Abc}
Listeria monocytogenes	0.046±0.00^{ABa}	19.53±11.72^{Ab}	0.070±0.024^{Aba}	46.88±15.63^{Ab}	0.029±0.018^{Bb}	11.72±3.91^{Aa}	0.093±0.000^{Ac}	39.07±23.44^{Ab}	0.070±0.018^{Aba}	31.25±0.00^{Ac}
Enterococcus feacalis	0.234±0.141^{Aa}	125.00±0.00^{Aab}	0.422±0.328^{Aa}	312.50±187.5^{Aa}	0.140±0.047^{Aab}	93.75±31.25^{Aa}	0.469±0.282^{Aab}	>500.00	0.187±0.000^{Aa}	187.50±62.5^{Abc}
Enterobacter aerogenes	0.140±0.047^{Aa}	187.50±62.5^{ABa}	0.187±0.000^{Aa}	250.00±0.00^{ABab}	0.234±0.147^{Aa}	125.00±0.00^{Ba}	0.140±0.047^{Abc}	375.00±125.0^{Aab}	0.281±0.094^{Aa}	250.00±0.00^{ABab}
Shigella flexneri	0.187±0.00^{Aa}	156.25±93.75^{Bab}	0.281±0.094^{Aa}	125.00±0.00^{Bab}	0.117±0.071^{Aab}	156.25±93.75^{Ba}	0.234±0.141^{Abc}	500.00±0.00^{Aab}	0.187±0.000^{Aa}	375.00±125.0^{ABa}
Bacillus cereus	0.078±0.32^{Aa}	39.07±23.44^{Aab}	0.117±0.071^{Aa}	46.88±15.63^{Ab}	0.029±0.018^{Ab}	7.81±0.00^{Aa}	0.058±0.035^{Ac}	78.13±46.88^{Ab}	0.117±.0.071^{Aa}	19.53±11.72^{Ac}
Pseudomonas aeroginosa	0.070±0.024^{Ba}	93.75±31.25^{Bab}	0.234±0.141^{Ba}	250.00±0.00^{Bab}	0.070±0.024^{Bab}	156.25±93.75^{Ba}	0.750±0.000^{Aa}	500.00±0.00^{Aa}	0.281±0.094^{Ba}	156.25±93.75^{Bbc}
Escherichia coli	0.140±0.047^{Aa}	62.50±0.00^{Aab}	0.187±0.000^{Aa}	93.75±31.25^{Aab}	0.140±0.047^{Aab}	125.00±0.00^{Aa}	0.187±0.000^{Abc}	312.50±187.5^{Aab}	0.140±0.047^{Aa}	93.75±31.25^{Abc}

a-d (↓): Values with the same capital letters in the same column for each analysis differ significantly (P < 0.05).
A-C (→): Values with the same capital letters in the same rows for each analysis differ significantly (P < 0.05)

The highest antibacterial effect was observed in the diethyl ether extract on *Listeria monocytogenes* with a zone diameter of 23.98 mm whereas the lowest antibacterial effect was on *Enterococcus faecalis* with a zone diameter of 8.13 mm in the acetone extract ($P < 0.05$).

Among the five different extracts, the highest antibacterial effect was determined in the extracts prepared with diethyl ether (Table 3), followed by ethanol and chloroform extracts ($P < 0.05$). Among the extracts, the lowest antibacterial effect on ten different pathogenic bacterial strains was determined in the acetone extract ($P < 0.05$). As a result of similar studies on the subject, it has been stated that the high antibacterial effects of extracts were caused by carvacrol and thymol, which are abundant in the structure of plants (Aslım and Yucel, 2008; Bostancioglu et al., 2012).

Of the five different extracts obtained from *Oenothera biennis*, the lowest MIC and MBC values were determined in diethyl ether, ethanol and methanol extracts, respectively, whereas the highest MIC and MBC values were determined in the acetone extract (Table 4; $P < 0.05$). The lowest MIC values of the extracts were on *Bacillus cereus* and *Listeria monocytogenes*, respectively, whereas the highest values were on *Pseudomonas aeroginosa*, *Yersinia enterecolitica* and *Enterobacter aerogenes*, respectively ($P < 0.05$).

The lowest MIC and MBC values of the plant extracts on ten different pathogenic bacteria strains were 0.011 mg/L and 7.81 mg/mL in the diethyl ether extract against *Bacillus cereus*, whereas the highest values were 0.750 mg/L and >500 mg/mL in the acetone extract against *Pseudomonas aeroginosa* (Table 4).

It was determined that the lowest MIC and MBC values, as in *Oenothera biennis*, were determined in the *Origanum minutiflorum* O. Schwarz et. P. H. extract obtained from the diethyl ether extract whereas the highest MIC and MBC values were determined in the acetone extract (Table 5; $P < 0.05$). The lowest MIC value of the diethyl extract was 0.029 mg/L on *Listeria monocytogenes* and *Bacillus cereus*, while the lowest MBC value of the diethyl extract was 7.81 mg/mL on *Bacillus cereus* ($P < 0.05$). The acetone extract of the *Origanum minutiflorum* O. Schwarz et. P. H. Davis had the highest MIC and MBC values against ten different food-borne pathogenic bacteria among the extracts obtained with five different solvents ($P < 0.05$). The highest MIC and MBC values of this extract were found to be 0.750 mg/L and >500 mg/mL on *Pseudomonas aeroginosa* ($P < 0.05$).

According to variance analysis results, the antibacterial effect of extracts obtained from two different plants using five different solvents on ten different foodborne pathogens, it was found that plant species, bacterial species, solvent species, solvent species x bacteria species interaction, solvent species x plant species interaction, bacterial species x plant species interaction and solvent species x bacterial species x plant species interaction were found to be significant ($P < 0.0001$; Table 6).

Similarly, bacterial species, solvent type, solvent type x bacterial species interactions had a significant effect on the MIC value ($P < 0.0001$). In terms of the effect on the MBC value, it was determined that plant species, bacterial species, solvent type interactions were significant at $P < 0.0001$, while solvent type x bacterial interaction was significant at $P < 0.05$ and bacterial species x plant species interaction was significant at $P < 0.01$ (Table 6).

Albayrak and Aksoy (2017), similar to our study, have stated that the antibacterial effect of *Origanum minutiflorum* was high. As a result of the research, the highest antibacterial effect of ethanol extract has been reported to be on *Aeromonas hydrophil*ic with a 24-mm-zone diameter and *Streptococcus pneumonia* with an 18-mm-zone diameter, respectively. The researchers have reported that the lowest MIC and MBC values of ethanol extract of the plant were 0.78 mg/mL and 0.78 mg/mL, respectively, on *Klebsiella pneumonia*.

Table 6
Analysis Results of Variance Analysis of Oenothera biennis and Origanum minutiflorum O. Schwarz et. P. H. Davis on Solvent, Antibacterial Effect, MIC and MBC Values (P value)

Factors	Antibacterial Effect	MIC	MBC
Plant species	<0.0001	0.057	<0.0001
Bacteria species	<0.0001	<0.0001	<0.0001
Solvent type	<0.0001	<0.0001	<0.0001
Solvent type x Bacteria species	<0.0001	<0.0001	0.05
Solvent type x Plant species	<0.0001	0.207	0.204
Bacteria species x Plant species	<0.0001	0.360	0.01
Solvent type x Bacteria species x Plant species	<0.0001	0.809	0.136

$P < 0.05$: Statistically significant, $P < 0.01$: Statistically very significant, $P < 0.0001$: Statistically too much significant, $P > 0.05$: Not statistically significant.

4. Conclusion

According to the results of this study, both plant species, especially *Oenothera biennis*, were found to have high antibacterial effects. The fact that the highest activity was found in diethyl ether extract among different solvents used showed that the components found in the composition of the leaves of the plants which exhibit antibacterial effect were best decomposed in this solvent.

In recent years, the trend towards the use of natural products as an alternative to artificial food additives and pharmaceuticals has led manufacturers to research this subject. Successful results obtained from many studies show the usability of such products that are obtained from a large number of plants.

The cultivation of these two plants, which have been consumed for different purposes for many years, in larger areas and the products such as extracts, essential oils, and essences to be obtained from these plants can be used as natural preservatives, shelf-life extenders and antibacterials in food industry, and medicine industry including pharmacology, medical and veterinary.

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Determination of the Relationship between NDVI and Yield by Using Remote Sensing for Silage Corn in Konya Region

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ABSTRACT

This study focuses on the yield estimation of silage corn in the province of Konya. This study was carried out in Selcuk University Sarıcalar Research and Application Farm in province of Konya. In this study, normalized difference vegetation index (NDVI) values obtained by using remote sensing tecniques were compared with yield and the availability of estimation of yield by using NDVI was determined.

In the Study, approximately 1000 m^2 of silage corn planted in the field. The field is divided into plots. Different doses of nitrogen applied to different plots to obtain different yields on different plots. In this way, 5 parcels having different yields were obtained. Aerial images were taken from these plots before the flowering period, during the flowering period and after the flowering period. NDVI values were calculated from these images. Yields of plots were measured in the time of harvest.

NDVI values were compared with the yield values. The highest correlation (R^2=0.945) were found between the images obtained during the flowering period and yields. It showed that the estimation of the yield is available with image taken during this period.

1. Introduction

Monitoring of agricultural products during the vegetation period and pre-harvest reliable yield estimation of agricultural products are important for economies of countries in terms of planning national policy, and food security (Hayes and Decker, 1996; Wu et al., 2012; Fang and Hoogenboom, 2011; Zhao et al. 2011; Prasad et al., 2006).

Classic product monitoring and yield estimation methods are usually based on a random sampling of the land. These methods are generally laborious, time consuming and expensive (Prasad et al., 2006; Fang et al. , 2008).

Remote sensing for monitoring crop growth is quick and effective method, therefore it is very important technique and valuable information source for agricultural applications. (Li and Chen 2011; Prasad et al. 2006; Hatfield and Prueger 2010; Bernardes et al. 2012).

Remote sensing techniques in agriculture is often used in areas such as yield estimation (Meroni et al., 2013; Kogan et al. 2012), the product area estimation (Fritz et al., 2008; Gallego et al., 2014), irrigation scheduling (Ahmad et al., 2009; Asher et al., 2013), and the product mapping (Delrue et al., 2013; Biradar et al., 2009). Yield estimation has an important place in remote sensing applications.

Some indexes such as NDVI (normalized difference vegetation index), SAVI (soil-adjusted vegetation index) and EVI (enhanced vegetation index), obtained from plants vegetative reflections using remote sensing is closely related to the vegetative status of the plant. The NDVI introduce by Deering (1978) is most frequently used index and often used for yield forecasting applications due to its close relationship with yield (Tucker et al., 1980).

Remote sensing data used for used for calculation of vegetation indexes (VI) can be obtained from satellites or aerial remote sensing tools. Satellite based remote sensing data using for VI have some disadvantage such us cloudiness, low resolution and high cost (Sakamoto et al., 2012). Obtaining data with spectral sensors mounted on unmanned aerial vehicles and

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similar platforms can overcome these disadvantages. In studies conducted previously unmanned aerial vehicles were used to obtain data from agricultural areas (Herwitz et al., 2004, Guillen-Climent et al., 2012, Sugiura et al., 2005).

In a study using UAV (unmanned aerial vehicles) (Berni et al., 2009), the availability of remote sensing data using unmanned aerial vehicles has been examined and it has been shown that these tools can be used easily in the imaging of agricultural areas.

Sakamoto et al. (2012) observed periodic changes in crop growth with the cheap camera system and determined that the system was effective.

Corn, an important cereal plant in the world, is also increasingly prevalent in Turkey (Ibrikci and Ulger, 2012; Bozkurt et al., 2006). In the studies conducted (Ulger et al., 1997; Gholamhoseini et al., 2013); it was observed that the corn plant showed different yield responses to the N fertilizer applied at different rates and the yield improved with the increasing N fertilizer rate.

The aim of this study is to investigate the relationship between the yield values obtained from the images taken with a spectral camera mounted on a simple kite system from corn plant plots, which obtained different yields by changing the nitrogen dose, and NDVI values.

2. Materials and Methods

In this study, approximately one decare was used for silage corn planting and BC-532 maize type was used for planting. A parachute type kite system is used for aerial photography. With the purpose of taking measurements from the plants in the field; an electronic caliper with 0.01 mm precision, a 4-volt rechargeable scales and meter with a precision of 1 gram were used. A 50 m tape meter was used to dimension the parcels in the field. In order to obtain remote sensing data, multispectral camera was used and computer and software were used for the processing and evaluation of data. In order to obtain remote sensing data, multispectral camera, computer and software were used for the processing and evaluation of data. RTK-GPS (Real Time Kinematic- Global Positioning System) was used for the purpose of determining the location of the parcels on the ground. Teflon plates are used as Ground Control Point (GCP).

In this study, it was aimed to obtain different yields by dividing the land where the corn cultivation is made by the parcels in order to compare the yield with the remote sensing data. Nitrogen doses, which are effective parameters on product yield, have been used to achieve this (Tunalı et al., 2012). The seeding process was carried out in the summer of 2012. To obtain different yields, 0, 10, 20, 30, 40 kg N / decare doses of nitrogen were used in the intended fertilizer. The experiment was set up in 3 replications according to the design of random blocks and each replicate consists of 8 rows with a distance of 0.7 meters and a length of 10 meters.

On the land to be planted, the primary soil treatment was carried out with a plow, the doubling was carried out with crowbar cultivator and a seed bed preparation was made with a gear-rotary harrow combination. Pneumatic precision sowing drill was used in the sowing process and the planting depth, row spacing and distance between rows were set at 7 cm, 25 cm and 0.7 m respectively. At the time of sowing, soil temperature was measured as 17 ° C and air temperature was measured as 30 ° C. Sowing norm was set at 2.5 kg / da.

According to the applied nitrogen doses, the parcels were named N0, N10, N20, N30, and N40, respectively. Nitrogen application of 0, 10, 20, 30, 40 kg/da in total was made to these parcels respectively. After planting, TSP (Triple Süper Fosfat) containing P of 10 kg / da was applied to the N0 named parcel and DAP (Diammonium phosphate) fertilizer containing 4 kg / da N and 10 kg / da P was applied to the other parcels. The remainder of the nitrogen is given in urea form after the second hoeing.

7 days after sowing, plant germination began. The first anchor, the second anchor, the throat filling and weed spraying processes were applied respectively during plant development. The water was irrigated a total of 5 times, 3 times sprinkling to the second hoeing application and then the furrow irrigation.

The plants entered the flowering period 70 days after sowing and were harvested 98 days later.

2.1. Harvesting and Plant Measurements During Harvest

The harvesting process was performed manually and the harvested plants for each parcel were weighed with a charged scale. The yields of the parcels were calculated by proportioning the plant weights to the areas of the harvested parcels.

During the harvesting, 20 plants were identified in each plot and the plant height, number of cobs, height of cob, stem diameter, leaf length, leaf width, plant weight, leaf weight, weight of cob and stem weight of these plants were measured. These measurements were made with meters, electronic calipers and charged scales.

2.2. RTK-GPS measurement

A GPS point near the work site is installed as shown in Figure 1. Coordinates of the fixed point were calculated by performing continuous GPS measurement for two hours.

As shown in Figure 2, five GCP were installed in such a way that the points would surround the parcels and the teflon plates were placed at these points.

Figure 1
Fixed station established in work area

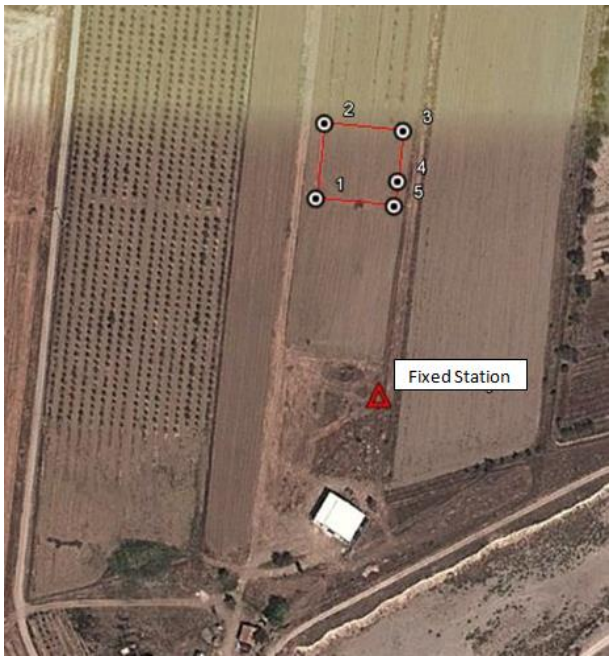

Figure 2
5 points established by RTK method in the study area

A GPS device was installed at a fixed point. With a second mobile GPS tool, 5 points were coordinated by RTK method, as shown in Figure 3, with 10 seconds waiting at each point. Coordinates are calculated in the format of geographical coordinates. All coordinates are obtained in WGS84, World Geodetic System datum. The points with new coordinates calculated in Figure 2 were displayed in the Google Earth program. The accuracy of the calculated points has also been confirmed visually.

In this study, it was aimed to calculate NDVI values with high correlation with yield through images taken from the land to compare with the yield values and to determine their usability in the yield estimation study. The images were taken in 3 different periods to be used in the NDVI calculation. Images were taken 15 days before flowering, 10 days after flowering and flowering.

Figure 3
Coordinate points with a roving GPS tool

The newly calculated coordinates by the RTK method are given in Table 1 below.

Table 1
Coordinates of installed points in the study area

Points	Latitude (°)	Longitude (°)	Altitude (m)
1	32.60875	38.09319	1042.76000
2	32.60880	38.09351	1042.66198
3	32.60923	38.09348	1042.92102
4	32.60920	38.09326	1042.75500
5	32.60918	38.09316	1042.72302

2.3. Receiving and Analyzing Multi-Band Images from Parses

The multi-band camera to capture images before shooting is set to auto mode so that it shoots every ten seconds. Days and times that the wind is in the right direction and at the proper speed to take pictures were determined by following the Website of the Meteoroloji Genel Müdürlüğü. The wind speed should be between 10-15 km / h. Once the proper wind direction and speed have been captured, the kite has been blown and has been followed for some time in the air. When the kite is stationary in the air, the camera system is connected to the kite by releasing about 50-60 m of rope. Ropes were released until the kite on the parcel. In this way the kite has been raised to an altitude of 300-500 m. During the flight, it was constantly checked whether or not the kite was on the parcels. The shooting was finished after the camera shot on the field for about two hours.

After the shooting process was finished, the most suitable land images were selected by examining the images one by one for analysis. The first selected images are positioned on the coordinate plane (Figure 4).

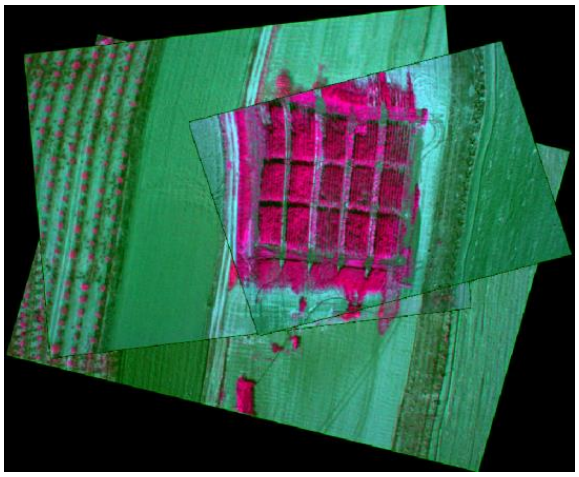

Figure 4
Coordinated picture frames

Then selected images were analyzed with Tetracam PixelWrench2 software. The images were loaded into the program, then calibrated from the 'index' menu. With the calibration process, the maximal reflections of the rays in the near infrared and red regions in the images were determined thus the program is able to calculate the reflection values from the plants by comparing them with these values. Then NDVI calculation was selected from the same menu and the mean NDVI values for each plot individually were calculated. It's one of the analyzed images is shown in Figure 5.

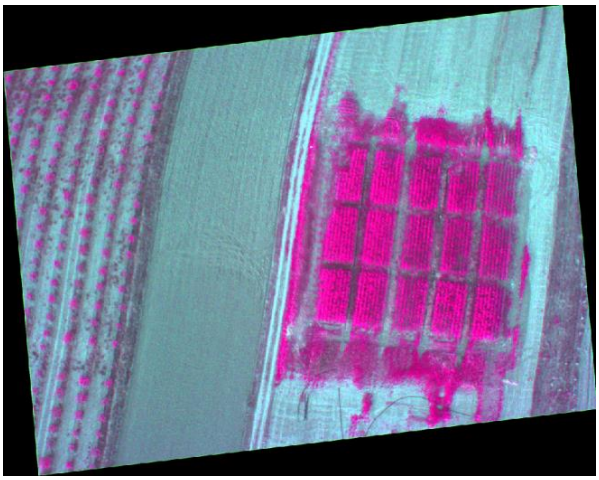

Figure 5
An analyzed image

3. Results and Discussion

3.1. Plant measurements

To obtain different yields, the parcel was named N0 (0kg N), N10 (10kg N), N20 (20kg N), N30 (30kg N) and N40 (40kg N) according to the nitrogen application and three replications were applied. Plant height, number of cobs, height of cobs, stem diameter, leaf length, leaf width, plant weight, leaf weight, cob weight and stem weight were measured during harvesting and the average of the repeated measurements were calculated. The results of these measurements are given in Table 2.

Table 2
Measurements taken from plants during harvest in trial parcels

Nitrogen dose	Length	Number of cob	Height of cob	Stem diameter	Leaf length	Leaf width	Plant weight	Leaf weight	Cob weight	Stem Weight
(kg/da)	(mm)	(tane)	(mm)	(mm)	(mm)	(mm)	(g)	(g)	(g)	(g)
N0 (0kg N/da)	1380,67	0,73	855,83	19,14	719,73	84,93	478,07	86,17	178,50	272,90
N10 (10kg N/da)	1731,67	1,23	524,29	20,53	782,67	122,00	697,93	115,03	257,23	325,67
N20 (20kg N/da)	1917,33	1,07	630,00	19,67	750,07	92,07	633,33	105,50	255,99	271,84
N30(30kg N/da)	1997,33	1,12	468,78	20,87	777,17	99,18	921,33	130,23	375,40	415,70
N40 (40kg N/da)	2075,24	1,37	615,61	21,52	795,11	101,88	1088,34	133,76	518,13	436,46

The obtained yield values of all application parcels and their replicates were evaluated by performing analysis of variance. The results of the analysis of variance obtained are given in Table 3.

When Table 4.2 was examined, it was found that the distribution of yield values obtained after harvest was statistically different between applications ($P < 0.01$), and between repeats were statistically the same ($P > 0.05$).

Table 3
One-way variance analysis results according to yield values between applications and recurrences

Source of Variance	SS	DF	MS	F value	P value
Application	1.19	4	2974736	248.1	0.00**
Recurrence	106306.6	2	53153.3	4.4	0.51
Error	95908	8	11988		
Total	1.2	14			

**P<0.01

The yield values obtained from all the parcels during harvest are given in Table 4 .

Table 4
Yield values of experimental plots according to nitrogen dosing

Nitrogen dose (kg/da)	Yield (kg/da)
N0 (0kg N)	1807
N10 (10kg N)	2673,66
N20 (20kg N	3542,49
N30(30kg N)	4093,78
N40 (40kg N)	4118,425

3.2. Analysis Results of Data Obtained by Remote Sensing

Images taken by remote sensing were taken at three different times: before flowering (15 days before), during flowering and after flowering (10 days after flowering). The obtained NDVI values of the parcels named as N0 (0kg N), N10 (10kg N), N20 (20kg N),

N30 (30kg N), N40 (40kg N) and three replicates were evaluated by analysis of variance and the obtained analysis The results are given in Table 5.

When Table 5 is examined, it is observed that the The distribution of NDVI values obtained during the flowering period is statistically different between applications (P<0.01) and indifferent between repetitions (P> 0.05). It was found that the The distribution of NDVI values obtained before and after flowering were statistically not different between the applications and repetitions at 5% significance level.

The mean NDVI values of the parcels of different nitrogen dose administration calculated from the images taken during all three periods of flowering before flowering and after flowering over the land are given in Table 6.

Table 5
Results of one-way variance analysis according to NDVI values between applications and recurrences

The period the images were taken	Source of Variance	SS	DF	MS	F value	P value
Before flowering	Application	0.03	4	0.007	2.231	0.155
	Recurrence	0.006	2	0.003	0.829	0.471
	Error	0.027	8	0.003		
	Total	0.062	14			
During flowering	Application	0.099	4	0.025	10.691	0.003**
	Recurrence	0.003	2	0.001	0.569	0.588
	Error	0.019	8	0.002		
	Total	0.12	14			
After flowering	Application	0.048	4	0.012	1.542	0.279
	Recurrence	0.002	2	0.001	0.140	0.871
	Error	0.027	8	0.003		
	Total	0.113	14			

**P<0.01

Table 6
The mean NDVI values according to the nitrogen dose applications on the parcel

Applications	Before flowering NDVI values	During flowering NDVI values	After flowering NDVI values
N0 (0kg N)	0.825	0.713	0.769
N10 (10kg N)	0.872	0.846	0.859
N20 (20kg N	0.883	0.880	0.881
N30(30kg N)	0.937	0.935	0.936
N40 (40kg N)	0.945	0.932	0.939

3.3. Relationship Between NDVI Values and Yield Values Obtained by Remote Sensing

Figure 6, Figure 7 and Figure 8 show the yield values measured during harvest in the field and the NDVI values calculated from the images taken images taken as remote sensing data before flowering, during flowering and after flowering over the land.

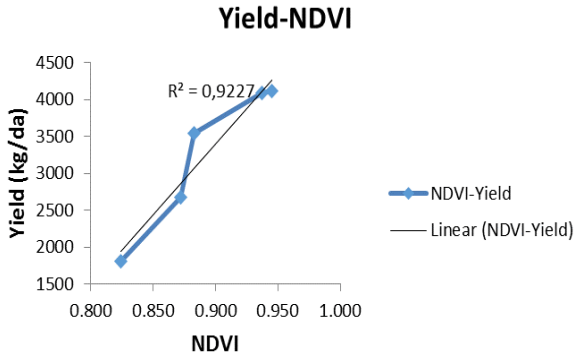

Figure 6
Relationship between NDVI values and yield before flowering

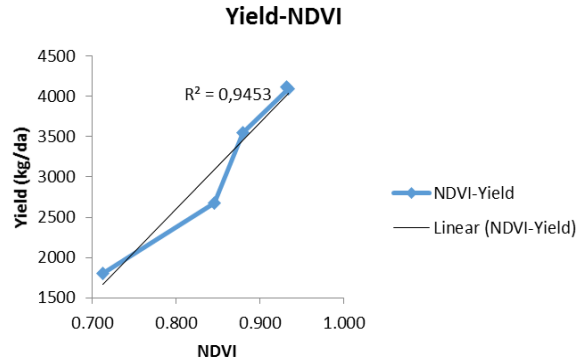

Figure 7
Relationship between NDVI values and yield during flowering

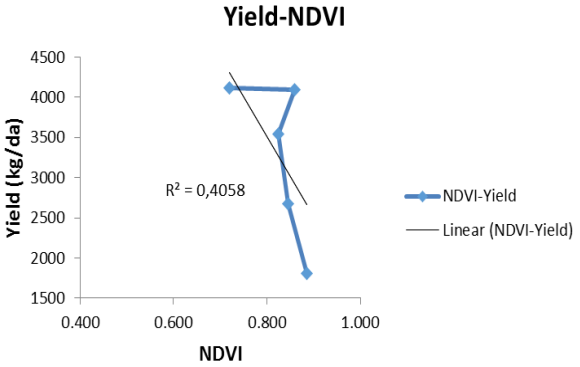

Figure 8
Relationship between NDVI values and yield after flowering

The equations 1, 2, and 3 of the graphs in Figure 6, Figure 7, and Figure 8, respectively, are given below.

$y = 19{,}208x - 13894$ (1)

$y = 10{,}651x - 5923{,}8$ (2)

$y = -9{,}9988x + 11515$ (3)

In the equations for the graphs in the figures, y is the value of the equation, and x is the NDVI value. In order to know how high the relation between the two variables is, the determination coefficient (R^2) values are calculated and expressed in the figures. It is understood that the relationship is high as the determination coefficient approaches 1, and the relationship is low as it moves away from 1.

As can be seen, the relationship between yield and NDVI values is very high (R^2 = 0.945) when images taken during the flowering period are used. This shows that the NDVI values calculated from the data obtained in the flowering period can be used to estimate the yield with high accuracy in the corn plant.

5. Conclusions and Recommendations

In this study, remote sensing images of silage corn plants planted in Selçuk Üniversitesi Sarıcalar Araştırma ve Uygulama Çiftliği in Konya were analyzed. Images from the land were taken using a special sensor camera capable of recording the near infrared, red and green wave lengths used in the remote sensing technique and the kite system. NDVI values were calculated by using these wave lengths on the images and the relationship between these values and the yield is determined. Thus the adequacy of these values were determined for use in yield estimation..

The plant height, number of cobs, height of cobs, stem diameter, leaf length, leaf width, plant weight, leaf weight, cob weight and stem weight were determined in the study. It has been investigated in which vegetative period of growing silage corn plant can be used to estimate the yield of remote sensing. It has been determined that the flowering period, which is the most prominent of the vegetative development, is the best time to take the remote sensing data. In the flowering period of the plant, the relationship between the yield and the NDVI values calculated from the remote sensing data was found to be very high (R^2 = 0.945).

In comparison with previous studies, Şimşek et al. (2007) found a relatonship between estimated yield values and observed yield values at r ² = 0.9067 in a study on wheat yield estimation and Unal and Aydoğdu (2012) found that the relation between biomass and TNDVI (Transformed Normalized Difference Vegetation Index) variables calculated by the Light Use Activity (LUE) model from satellite data is r^2 = 0.69 in studying the relationship between biomass and vegetation index.

The kite system used for taking images in this study is the cheapest system among the above picture taking systems. Because the system consists of kite, rope and picture taking system and it can be used repeatedly without any other expense (Üstüntaş and Bacaksız, 2010).

Open space is required for this system. The system can be used in the field. The picture-taking can be done in the open field with the appropriate wind. Pictures can be taken at times of 10-15 km / h wind speed depending on the weather conditions. Kite can not be removed under these values, it is difficult to control it below these values.

As a result of the study, a linear equation was established by using the relationship between NDVI values and yields of the flowering period in which the yield-NDVI relation is highest. This equation can be used for similar yield estimation studies due to the high correlation found.

Although yield prediction studies using this kind of low platform were not previously available for silage corn plants in this region, the data obtained in this study can be used in estimating yields using low or high remote sensing platforms. Such studies are important because of the increase in corn cultivation in the region and the fact that it is an important commercial plant due to the high importation of corn.

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Comparison of Resampling and Bayesian Approaches in Variance Component Estimation of a Hierarchical Univariate Mixed Effect Model

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ABSTRACT

The purpose of the study is to investigate the relative performance of two estimation procedures, a semi-frequentist estimation technique (via a Bootstrapped the restricted maximum likelihood: Bootstrap-REML) and Bayesian method (via a Gibbs sampler), for estimation of variance components of a two level hierarchical linear mixed model. For this purpose one variable named X was generated using R simulation with the structure of two level nested designs which showed Gaussian distribution. The variable X contains 10000 data, with an average of 0 and variances of 100 and. For this data, five different scenarios were created according to the rate of variance components and analyzes were carried out. All of the estimations and definitions of autocorrelation, changes of the total variance and estimation biases were performed for the posterior distributions and bootstrapped parameter distributions of all the scenarios. In general, the results obtained with both methods are close to each other, although the bias of the results obtained with the Gibbs sampling method was found less and autocorrelation was not found for Gibbs sampling estimates. In conclusion, according to the results of this study, it is not possible to say that using the Bootstrap-REML estimator under Gaussian distribution and balanced data is a good alternative to Bayesian Gibbs sampler.Perhaps different results may be obtained from another study using unbalanced data, non-normally distributed data and high sample sizes.

1. Introduction

Two different approaches are effective in statistics; these are the classical (frequentist) approach and the probabilistic (Bayesian) approach (Browne & Draper 2006; Wagenmakers et al 2008). The classical approach is based on the deductive method and evaluates the parameter as an unknown constant and is based on the frequency-based estimation of probability. The Bayesian approach is a technique based on the induction method and evaluates the parameter as a chance variable with a probability distribution. The Bayesian approach reveals the probability of an event by combining it with experience (prior) with the information obtained from the trial.Bayesian theorem gives the relationship between conditional probabilities and marginal probabilities in a probability distribution for a random variable.Bayes Theorem was presented in 1763 with the article "An Essay towards Solving a Problem in the Doctrine of Chances" written by Thomas Bayes, a British priest and mathematician. Although centuries have passed since its publication, the theory has found its chance to regain popularity after the mid-20th century.The classical approach accepts the frequency definition of probability. According to this definition, the probability of an event is the frequency of many repeated attempts of that event. In the Bayesian approach, the parameter is considered as a random variable with a probability distribution. Accordingly, a prior probability distribution is determined for the estimator of the parameter. Thus, past experiences are included in the analysis. The final probability distribution (posterior) of the parameter is obtained by combining with the actual data. In the classical approach, the parameter is seen as an unknown constant. Parameter estimation is calculated only based on the data available. The Bayesian approach, the point estimate of the parameter is usually the mean value of the final distribution (posterior mean), when the value calculated using appropriate methods is defined as the best estimate (point estimate) in the frequentist approach.

Resampling is a way to reuse observations of existing sample data to create new hypothetical samples that represent the actual population. It is generally used when the population distribution is unknown and in cases where effective sample size is difficult to reach.

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Some resampling methods (Bootstrap, Jackknife, etc.) have been used frequently in recent years for making predictions of unknown parameters of a population, establishing confidence intervals and testing hypotheses. Bootstrapping is the most popular resampling method today and uses sampling with replacement to estimate the sampling distribution of the estimator (Delpish 2009). The difference between resampling methods and Bayesian approach is based on repetitive sampling in the same sample in resampling technique. However, in the Monte Carlo simulation, the data is created purely on a theoretical basis through an algorithm. The use of resampling methods for parameter estimation as an alternative to the classical approach is similar to the Bayesian approach when there is no prior knowledge of the parameters of the population being studied, but only one sample is observed. This parameter estimation method, which basically contains the frequentist algorithm but looks like a Bayesian technique, can be called a semi-frequentist approach.

Statistical models are three types as a fixed effect, random effect, mixed effect. While the hypothesis tests that compare the classes of the variables are performed for fixed effect models, it is desired to know the rates of the components that create total variation in random and mixed effect models (Searle et al 2006; Rash & Masata 2006). One of the goals of applied statistical methods is to estimate variance components. Researchers want to determine the components of the variance observed in the data obtained at the end of the experiment and how much of total variance is caused by which reasons (Dağ et al 2003; Gökmen et al 2008; Altay et al 2019). It is desirable that the rate of error variance is small in the total variance and that the part of the total variance that can be explained by mixed effects is high. Researchers want to make some generalizations or conclusions based on their results (Zülkadir & Aytekin 2009; Aytekin et al 2019). Many studies are carried out to estimate the variance components in fields such as agriculture, genetics, medicine, economics, astronomy and space sciences, and physics, where the applied statistics field is used extensively (Zülkadir et al 2008).

In a mixed linear model ($y = Xb + Zu + e$), if the variance-covariance matrix V is unknown, then the variance D of $V = ZDZ' + R$ and the error variance R must be estimated. The estimation of these two matrices forming V is called the estimation of the variance components. Various methods have been developed to make these predictions. The first studies for the estimation of variance elements were performed by R. A Fisher (Robinson 1987, Searle et al 2006). The basic principle of this method, known as the ANOVA (Analysis of Variance) method, consists of solving the linear equation system obtained after equalizing the mean of squares to their expected values (Theobald et al 1997). However, studies at that time were limited only to balanced data or single factor unbalanced data (Robinson, 1987). Henderson developed the methods named after him (Henderson Type 1, 2, 3) (Searle et al 2006). Since ANOVA and Henderson methods are designed for balanced data, negative variance elements can also be estimated in the data obtained from the sample. In contrast, ML (Maximum Likelihood-maximum likelihood) and REML (Restricted Maximum Likelihood-restricted maximum likelihood) methods have been developed (Hartley & Rao 1967; Patterson & Thompson 1971). These two methods based on likelihood are asymptotic normality, consistency and being within the parameter definition range (Fırat 2000). ML and REML methods are the most used applications because the variance elements do not give negative estimates. Different estimators are also used in the Bayesian estimation of variance elements. According to the Bayesian approach, the expected values are obtained by selecting samples from the required distribution with Monte Carlo integration and using the sample averages. There are estimation methods such as Metropolis Hastings algorithm and Gibbs sampling to obtain Markov chains according to specific properties. Gibbs sampling, which is a powerful iterative method for estimating posterior distributions, is a very popular method for predicting variance components. Gibbs sampling approaches the joint conditional density function of all parameters in the model by sampling from all full conditional density functions (Fırat, 1996).

In a study by Harville (2004), was reported to the Gibbs sampler can be used to estimate iterates of a first-order REML algorithm. In the study, it was claimed that the use of the REML estimator is good for large data sets and the use of the Gibbs sampler is a good alternative to traditional numerical methods.In a study by Browne & Draper (2006), simulation studies whose design is realistic for education and medical research (and other research areas) were used to compare Bayesian and probability-based methods for the estimation of variance components.In the study performed by Delpish (2009), the variance components were estimated in the sample distributed χ^2 using the minimum norm quadratic estimation estimator with the Bootstrap technique and using REML estimator for a two-level hierarchical linear model.According to the results of the study, although the estimations of fixed effects are correct both through Bootstrap MINQUE and REML, the efficiency of the estimates was determined to be affected by the distribution of errors for both procedures, especially for variance-covariance component estimates.It was concluded that the Bootstrap via MINQUE appears to be an attractive alternative to estimation in cases where normality is not guaranteed.The purpose of the study is to investigate the relative performance of two estimation procedures, a semi-frequentist estimation technique (via a Bootstrapped the restricted maximum likelihood: Boot-REML) and Bayesian method (via a Gibbs sampler), for estimation of variance components of a two level hierarchical linear mixed model.

2. Materials and Methods

In the study, one variable named X for the structure of two level nested designs was obtained using simulations in an R package which showed Gaussian distribution. The variable X contains 10000 data, with an average of 0 and variances of 100 which are shown in the frequency histogram plots in Figure 1.

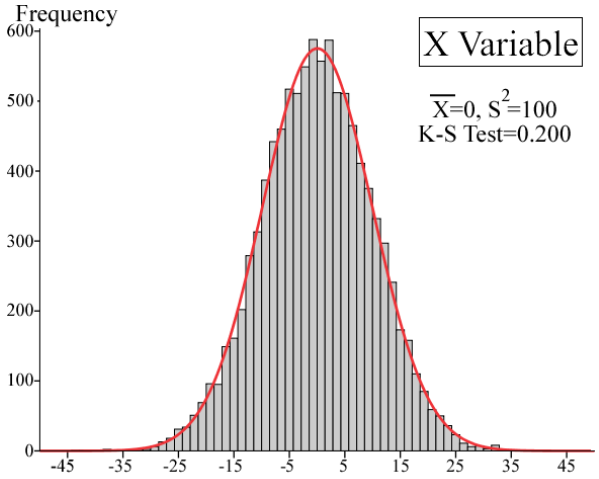

Figure 1
Frequency histogram with Gaussian distribution curve-of X variable

According to the two levels of nested design (a and b (a)), which constitute the two factors that this X variable is associated with, 5 different scenarios have been constructed using the classical ML estimator for the proportions of the variance components. The five different scenarios mentioned are presented in Table 1.

Table 1
Variance components scenarios of simulated data

Scenario	σ_a^2	$\sigma_{b(a)}^2$	σ_e^2
1	2	3	95
2	20	5	75
3	45	5	50
4	70	5	25
5	90	5	5

In the analysis of the data, the univariate mixed linear model shown as y = Xβ + Zu + e was used for the N dimensional y observation vector. In the model, X, g dimensional fixed effects vector; mat, Nxg dimensional fixed effects pattern matrix; Z, s dimensional chance-related effects vector; u is the pattern matrix of Nxs dimensional chance-related effects and e is the vector of N-size chance-related errors.

The Gibbs sampler was used in Bayesian analysis of variance component estimation. the prior distribution in Gibbs sampling; the uniform prior ($f(\beta)$=sabit) for fixed effect parameter and it is assumed that random effects show normal distribution ($u|\sigma^2_a \sim N(0,I,\sigma^2_a)$). It is assumed that the conjugate density functions of the prior distributions of the variance components σ_a^2, $\sigma^2_{b(a)}$and σ_e^2 as follows (1);

$$f\left(\sigma_a^2,\sigma_{b(a)}^2,\sigma_e^2 \mid v_a,s_a^2,v_{b(a)},s_{b(a)}^2,v_e,s_e^2\right) \propto (\sigma_a^2)^{-\frac{1}{2}(v_a+2)}(\sigma_{b(a)}^2)^{-\frac{1}{2}(v_{b(a)}+2)}(\sigma_e^2)^{-\frac{1}{2}(v_e+2)} exp\left[-\frac{1}{2}\left(\frac{v_a s_a^2}{\sigma_a^2}+\frac{v_{b(a)}s_a^2}{\sigma_{b(a)}^2}+\frac{v_e s_e^2}{\sigma_e^2}\right)\right] \quad (1)$$

It is understood from this function (1), that σ_a^2, $\sigma^2_{b(a)}$ and σ_e^2 follow independent and inverse chi-square distributions. Thus, σ_a^2, $\sigma^2_{b(a)}$ and σ_e^2 are interpreted as the prior expected values of σ_a^2, $\sigma^2_{b(a)}$ and σ_e^2, respectively, whereas the precision parameters are equivalent to the degrees of freedom of v_a^2, $v^2_{b(a)}$and v_e^2 (Fırat, 1996a). Gibbs sampling, which is a powerful iterative algorithm to study posterior distributions in complex Bayesian models, generates sample values for the common posterior density distribution of all parameters in the model by sampling from all full conditional distributions, respectively. For this purpose, all variables (β, u, σ_a^2, $\sigma^2_{b(a)}$ and σ_e^2) are given a random initial value and a Markov chain is created when a cycle is completed by updating the previous one for each variable (Fırat, 1996b).

In this study, this process was repeated 55000 times for variable X and repeated each scenario, and marginal posterior distributions were obtained from a single long chain per scenarios. In the meantime, the first 5000 burn-in parts of Gibbs chains were removed, and the thinning interval value was accepted as 200 for the remaining chain for dilution according to the effective independent sample numbers calculated by using time-interval auto-covariances. Gibbs sampling was performed using the R program's MCMCglmm library (Hadfield, 2010). In this study, simulation data was used and no fictional data was simulated, and parameters were selected appropriately for convenience in calculations and estimates. In the estimates of the variance components of each scenario obtained from the mentioned data, the methodology of the REML estimation is described by Fırat (2000). As explained by Efron & Tibshirani (1993), Bootstrap technique was applied for variable X and each scenario. For this purpose, in the data set consisting of 10000 observations, the observations were changed and bootstrap sample datasets were generated with a choice of 1/10000 probability. In the study, 250 different samples were obtained with the Bootstrap method for each scenario and the SAS macros presented below were written to perform this operation. The SAS program macro also includes the varcomp procedure and REML method used for variance component estimation.

Table 2
A SAS macro codes for Bootstrapped REML variance component estimator

```
title'Simulated Data forBootstrapping
REML';
dataefruz;
input f1 f2 ID X1;
label f1  ='Effect 1'
         f2  ='Effect 2'
         ID  ='ID'
          X1  ='X variable';
datalines;
1      201    601    19.76
1      201    602    4.62
1      201    603    6.12
.      .      .      .
.      .      .      .
.      .      .      .
200    600    10599 22.84
200    600    10600 25.22
;
%macroboot;
%letn_boot=250;
%do i=1%to&n_boot;
       data cboot1;scan: set
       efruzend=last;n+1;
if not lastthengotoscan;
do j=1to n;
seed=floor(1000000000*(sqrt(time())-
floor(sqrt(time()))));
k=ceil(ranuni(seed)*n);
setefruzpoint=k;
if _error_ thenabort;
output;
end;
stop;
run;
       data a3;set cboot1 ;
newobs=_n_;
run;
data boot52;set a3;
run;
procvarcompdata=boot52 method=reml;
Class f1 f2 x1 ;
model x1 = f1 f2(f1);
run;
       %end;
              %mendboot;
              %boot
```

After all estimations the definitions of autocorrelation and bias were performed on the posterior distributions and bootstrapped parameter distributions generated for the variance components of each of the scenarios. Data simulation, Gibbs sampling, Durbin-Watson statistic and, all other statistical analyses were performed using different packages of the R program, Bootstrap and REML estimations of variance components were performed using different procedures of the SAS program.

3. Results and Discussion

The descriptive statistics of posterior distributions of parameters and the distributions of Bootstrap samples are presented in Table 3 and Table 4, respectively.

Table 3
The descriptive statistics of posterior distributions of variance component estimates (VC) from Gibbs sampler

Scenario	VC	Mean	SE	Median	Confidence Intervals	
					2.5%	97.5%
S1	σ_a^2	2.05	0.01	2.05	2.02	2.08
	$\sigma_{b(a)}^2$	3.04	0.01	3.04	3.02	3.07
	σ_e^2	93.95	0.06	93.91	93.82	94.07
S2	σ_a^2	21.09	0.11	21.06	20.84	21.34
	$\sigma_{b(a)}^2$	4.60	0.02	4.57	4.55	4.64
	σ_e^2	73.82	0.05	73.77	73.71	73.93
S3	σ_a^2	45.35	0.19	45.07	44.91	45.78
	$\sigma_{b(a)}^2$	4.66	0.02	4.68	4.62	4.71
	σ_e^2	49.34	0.03	49.34	49.27	49.42
S4	σ_a^2	70.82	0.31	69.98	70.12	71.52
	$\sigma_{b(a)}^2$	4.15	0.01	4.15	4.12	4.19
	σ_e^2	24.79	0.02	24.79	24.76	24.83
S5	σ_a^2	91.53	0.42	90.82	90.57	92.48
	$\sigma_{b(a)}^2$	3.88	0.01	3.86	3.85	3.92
	σ_e^2	4.60	0.00	4.60	4.59	4.61

The mean and median values of the distributions obtained by estimating the variance components with both Gibbs sampling and the Bootstrap-REML estimator show that the posterior distributions are Gaussian.

Table 4
The descriptive statistics of variance component estimates (VCE) distributions of Bootstrap-REML estimation

Scenario	VC	Mean	SE	Median	Confidence Intervals	
					2.5%	97.5%
S1	σ_a^2	7.05	0.05	7.08	6.94	7.16
	$\sigma_{b(a)}^2$	2.12	0.04	2.12	2.04	2.20
	σ_e^2	88.76	0.09	88.75	88.56	88.95
S2	σ_a^2	23.24	0.04	23.22	23.16	23.32
	$\sigma_{b(a)}^2$	5.22	0.04	5.17	5.12	5.31
	σ_e^2	69.88	0.08	69.82	69.70	70.06
S3	σ_a^2	46.40	0.03	46.45	46.34	46.47
	$\sigma_{b(a)}^2$	5.33	0.03	5.35	5.26	5.41
	σ_e^2	46.65	0.07	46.60	46.50	46.80
S4	σ_a^2	72.40	0.02	72.41	72.34	72.45
	$\sigma_{b(a)}^2$	2.46	0.02	2.43	2.41	2.52
	σ_e^2	23.53	0.05	23.45	23.42	23.65
S5	σ_a^2	92.93	0.01	92.93	92.90	92.96
	$\sigma_{b(a)}^2$	1.64	0.01	1.62	1.61	1.68
	σ_e^2	4.03	0.02	4.02	3.99	4.08

By the scenarios and components, the amount of bias (%), change (%) and Durbin Watson statistics for distributions estimated using Gibbs Sampling and Bootstrap-REML estimatorwere presented in Table 5 and Table 6, respectively.

Significant differences were observed between Bootstrap-REML and Gibss sampling methods in terms of biases in parameter estimates and changes in total variance. When Gibbs sampling results are examined, biased results are lower in scenarios where the error variance share is large, on the contrary, bias in estimates increased as the rate of error variance decreased. In the Gibbs sampling method, the bias of the b(a) factor of nested designed model was found to be higher than the bias results of other variance components.In terms of biased estimates in the estimation of variance elements, the results of the Bootstrap-REML method were found worse than the Gibbs sampling.

Especially in scenario 1 where the error variance is highest, the biases realized with the Bootstrap-REML method for σ_a^2, $\sigma_{b(a)}^2$ and $\sigma_e^2$are 257.37%, 29.27% and 6.57%, respectively. In terms of bias in estimates, the results obtained for scenario 4 and scenario 5 were found to be quite high in the analyses made with the Bootstrap-REML method. The lowest biased variance component estimation results were found for Gibbs sampling for scenario 1and for Bootstrap-REML for scenario 3.

Table 5
The amount ofbias (%), change (%) and Durbin Watson statistics for distributions estimated using Gibbs Samplingby scenarios and components

	Variance Component	Bias %	Change %	Durbin Watson
S1	σ_a^2	2.49	0.96	1.90
	$\sigma_{b(a)}^2$	1.46		2.05
	σ_e^2	1.11		1.95
S2	σ_a^2	5.46	0.49	1.87
	$\sigma_{b(a)}^2$	8.10		1.99
	σ_e^2	1.57		1.99
S3	σ_a^2	0.77	0.65	2.10
	$\sigma_{b(a)}^2$	6.70		1.96
	σ_e^2	1.31		2.01
S4	σ_a^2	1.18	0.23	2.03
	$\sigma_{b(a)}^2$	16.93		2.04
	σ_e^2	0.83		2.12
S5	σ_a^2	1.70	-0.01	1.92
	$\sigma_{b(a)}^2$	22.31		2.07
	σ_e^2	7.98		1.98

Table 6
The amount of bias (%), change (%) and Durbin Watson statistics for distributions estimated using Bootstrap-REMLby scenarios and components

	Variance Component	Bias %	Change %	Durbin Watson
S1	σ_a^2	252.37	2.07	0.06
	$\sigma_{b(a)}^2$	29.27		0.02
	σ_e^2	6.57		0.05
S2	σ_a^2	16.19	1.66	2.04
	$\sigma_{b(a)}^2$	4.30		2.06
	σ_e^2	6.82		1.92
S3	σ_a^2	3.12	1.61	2.12
	$\sigma_{b(a)}^2$	6.65		2.27
	σ_e^2	6.70		2.28
S4	σ_a^2	3.43	1.61	1.94
	$\sigma_{b(a)}^2$	50.75		1.91
	σ_e^2	5.87		2.19
S5	σ_a^2	3.26	1.39	2.20
	$\sigma_{b(a)}^2$	67.13		1.76
	σ_e^2	19.35		2.12

The distributions of parametersobtained from Gibbs sampling and Bootstrap-REML estimator were presented in Figure 2 and Figure 3, respectively.

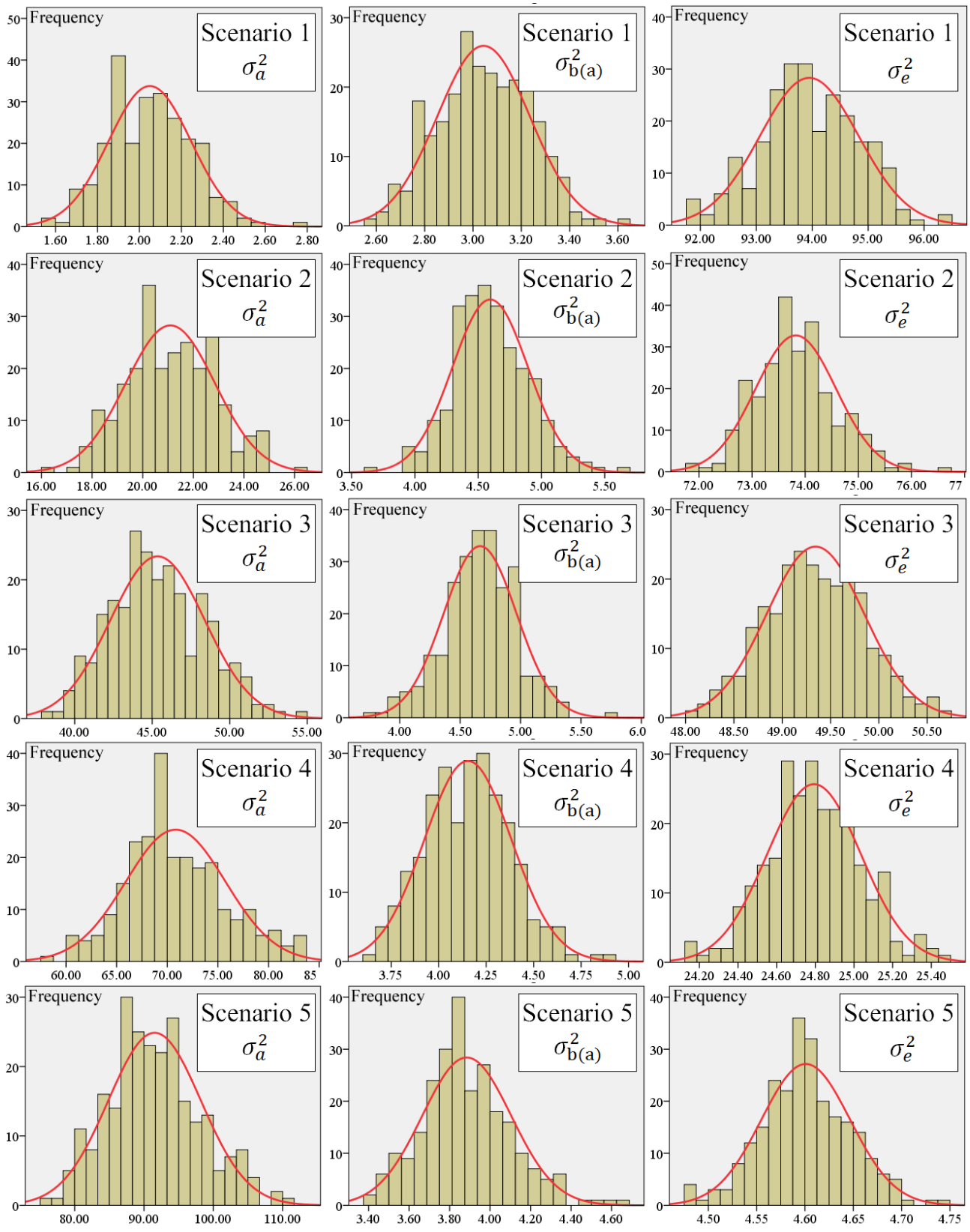

Figure 2
The frequency distributions for variance components estimated using the Gibbs sampling for each scenario and for each parameter

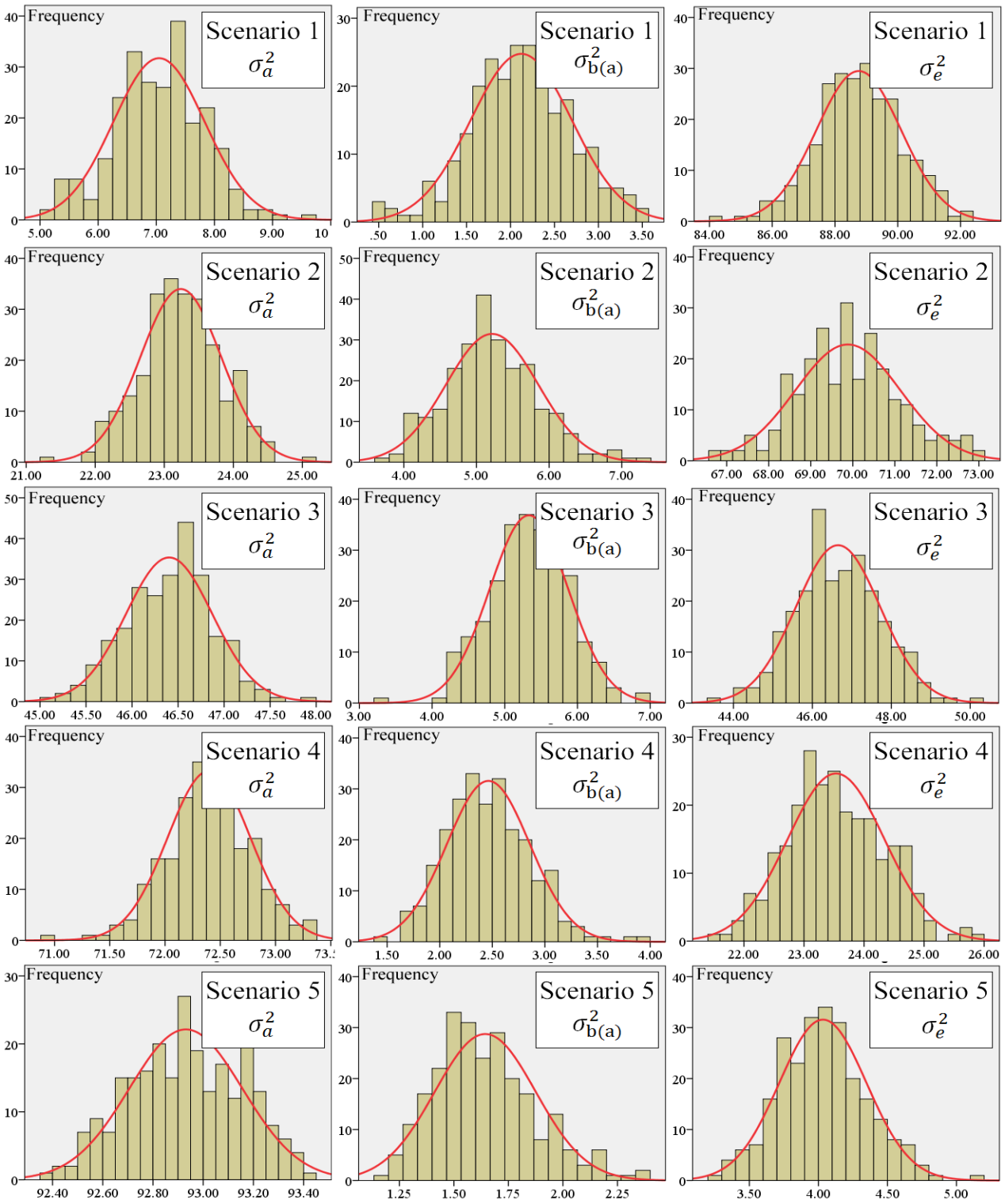

Figure 3
The frequency distributions for variance components estimated using the Bootstrap-REML sampler for each scenario and for each parameter

Similar results were obtained for both estimation methods in terms of changes in the total variation, which is another criterion in which Gibbs sampling and Bootstrap-REML method can be compared in the estimation of variance components. Similar results were obtained for both estimation methods in terms of changes in the amount of total variance, which is another criterion in which Gibbs sampling and Bootstrap-REML method can be compared in the estimation of variance components. While the decrease in the total variance estimated by both methods occurs, the amount of this decrease is less of the Gibbs sampling method than the Bootstrap-REML method. In point of autocorrelation, in all the scenarios tested in both estimation methods, only the Bootstrap-REML method deter-

mined a significant positive relationship in the distribution of all three parameters in scenario 1.

In a study conducted by Delpish (2009), variance elements were estimated by using REML and Bootstrap-Minque estimators, and bias amounts were quite small in accordance with this study. Different researchers (Swallow & Monahan 1984; Raudenbush & Bryk 1986; Delpish 2009; Narinç et al 2011) have performed similar comparison using different variance component estimator for balanced-unbalanced data or non-Gaussian distributed data. In this study, 5 different scenarios were emphasized by keeping the sample size (10000) constant. Based on the results of Delpish's work, it is possible to say that the Bootstrap-MINQUE is an attractive alternative to predictions when normality is not guaranteed. Maas & Hox (2005) proposed a similar proposal, according to which they said that Bootstrap was a different approach that caught the attention of analysts if the assumption of normality was violated. However, according to the results of this study, it is not possible to say that using the Bootstrap-REML technique under Gaussian distribution is a good alternative. Perhaps different results may be obtained from another study using unbalanced data, non-normally distributed data and high sample sizes. Therefore, it is recommended that the similar study be carried out for unbalanced data, non-normally distributed data and high sample sizes.

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Fuzzy Knowledge-Based Model for Prediction of the Terminal Velocities of the Chickpea and Dry Bean Seeds

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ABSTRACT

Aerodynamic properties of solid materials have long been used to convey and separate seeds during harvest and postharvest operations. In this study, the terminal velocities of chickpea (Cicer arietinum L.) and dry bean (Phaseolus vulgaris L.) seeds as a function of seed mass and projected area were determined and also it was predicted by the fuzzy knowledge-based model. The results showed that the terminal velocity increased non linearly from 6.46 to 7.567m s^{-1} for chickpea and from 5.224 to 6.463 m s^{-1} for dry bean with an increase in seed mass and projected area. In this paper, a sophisticated intelligent model, based on Mamdani approach fuzzy modeling principles, was developed to predict the terminal velocities of chickpea and dry bean seeds. The verification of the proposed model is achieved via various numerical error criteria. The relative error of predicted values was found to be less than the acceptable limits (10%).

1. Introduction

Chickpea (Cicer arietinum L.) and dry bean (Phaseolus vulgaris L.) are a high protein (22-34%) legume crop used primarily for direct human consumption. It is best adapted to the cooler temperate zones of the world, or the winter season in the Mediterranean climates. In Turkey, legume production has a total area of 8.8 million decars. Chick pea and dry bean are planted in 67% of this area. The total production of chickpeas and dry beans is about 850,000 tons that is about 70% of total legume production.

In handling and processing of agricultural products air or water are often used as a carrier transport for the separationofthedesirableproductfromthatofunwanted materials. Seed deparation can be accomplished by using pneumatic separators, screen cleaners, or gravity tables. Many commercial cleaners incorporate more than one of these cleaning methods. Thepneumatic separation and conveying systems have been used in agricultural machinery and food processing equipment for many years. When an air stream is used for separating a product such as legume from its associated foreign materials, such as straw and chaff, knowledge of aerodynamic characteristics of all the particles involved is necessary. Therefore, the aerodynamic properties, such as terminal velocity, and drag coefficient, are needed to determine the proper air speed in either air conveyor or pneumatic separator. These parameters are affected by the density, shape, size, and moisture content of produce (Mohsenin, 1978; Omobuwajo et al., 1999; Gupta, et al., 2007)).

Several investigators determined the terminal velocity of various seeds such as African bread fruit seeds by Omobuwajo et al. (1999), millet grain by Baryeh (2002), pine nuts by Ozguven and Vursavus (2005), lentil seeds by Çarman (1996), makhana by Jha and Kachru(2007)and pistachio nut by Razavi et al. (2007).Terminal velocities were measured for both tef grain and straw. Terminal velocity increased linearly from 3.08 to 3.96ms^{-1} with increase in moisture content from 6.50% to 30.21% w.b. by Zewdu (2007). Kural (1995)found that the effect on terminal velocity of the projection area, mass and sphericity of agricultural

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producesuch as wheat, barley, lentil and dry bean,were significant.

Fuzzy logic, which was first introduced by Zadeh (1965), is a self-learning technique that provides a mathematical tool to convert linguistic evaluation variables based on expert knowledge into an automatic evaluation strategy. Fuzzy set theory has been applied to a wide range of applications, such as process control, management, economic decision-making, operations research, event classification and image processing. Farzaneh et al., (2017) used a fuzzy system to predict physical properties of the fava bean seeds including geometric values as such length; width; thickness; arithmetic and geometric mean diameter; sphericity index surface and the area of the image. Yang et al. (2005) showed the feasibility of image processing and fuzzy logic control in the development of a precision farming herbicide application system. Çarman (2008) used a fuzzy system to predict soil compaction under pneumatic tires.

The objective of this study was to investigate the terminal velocities as a function of mass and projected area of chickpea and dry bean seeds. Inaddition, in this study was the construction of fuzzy knowledge-based models for the prediction of the terminal velocities based on the Mamdani approach. The mathematical and statistical methods were used to validate the fuzzy models.

2. Materials and Methods

The chickpea and dry bean seeds used for the present study were obtained from a farmer field in the Çumra district of Konya that were cultivated in 2019 cultivation season. After attaining optimum maturity, samples of the seeds were harvested by hand and cleaned in an air screen cleaner. The harvest moisture content of chick pea and dry bean seeds was 16% and 26 % (w.b.). Thirty randomly chosen seeds were measured and the mean valued determined in experiments. Some physical properties of the chick pea and dry bean seeds were given in Table 1.

Table 1
Some physical properties of the chick pea and dry bean seeds

		Chickpea	Dry bean
Seed mass (g)	Max	0.550	0.580
	Mean	0.427	0.436
	Min	0.240	0.290
Projected area (cm^2)	Max	0.893	1.089
	Mean	0.656	0.884
	Min	0.497	0.711
Sphericity index (%)	Max	91.50	69.70
	Mean	85.41	62.73
	Min	77.70	57.20

The seed shapes were determined in terms of their sphericity and roundness indices as well as the aspect ratio (Mohsenin, 1978) using randomly selected seeds. The volume of a solid is equal to the volume of a triaxial ellipsoid with intercepts a, b and c; the sphericity index (Sp) was therefore defined as;

$$S_p = \frac{(abc)^{1/3}}{a} x100$$

Each seedmasswas weighed with a digital electronic balance having an accuracy of 0.001 g.

The projected area was determined from the pictures of seeds which were taken by a digital camera (13 Mpixels camera), in comparison with the reference area to the sample area by using the Fiji imagej computer program (Isık and İzli, 2007).

To determine the V_t value of chick pea and dry bean seeds, a vertical wind tunnel was designed based on recommendations by Nalbandi et al.(2010), Shahbazi, et al.(2014) and Afonso et al. (2007). A centrifugal fan powered by 0.37 kW motor was used in the inlet of the wind tunnel to supply air flow. The airflow rate of the fan was controlled at the inlet and adjusted by changing the velocity of the electric motor through an inverter set. To measure the V_t of the seeds, a uniform velocity field was required in the cross section of the tunnel, where seeds were suspended. For this purpose, two straightener sections were set up which consisted of one layer of fine wire mesh screen located above the honey comb. The final section of the wind tunnel consisted of a plexiglass region where the V_t of seed was measured. To determine the terminal velocity, each seed was placed in the centre of the crosssection of the wind tunnel on the screen. The air flow was then increased until the seed flotation point. At this moment, when the rotational movement of the seed was lowest, the air velocity was measured using a vane anemometer having at least 0.01 m s^{-1}accuracy. The V_t of each seed was measured three times. For each condition the V_t was calculated as the average of the velocity values obtained at the centre of the test section.

For implementation of fuzzy set theory into the models, the fuzzy logic toolbox from MATLAB R2016a was used. For prediction of terminal velocity by using fuzzy expert system (FES), seed mass and projection area were used as input parameters and terminal velocity was used as output. For fuzzification of these factors the linguistic variables low (L), middle (M) and high (H). In this research, a Mamdani max-min inference for inference mechanism and the center

of gravity (Centroid) defuzzifier formula method for defuzzification were used because these operators assure a linear interpolation of the output between the rules. Total of 9 rules were formed. Rules can be interpreted as follows.

Rule 1: If projection area=L and mass=L then terminal velocity=L

Rule 2: If projection area =L and mass =M then terminal velocity =M

Rule 3: If projection area=L and mass=H then terminal velocity=M

Rule 4: If projection area =M and mass =L then terminal velocity =M

Rule 5: If projection area=M and mass=M then terminal velocity=M

Rule 6: If projection area =M and mass =H then terminal velocity =M

Rule 7: If projection area=H and mass=L then terminal velocity=M

Rule 8: If projection area =H and mass =M then terminal velocity =M

Rule 9: If projection area =H and mass =H then terminal velocity =H

Fuzzifications of the used factors were made by aid follows functions. These formulas are determined by using measurement values.

For chickpea;

$$projection\ area(i_1) = \begin{Bmatrix} i_1; 0.3 \le i_1 \le 1.0 \\ 0;\ otherwise \end{Bmatrix}$$

$$mass(i_2) = \begin{Bmatrix} i_2; 0.1 \le i_2 \le 0.7 \\ 0;\ otherwise \end{Bmatrix}$$

$$terminal\ velocity(o_1) = \begin{Bmatrix} o_1; 4.5 \le o_1 \le 9.5 \\ 0;\ otherwise \end{Bmatrix}$$

For dry bean;

$$projection\ area(i_1) = \begin{Bmatrix} i_1; 0.3 \le i_1 \le 1.2 \\ 0;\ otherwise \end{Bmatrix}$$

$$mass(i_2) = \begin{Bmatrix} i_2; 0.1 \le i_2 \le 0.7 \\ 0;\ otherwise \end{Bmatrix}$$

$$terminal\ velocity(o_1) = \begin{Bmatrix} o_1; 4.5 \le o_1 \le 7.5 \\ 0;\ otherwise \end{Bmatrix}$$

The memberships of the used factors were obtained from above the formulas and shown in the Figures. 1-6. These membership functions helped in converting numeric variables into linguistic terms. For example, the linguistic expressions and membership functions of terminal velocity for dry bean obtained from the developed rules and above the formula were given as following.

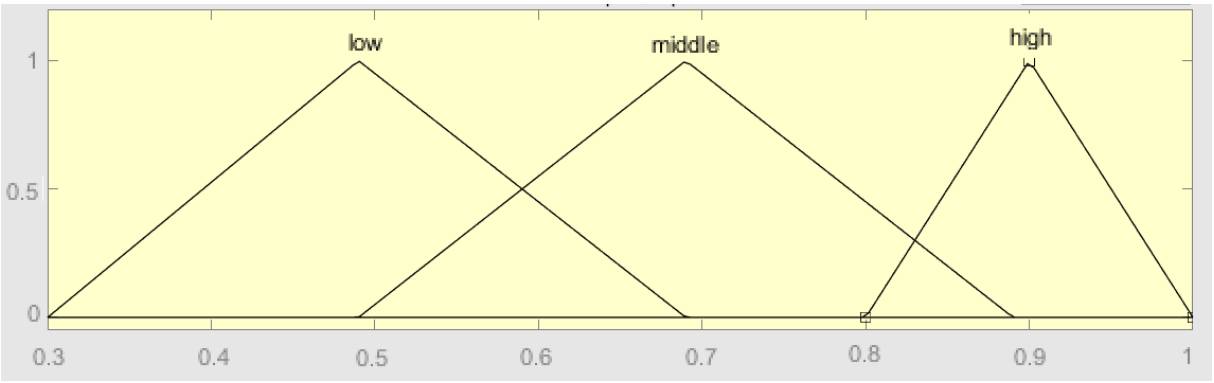

Figure 1
The membership function of projection area (input1) for chickpea.

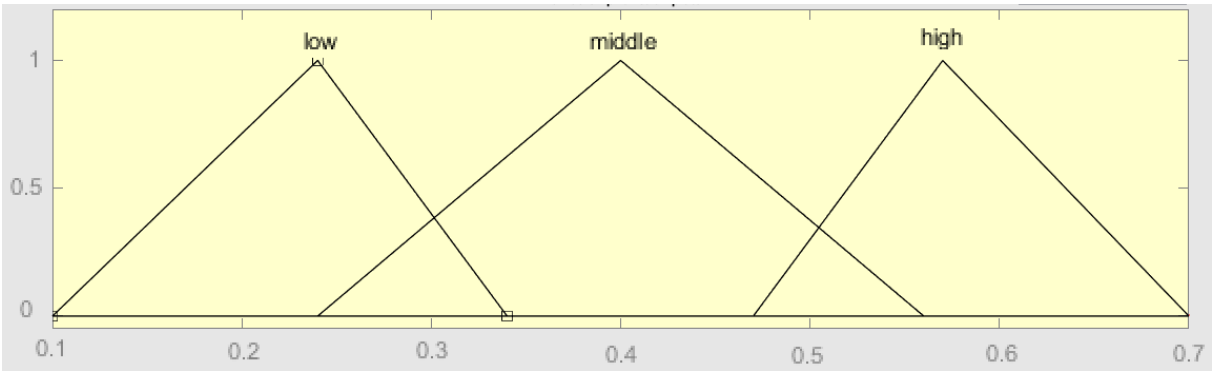

Figure 2
The membership function of mass (input2) for chickpea.

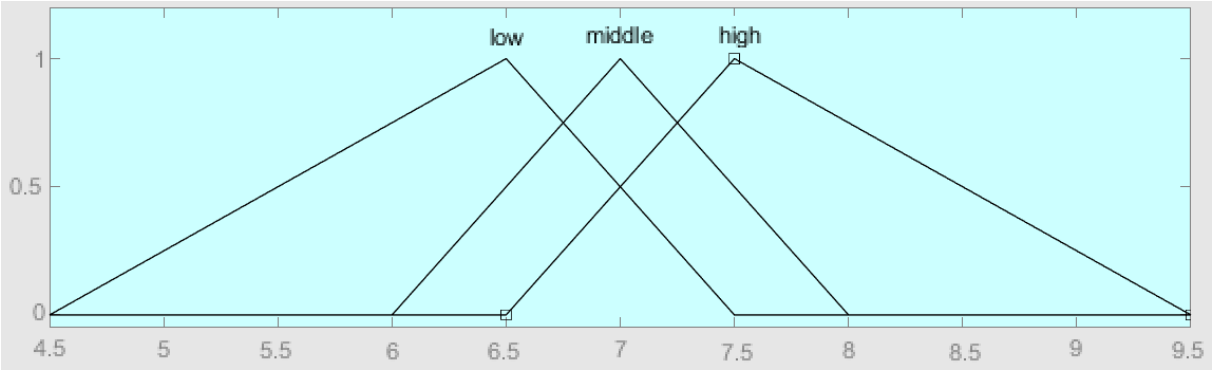

Figure 3
The membership function of terminal velocity (output) for chickpea.

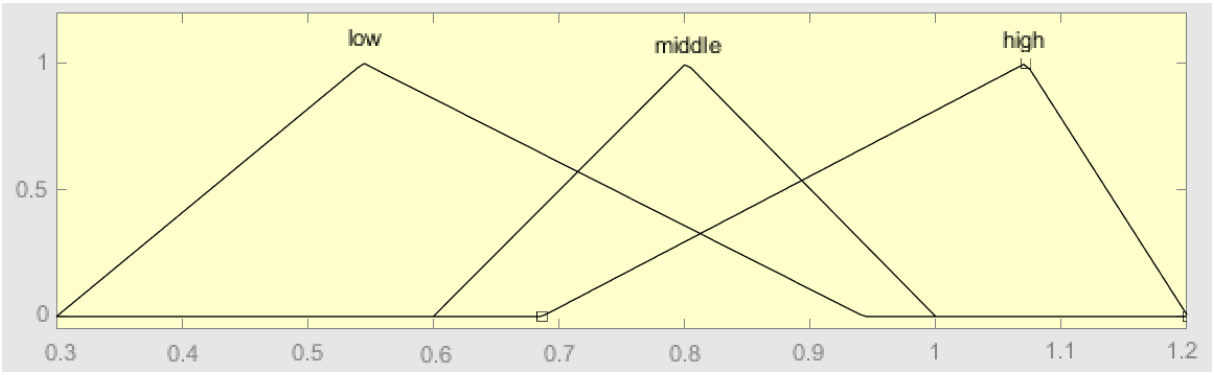

Figure 4
The membership function of projection area (input1) for dry bean.

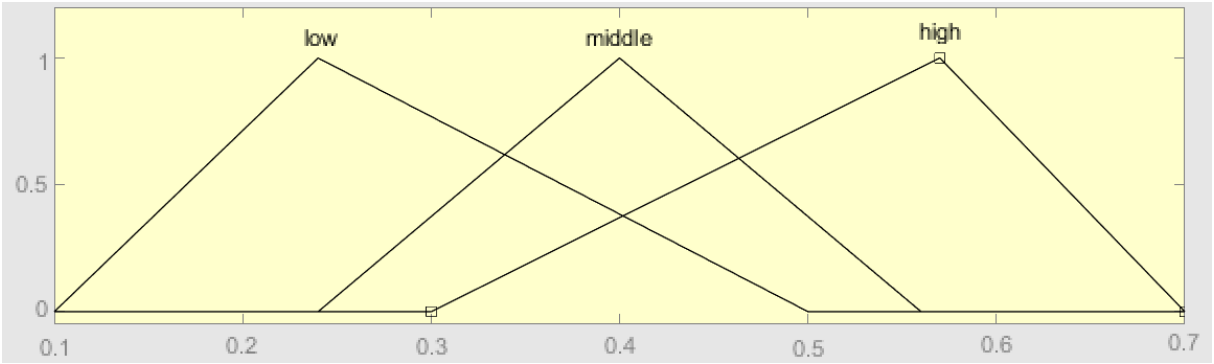

Figure 5
The membership function of mass (input2) for dry bean.

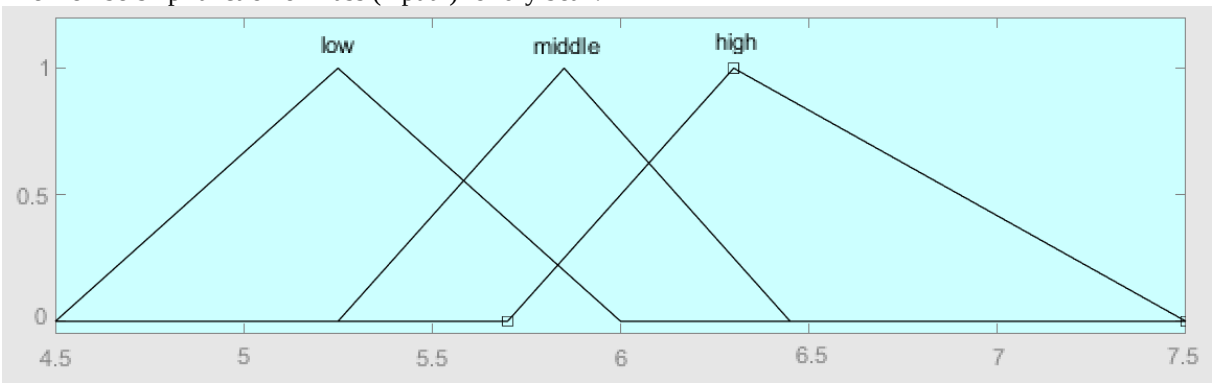

Figure 6
The membership function of terminal velocity (output) for dry bean.

$$\mu_{low}(i_1) = \begin{cases} 0; i_1 < 0.3 \\ \frac{i_1 - 0.3}{0.2443}; 0.3 \le i_1 \le 0.5443 \\ \frac{0.9429 - i_1}{0.3986}; 0.5443 \le i_1 \le 0.9429 \\ 0; i_1 > 0.9429 \end{cases}$$

$$\mu_{middle}(i_1) = \begin{cases} 0; i_1 < 0.6 \\ \frac{i_1 - 0.6}{0.2014}; 0.6 \le i_1 \le 0.8014 \\ \frac{1.0 - i_1}{0.1986}; 0.8014 \le i_1 \le 1.0 \\ 0; i_1 > 1.0 \end{cases}$$

$$\mu_{high}(i_1) = \begin{cases} 0; i_1 < 0.6857 \\ \frac{i_1 - 0.6857}{0.3853}; 0.6857 \le i_1 \le 1.071 \\ \frac{1.2 - i_1}{0.129}; 1.071 \le i_1 \le 1.2 \\ 0; i_1 > 1.2 \end{cases}$$

In defuzzification stage, truth degrees (α) of the rules were determined for the each rule by aid of the min and then by taking max between working rules. For example, for dry bean; $projection\ area(i_1) =$ 0.556 cm^2 and $mass(i_2) =$ 0.21 g, the rule 1 will be fired.

$\propto_1$= min (low projection area, low mass)=min (0.9706, 0.7857)=0.7857

From Mamdani max-min inference, the membership function of system will be found as max($\propto_1$)=0.7857. Then the crisp output can be calculated. In defuzzification, the method center of gravity was used as follows.

$$O^* = \frac{\int O.\mu_{(o)} dO}{\int \mu_{(o)} dO}$$

where O^* is the crisp value of output, O is the fuzzificated value and $\mu_{(o)}$ is the membership degree of fuzzificated value.

The predictive ability of the developed fuzzy logic system was examined according to the mathematical and statistical methods. In order to determine the performances of the results, ε, D and R^2 values that are considered to be the principal accuracy measures and that are based on the concept of the mean error and are commonly used were calculated using the following equations (Mikailsoy et al., 2018):

$$R^2 = 1 - \left(\sum_{i=1}^{n} (\tilde{y}_i - y_i)^2\right) \Big/ \left(\sum_{i=1}^{n} (\tilde{y}_i)^2\right)$$

$$D = 1 - \sum_{i=1}^{n} (y_i - \tilde{y}_i)^2 / \sum_{i=1}^{n} [|y_i - \bar{y}| + |\tilde{y}_i - \bar{y}|]^2$$

$$\varepsilon = \frac{100}{n} \sum_{i=1}^{n} \frac{y_i - \tilde{y}_i}{y_i}$$

Where; R^2 is the coefficient of determination, D is the agreement index, ε is the relative error of the system, n is the number of data, y_i, is the measured ue,$\tilde{y}_i$, is the predicted value, and $\bar{y}$ is the mean value. The index D ranges from 0 to 1, where the value 1 means a perfect accuracy of the predicted data, and the value 0 means that there is no accuracy.

3. Results and Discussion

The values of terminal velocity were found from 6.463-7.567 m s^{-1} for chickpea seeds and from 5.224-6.463 m s^{-1} for dry bean seeds. According to the test results, the greater seed mass and projected area tests showed higher values of terminal velocity. The greatest terminal velocity obtained at seed mass of 0.55 g and projected area of 0.776 cm^2 for chickpea and at seed mass of 0.54 g and projected area of 1.089 cm^2 for dry bean. Kural (1995) reported that variation in physical properties of seeds such as mass, sphericity index and projected area, influenced terminal velocity significantly. The similar results was also found among seeds: lentil by Shahbazi et al., (2015), millets by Baryeh (2002), pistachio by Kashaninejad et al., (2006).

Depending on the seed mass and projection areas of chickpea and dry bean seeds, the change in terminal velocities were given in Figures 7 and 8. The correlation coefficient of the non linearly relationship between dependent variable with seed mass and projection area was found to be quite high. The values of terminal velocity of chickpea and dry bean seeds increased with increasing of seed mass and projected area. For chickpea and dry bean, approximately, an increase of 50% in seed projected area resulted in an terminal velocity increase of 17 %. Approximately, a mass increase of 58 % at chickpea seed and of 87 % at dry bean seed caused a 15 % and 24 % increase of terminal velocity, respectively. Shahbazi et al., (2015) found that the terminal velocity occurred an increase of 32% with increasing projection area from 32.94 to 37.22 mm^2 for lentil seeds.

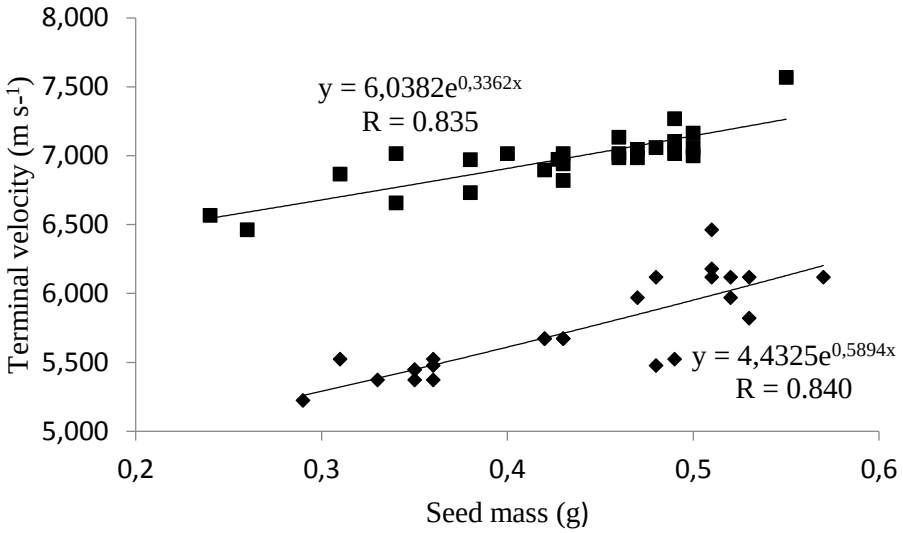

Figure 7
The effect on terminal velocity of seed mass for chickpea (■) and dry bean (♦)

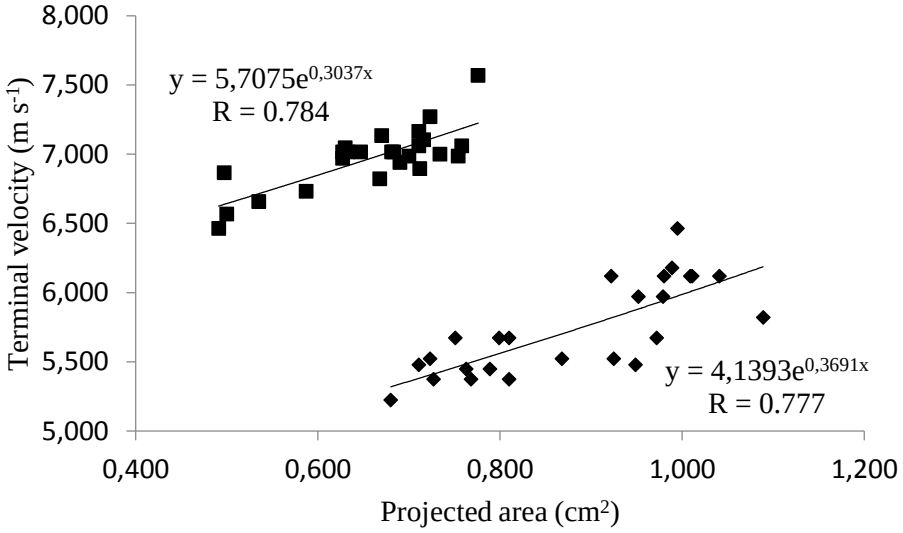

Figure 8
The effect on terminal velocity of projected area for chickpea (■) and dry bean (♦)

The results of the developed FES were compared with the experimental results. The mean of measured and predicted values were 5.738 and 6.032 m s^{-1} for dry bean, 6.974 and 7.017 m s^{-1} for chickpea respectively. The correlations between measured and predicted values of terminal velocity for chickpea and dry bean seeds were given in Figs. 9 and 10. The relationships were significant for all parameters. The correlation coefficients of relationships were found 0.809 for chickpea and 0.826 for dry bean. Farzaneh et al., (2017) studied with fuzzy logic system to predict an extensive range of physical properties of fava beans in the selected moisture contents of the input seeds (9.3-31.3 %). The high correlation coefficient value (0.999) between experimental and predicted values by fuzzy logic was found. Electronic maps of tree features such as tree type, age, yield, visual appearance and fruit length were created by fuzzy expert system for managing the groves. The average evaluation results for all five groves obtained from the FES showed 87 % general conformity with the results from the human expert (Mazloumzadeh et al., 2010).

In the FES model, for dry bean, the coefficient of determination (R^2) was found to be 0.996 and the agreement index (D) value, which was the highest, was found to be 0.772; for chickpea, the R^2 value was found to be 0.997 and the D value was found to be 0.729. The mean relative error of measured and predicted values were 4.029 % for chickpea and 5.611 % for dry bean. For chickpea and dry bean seeds, the relative error of predicted value was found to be less than the acceptable limits (10%) (Çarman and Taner, 2012). Roy et al., (2019) have developed a fuzzy prediction model of

almond oil extraction. As a input parameters, pressure, temperature, heating time and moisture content were used, and the oil yield was output parameter. The coefficient of determination (R^2) and the mean relative error of predicted values was found as a 0.982 and 7.63 %, respectively.

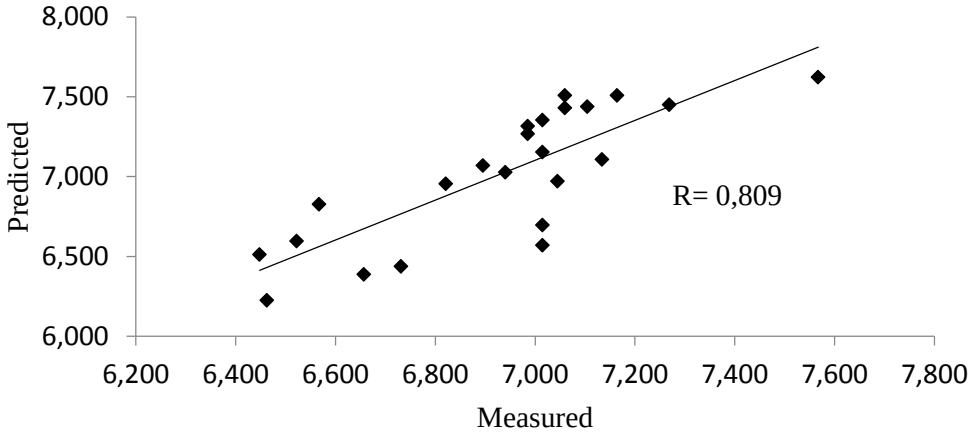

Figure 9
Correlation between measured and predicted values of terminal velocity for chickpea.

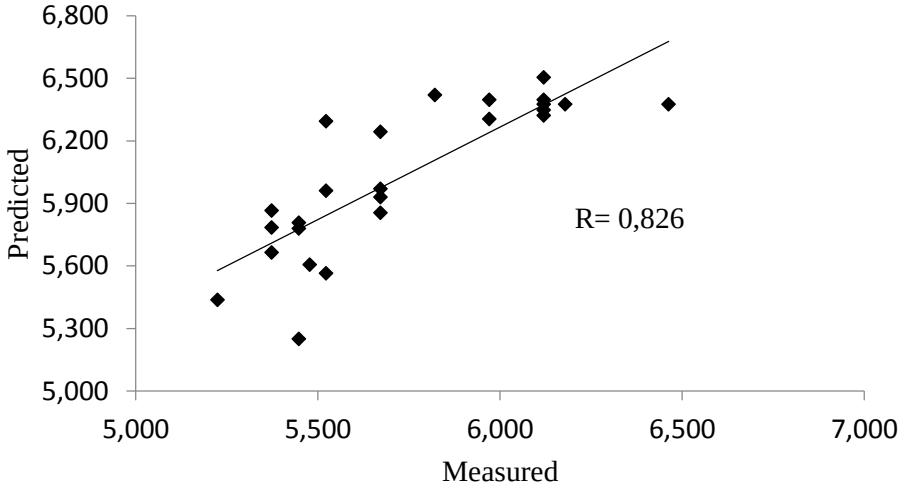

Figure 10
Correlation between measured and predicted values of terminal velocity for dry bean.

4. Conclusion

Maximum terminal velocity of chickpea and dry bean seeds to determine the proper air speed for conveying can be considered to be about 7.567 m/s and 6.463 m s^{-1}, respectively. Values higher than these numbers will lead to braking and wasting of seeds and less than that probably would not give results in separating of the seeds from each other or foreign material.

Prediction of terminal velocities of biological material is necessary for agricultural engineering applications. In comparison to other predictive modeling techniques (such as classical regression analysis), fuzzy models have the advantage of being simple (relations between input and output variables can be explained in a linguistic-based rule base) and robust (performance is not depending on training and new input variables and rules can be easily added). This study describes the developed fuzzy model consisting of 9 rules for the prediction of the terminal velocity of chickpea and dry bean seeds. In this paper, according to evaluation criterions of predicted performance of developed fuzzy knowledge-based model was found to be valid. The developed model can be used as a reference in studies related to determining the aerodynamic properties of biological material.This system can be developed further with increasing the knowledge rules from one side and with adding the neural network to the system from the other side.

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Research Article

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Managing the Humic Acid Fertilizing of Chickpea and Protein Status**

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ABSTRACT

Legumes are consumed for the nutrition of more than 2 billion people over the world. As a legume, chickpea presents valuable nutritional components especially welded by higher protein and dietary fiber that is resistant to enzymatic digestion in human body. Konya City is one of the most chickpea producers in Turkey. In recent years, application of humic acid based fertilizer is increased considerably. Aim of the study was determination of protein ratio and protein yield of the field released chickpea seeds. A total of 4 humic acid doses (from dose 1 to dose 4: 0, 6, 9 and 12 kg da^{-1} respectively) were applied by 2 equal part (pre-sowing and pre-flowering periods) to the "Çağatay" chickpea variety in Konya ecology. Field trial was set up by randomized blocks design with 3 replications. According to results, protein ratio was detected between 20.56% (dose 4) and 25.89% (dose 3) while protein yield (kg da^{-1}) was ranged from 39.77 (dose 1) to 63.56 (dose 3) values. In the study, 9 kg da^{-1} humic acid application presented the highest values for protein ratio and protein yield. On the other hand, change in humic acid doses resulted from variable values. Deep and long terms studies should evaluate more stable and trustable results to decide optimum fertilizing for desired protein statues and sustainable agricultural systems.

1. Introduction

Nutrition means a behavior for the purposes that; protection of health, growing and development, increasing of life quality and required for the body using sufficient levels of nutritional components by accurate timing and consciously (Viola et al., 2016). Human being provides the nutritional needs of animal and plant based food sources. Nutrition should be balanced and healthy. Growing food sources is easier on plants compared by animals welded by climatic factors, providing, transporting, storage, processing, etc. components. Therefore, plant based food sources are more common than animal based types and cheaper (Topalak and Ceyhan 2015; Kahraman 2017; Kafadar et al., 2019). According to the long term data of FAO (Anonymous 2019), although legumes take second place in the production of field crops, consumption by per person is quite low. Additionally, chickpea is the most produced legume in Turkey.

Legumes are the second family following to cereals over the world production. As a legume, chickpea (*Cicer arietinum* L.) is a commonly consumed legume crop in the world and Turkey as well (Anonymous 2019). Seeds of chickpea contain 38-73% carbohydrate, 16-31% protein, 2-9% cellulose, 2-7% oil, 2-11% ash (Encan et al 2005). There are various types of chickpea consumption in the world (Attia et al 1994) such as; directly cooking, coffee, varied fermented foods, frying, appetizer (Sıkılı 2003), "leblebi" a kind of cookies and animal feeding (Kara 1996). Additionally, chickpea seeds include non-polymeric starch components which are an important healthy food source while most of the ingredients are formed by cellulose, hemi-cellulose and pectin. The mentioned contents are associated with prevention of some important diseases such as hearth, diabetes, obesity, some of the cancer types, decreasing of blood cholesterol, normalization of glucose and insulin ratio (Kahraman 2017).

Increasing to yield and quality in plant production strictly related to soil characteristics. One of the most important factors for soil yield is; reaction (pH) that is effecting availability of plant nutrition elements. Absorption of the soil elements by plants and soil microorganism activity is optimum on pH; 6-7 levels (Özbek 1973). Soil humic matters act as directly or indirectly on plant nutrition. Indirect effects are; water keeping, drainage and ventilation, improvement of soil physical features, changing the availability of soil minerals and absorption by roots. Humic matters create water soluble forms of metallic hydroxide by metallic ions and, controlling to many of those elements. Direct effects

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** Short communication

are; development of root, effecting of plant element metabolism in addition to fertilization causes to various prominent characteristics and mechanisms on plants (Lobartini et al 1997; Bozoglu et al 2007; Jankowski et al 2015; Toklu et al 2017; Sarı et al 2018).

Using organic fertilizers is an important component for sustainability systems in agricultural production. Humic acid is one of the most used fertilizers over the world. On the other hand, chickpea acts on suspending of agricultural sustainability welded by symbiotic nitrogen fixation mechanism, root system, etc. main features as a legume crop.

As one of the most chickpea producer, Konya City is selected as a location for the present research. Chickpea variety called "Çağatay" is commonly preferred by farmers. Using of humic acid based fertilizers is common in the region as well. So, various doses of humic acid applied to Çağatay chickpea variety in field conditions. The ratio of seed protein and protein yield is evaluated in the present manuscript.

2. Materials and Methods

In this paper, the unit dedicated as "**da^{-1}**" equal to 1000 m^{-2} and also equivalent to 0.1 ha^{-1} surface area of soil.

The field trial was located in Sarnıç Village of Altınekin Town in Konya City-Turkey ecological conditions. A certified chickpea variety "Çağatay" was used as plant material. Sowing was realized by hand on 14th March 2013. Densities of seeds were 45x15 cm on 7 rows for each plot by 4 m length. Randomized blocks design was set up by 3 replications. A total of 4 humic acid doses consisted from 0.0 (control), 6.0, 9.0 and 12 kg da^{-1} applied to soil by two equal parts as pre-sowing and pre-flowering periods.

Tillage of soil had 20 cm of depth following to cereal harvest on autumn season. A total of 15 kg da^{-1} DAP fertilizer (18% Nitrogen and 46% phosphorus content) was applied to soil before sowing. Hoeing was made by hand for 2 times and irrigation was realized sprinkler for 2 times as well. Harvest was made on 20th July 2013 by side effects of 45 cm from both sides.

According to meteorological data for long terms in Konya from March to July are reported as following: average temperature is 15.26^{O}C, total precipitation is 26.80 mm (Anonymous, 2016). characteristics of the trial soil presented a clay loam structure (57.20% saturation) for depth of 0-20 cm, good level of organic matter (3.08%), slightly alkali (pH: 7.87), saltless (0.04% total salt), over limy (15.90% for lime), higher content of potassium (216.67 kg da^{-1}), very high content of phosphorus (17.97 kg da^{-1}).

Protein analyzes in seeds was realized by Kjeldahl method while protein yield was calculated by taking into account seed yield. Some of the results wholly independent from this paper were discussed in another report (Kahraman 2017) while present research was realized to the aim of protein ratio and protein yield of the field released Çağatay chickpea variety seeds.

3. Results and Discussion

Results of the presented study that was realized in Altınekin/Konya-Turkey ecological conditions by using "Çağatay" certified chickpea variety and application of 4 humic acid doses are summarized in this part.

In the present research, analysis of variance for protein ratio was statistically significant on the level of 5% for protein ratio of the chickpea seeds. Protein ratio was detected; 20.56% on dose 4 (12.0 kg da^{-1} humic acid application), 21.72% on control (0.0 kg da^{-1} humic acid application – dose 1), 22.20% on dose 2 (6.0 kg da^{-1} humic acid application) and 25.88% on dose 3 (9.0 kg da^{-1} humic acid application), respectively. Results of the present research about protein ratio of the Çağatay chickpea seed showed that; overdose of humic acid application was not effective while recommended doses gave rise to an increase in the protein ratio of the chickpea seeds.

Protein ratio of chickpea seeds were reported in the previous researches as following; 22.53-23.69% (Carillo et al 2000), 26.91% (Brkic et al 2004), 16-31% (Encan et al 2005), 20.60-26.70% (Kaur and Singh 2004), 20.50-23.20% (Tayyar et al 2008), 21.00-24.00% (Kopaç Kork 2009), 21.99-27.15% (Doğan 2011), 18.83-20.43% (Erdin and Kulaz 2014), 17.90-22.06% (Bayrak and Onder 2017), while digestibility is 76-88% (Akçin 1988) besides biological value of egg is 100 and chickpea is 62 (Bayrak et al 2005). Slightly differences of the previous findings may be explained by; genetic structure, ecological conditions, cultural practices and especially by the humic acid application doses.

According to the results of this research, variance analysis was important for protein yield on 1% significance level. Protein yield of the Çağatay chickpea variety showed a wide range depending on the humic acid application doses as following; 39.77 kg da^{-1} on control (0.0 kg da^{-1} humic acid application – dose 1), 48.68 kg kg da^{-1} on dose 4 (12.0 kg da^{-1} humic acid application), 53.99 kg da^{-1} on dose 2 (6.0 kg da^{-1} humic acid application) and 63.56 kg da^{-1} on dose 3 (9.0 kg da^{-1} humic acid application). Present results introduced that; application of humic acid fertilizer was effective on protein yield of the chickpea that is limited by the usable values as obtaining the minimum value on control application and highest value on 9.0 kg da^{-1} application. Former studies on chickpea showed the protein yield as; 24.68 kg da^{-1} (Önder and Üçer 1999), 13.72-26.45 kg da^{-1} (Bayrak and Onder 2017), 47.75-71.08 kg da^{-1} (Ceran and Önder 2016). The mentioned values are quite similar with data collected from the present study.

Previous research (Kıraç 2016) on peanut which was subjected to humic and fulvic acid (HFA) applications showed that; application of HFA was significantly effected by symbiotic nitrogen fixation while in-

creased dose was adversely affected to several parameters. As a report of the study, the HFA application was positively affected by some of the investigated parameters and lower doses of HFA application were recommended. On the other hand, agronomic caharacteristics of plants are strictly related to genotype in addition to environmental factors (temperature and sunlight) and plant nutrition (Alam and Haider 2006). The content of dry matter is affected by photosynthetic activity, leaf area and leaf protein ratio (Ali et al 2004). On the other perspective, it is clear that fertilizing gives a lead to distinct changes in plant responses that are pointed out in another study as it stated in the following line. Phosphorus and zinc application to chickpea in Iran ecology proved that; plant height, number of main branch, 100 seed weight, seed yield, biological yield and protein concentration was significantly affected (Khourgamy and Farnia 2009). In another similar study in Iran (Mir et al 2014), phosphate and biologic biosuper phosphate application were also effected to 100 seed weight, seed yield and protein ratio.

4. Conclusions

Results of the present research showed remarkable effects such as; humic acid application level of overdose was not effective in the mean time recommended doses caused to increasing of the protein ratio.

According to the findings of the study, humic acid doses were effective and statistically significant on protein yield of Çağatay chickpea variety by the minimum value on control dose and highest value on 9.0 kg da^{-1} dose.

Application of several humic acid doses on chickpea variety Çağatay presented statistically significant statues on protein ratio and protein yield in the present research while 9 kg da^{-1} humic acid application presented the highest values for protein ratio and protein yield as well. Deep and changed/modified studies on the subject which may be summarized by; various genotypes, ecologies, cultural practices, doses and application methods would be guided to more stable and trustable results.

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Review Article

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Possible Effects of Climate Change on Weeds in Agriculture

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ABSTRACT

In recent years, activities such as rapid population growth, industrialization, urbanization and unconscious consumption of natural sources, have many negative effects on natural balance. As a result of these negativities, environmental problems arise. Global warming is one of the environmental problems faced today. Global warming can be defined as, the process of overheating of the Earth more than it should be due to greenhouse gases, such as H_2O (water vapor), CO_2 (carbon dioxide) and CH_4 (methane), slight prevention of sunlight reflecting from the Earth to the space. It is inevitable that, the rise of CO_2 concentration due to the global warming and the changes in the precipitation regime and amount because of the heat will affect plants as a whole. As a matter of fact, different researchers presented that the climate change and increase in CO_2 concentration cause alteration in plant growth, the rise in carbon dioxide affect the progress of cultivated plants in a positive way whereas, the rise in the heat and ozone affect the progress in a negative way. As a result of global warming, it can be thought that increasing CO_2 amount will increase crop production in general. However, the existence of weeds, which cause serious losses in productivity and quality, refute this opinion. The genetic variability of the weeds, which are constantly competing against cultivated plants in terms of light and place, is quite rich when compared with cultivated plants. Therefore, they can adapt to any changes that occur in the environment. Ultimately, cultivated plants would be affected more by the differences caused by global warming. Moreover, as a result of climate change, the decrease in the event of herbicide activity, an effective weapon against the weeds, will make weeds much bigger matter.

1. Introduction

In recent years, rapid population growth, industrialization, urbanization and unconscious use of natural resources cause environmental problems (Yıldız et al 2000). Global warming is one of the environmental problems faced today.

It can be defined greenhouse gases known as H_2O (water vapor), CO_2 (carbon dioxide) and CH_2 (methane), a variety of gases, the sun's rays reflected from the Earth after partially blocking the exit out of the atmosphere as a result of further warming of the Earth (Lynas 2008).

"Greenhouse gases" are gases of both natural and human origin that absorb and emit infrared radiation in the atmosphere (Fig. 1).

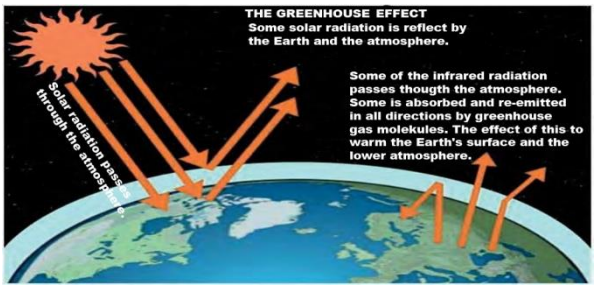

Figure 1
Greenhouse effect (Atabay et al., 2014)

Agricultural activities are responsible for about 20% of the world's growing greenhouse gases. So energy consumption, Plant Production, Animal Husbandry, fertilization, spraying, etc. in particular, CO_2, CH_4 and N_2O are responsible for increasing greenhouse gases (Fig. 3) (Houghton 2003; Pathak & Wassmann 2007).

Greenhouse gas emissions from carbon-source soils are increasing as a result of improper land use and unconscious and excessive fertilizing and pesticides (Fig. 4) (Lal 2006). The share of major greenhouse gases in global climate change is given in Figure 2.

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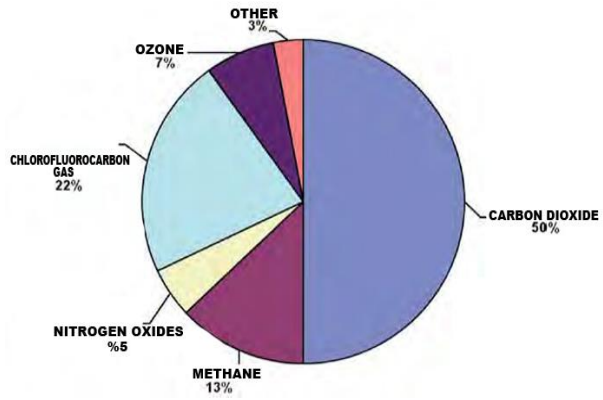

Figure 2
Share of greenhouse gases in global climate changes (Atabay et al 2014)

According to the Intergovernmental Panel on Climate Change (IPCC), atmospheric CO_2 concentration increased by 31% over the last 250 years. The average global temperature has also increased by 0.6°C in the last hundred years (IPCC 2002).

2. Turkey's Status

Turkey has started to experience its driest seasons in recent years. It is observed that deviations in the amount and distribution of rainfall seen throughout our country have negative consequences in underground and above ground water reserves and that these deviations have continuity (Fig. 5; Fig. 6) (Türkeş 2001).

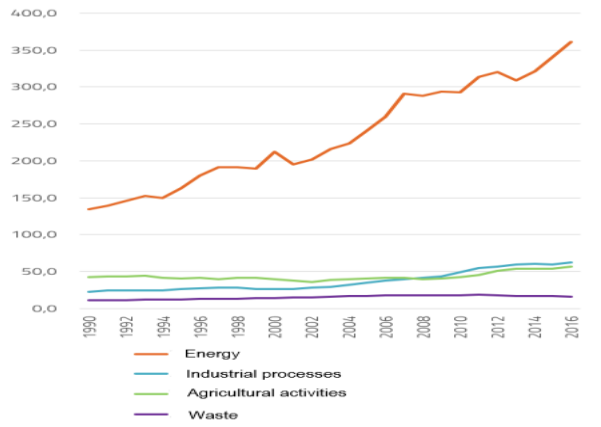

Figure 3
Development of greenhouse gas emissions by sector in Turkey 1990-2016 (Gündoğan 2018)

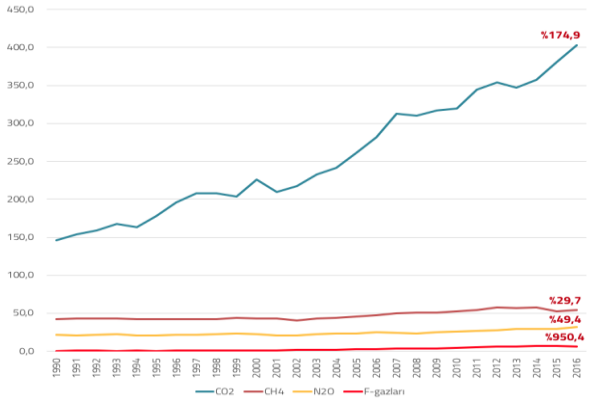

Figure 4
Development of greenhouse gas emissions by in Turkey (million tonnes) and change (%) 1990-2016 (Gündoğan 2018)

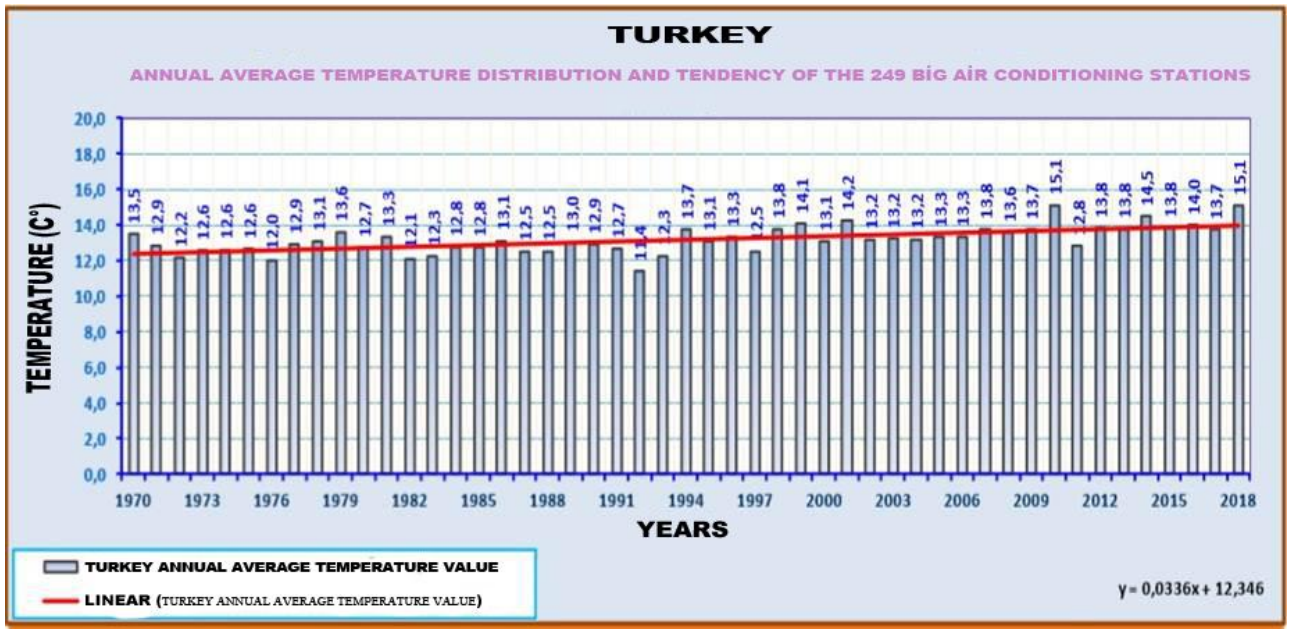

Figure 5
Turkey long-therm average temperature data (Anonymous 2019a)

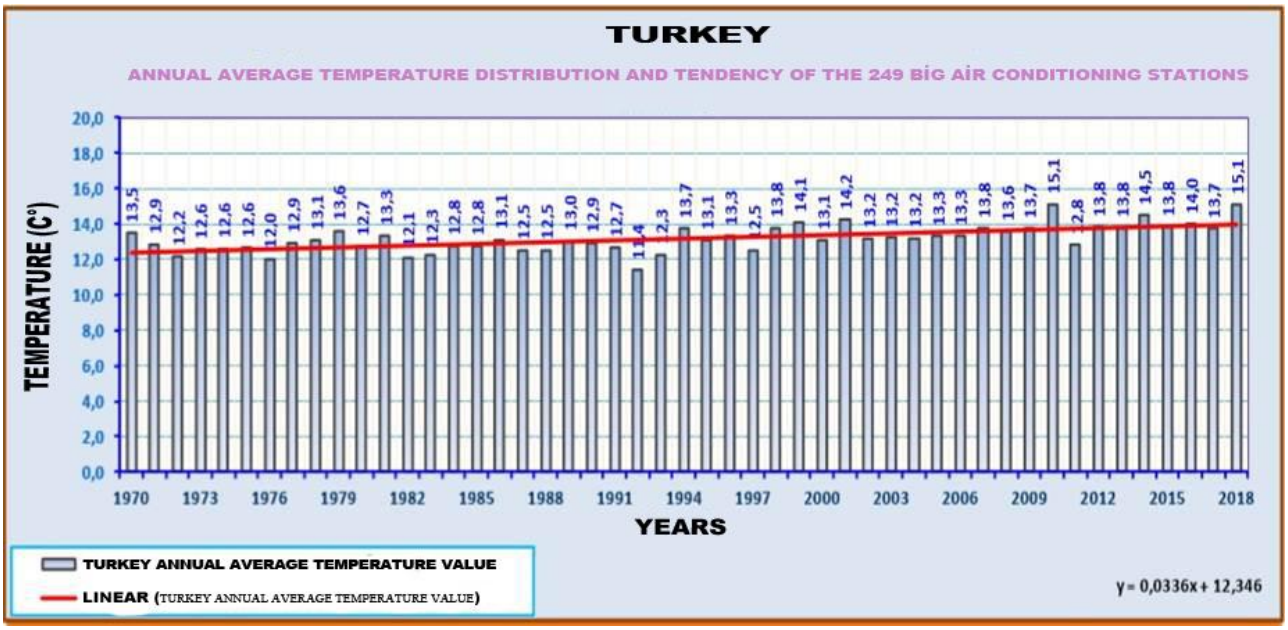

Figure 6
Long-term distribution of total annual precipitation data in Turkey (Anonymous 2019b)

3. Impact of Climate Change on Weeds

It has been shown that climate change and the increasing amount of CO_2 have a positive effect on the growth of crop plants in general, while increasing temperature and ozone have a negative effect (Ainsworth & Long 2005; Morgan et al 2006; Ainsworth 2008).

C_3 plants are temperate climate plants that need high CO_2 concentration, low temperature, and low ability to use light. C_4 plants need low CO_2 concentration, high temperature and lower water. They are resistant to seasonal drought and have a high ability to use light and are predicted to be adversely affected by the increased CO_2 rate (Doğan & Tüzer 2011).

Studies have shown that C_3 plants respond better to the increased amount of CO_2 than C_4 plants (Heyman & Sadras 2010). In general, doubling the concentration of CO_2 increases the biomass in C_3 plants by about 40%, while in C_4 plants this rate remains at 11% (Kimball 1983). However, the level of increase varies greatly depending on the type of plant. As a result of the increased in CO_2 concentration, growth in 27 herbaceous C_3 plants increased by 79-272% and in 11 different C_4 plants increased by 56-250% (Patterson & Flint 1990).

Since plants other than sorghum, maize and sugarcane etc. are C_3 plants, which are of global economic importance, it can be thought that climate change will give advantages to cultured plants and weeds will not pose a major problem. Furthermore, the fact that the important weeds that cause problems on earth are C_4 plants in general supports this judgment.

For example, only 4 of the 18 most important weeds in the world are reported to be C_3 plants (Holm et al 1977). However, one thing that is overlooked is that the number of species found in agricultural areas is far above that. It is the fact that these weeds, which under favorable conditions cause second degree damage, can replace others. Weed survey studies conducted in different cultivated plants in the world clearly reveal this situation (Uluğ et al 1993; Özer et al 2001).

Each cultured plant has its own unique weed and they are generally adapted to the production process of that cultured plant (Özer et al 2001). Wild oats, common Lamb's quarters, and barnyard grass are examples of wheat problems. In addition, the positive effect of the increase in the amount of CO_2 when compared with the same photosynthesis method of cultured plants and weeds is in favor of weeds.

a b c

Figure 7
a) *Avena fatua* **b)** *Chenopodium album*
c) *Echinochloa crus-galli* (Anonymous 2019c)

According to Patterson (1995), 2 times the amount of CO_2 increases the total weight of weeds by an average of 130% in C_3 weeds and 115% in C_4 weeds. Both C_4 and C_3 weeds will continue to pose problems in plantation as they adapt rapidly to new environmental conditions created by global warming. Even if the effectiveness of C_4 weeds decreases in agricultural areas due to increased temperature and CO_2, it is likely that C_3 weeds will be replaced immediately.

3.1. Effect on Weed-Crop Competition

Depending on the type of crop plant and weeds, competition is sometimes expected to change in favor

of cultured plant and sometimes weeds (Patterson, 1995). However, high CO_2 conditions are generally expected to make C_3 weeds more competitive (Ziska 2000).

Indeed, one study found that the ability of soybeans to respond positively to increased carbon dioxide is reduced by weeds. In competition with *Chenopodium album*, a C_3 weed, the decline in soybean yield was highest. However, when it competes with a C_4 plant, the redroot pigweed (*Amaranthus retroflexus*), the intensity of the competition was lower.

Figure 8
Amaranthus retroflexus (Anonymous 2019d)

3.2. Effect on Perennial Weeds and Herbicides

The control of perennial weeds is extremely difficult as it depends on the elimination of vegetative reproductive organs. For success it often has to be applied together with the use of the herbicide with mechanical control.

However, due to the increase in photosynthesis products, the increase is expected in vegetative reproductive organs such as rhizome, stolon, and root. While this increase will lead to an increase in the vegetative reproductive capacity of perennial weeds, it will also make it more difficult to control.

a b c

d e f

Figure 9
Some perannual weeds
a) *Sorghum halepense*, **b)** *Cirsium arvense*, **c)** *Acroptilon repens*, **d)** *Elymus repens*, **e**) *Alhagi pseudalhagi*, **f)** *Convolvulus arvensis* (Anonymous 2019e)

In addition, differences in the structure of weeds leaves and reasons such as the accumulation of starch in the leaves of C_3 plants lead to a decrease in the effect of herbicides used (Figure 10). Therefore, climate changes probably suggest that perennial weeds, especially invasive species, will increase in agricultural areas and become a bigger problem (Ziska & Teasdale 2000; Ziska et al 2004; Ziska 2008).

Figure 10
Effect of glyphosate on *Cirsium arvense* depending on the amount of carbon dioxide (Ziska 2010)

3.3. Impact of Climate Change on Invasive Plants

Studies under controlled conditions suggest that the response of invasive plants to climate change, especially CO_2 increases, is generally higher than that of local species (Willis et al 2010).

The increase in temperature is also thought to trigger the growth of invasive plants and thus cause them to complete their life span in a shorter time than normal. Thus, it is estimated that plants may show higher fertility and increase their spread (Burke & Grime 1996; Blicker et al 2002; Kolb et al 2002; Morris et al 2002; Gerlach & Rice 2003; Leger & Rice 2003).

Figure 11
Invasive parasite weed *Cuscuta campestris* Yunck. (Tamer 2012)

4. Weed Control Due to Climate Change

Herbicides are one of the most effective weapons in weed control. Reduced herbicide activity due to climate change will make weeds a much bigger problem (Ziska 1998; 2008; Ziska & Goins 2006). In addition, environmental stress conditions affecting cultured plants will also make cultured plants more susceptible to disease, pest and weed competition (Patterson 1995). This puts the management of weeds, which are a problem in agricultural fields due to climate change, in a much more important position. Indeed, yield losses from weeds are expected to increase.

5. Example Studies of Importance

Elymus repens (quack grass) growth, photosynthetic activity and tolerance observed under conditions of increased CO_2 glyphosate the chemical management in seeking to it was concluded that it would be difficult perennial weeds (Ziska & Teasdale 2000).

Ziska and Faulkner (2004), investigated the effectiveness of normal and augmented CO_2 conditions on the growth, biomaterial and glyphosate susceptibility of village references: canada thistle (*Cirsium arvense*). According to the results, it is stated that in the future, the chemical control of canada thistle and other perennial weeds will be difficult under high CO_2 conditions.

a b

Figure 12
a) *Cirsium arvense*, **b)** *Elymus repens* (Anonymous, 2019f)

Hobbs and Mooney (2005) reported that while climate change affects biodiversity on the one hand, it also promotes biological invasions from weed species that can easily adapt to extreme conditions. Loss of biodiversity due to biological invasions becomes even more serious due to climate change.

Stinson and Bazzaz (2006) found that high CO_2 administration increased the reproductive capacity and biomaterial of the invasive weed, *Ambrosia artemisiifolia*. Rogers et al (2008) investigated the effects of increased CO_2 on the growth of *Cyperus rotundus* and *C. esculentus*. The study concluded that these two invasive species would be more likely to spread in the future.

Figure 13
Cyperus rotundus (Anonymous 2019g)

Göncü (2013), in his study corn of different CO_2 ratios (*Zea mays* L.), the problem in *Sorghum halepense*, *Echinochloa cruss-galli*, *Amaranthus blitoides* and *Solanum nigrum*'s growth, competition and herbicide sensitivity was aimed to determine. The high CO_2 ratio positively affected the output of some weeds. In normal CO_2 conditions weeds reduced maize growth, while in high CO_2 conditions there was no decrease in growth. It has been determined that the growth parameters of weeds reach higher values in high CO_2 and competitive conditions. It has also been determined that generally high CO2 conditions can cause a decrease in herbicide activity.

Meşe (2014)' s research aimed to determine the growth, competition and herbicide susceptibility of weeds of Avena sterilis, *Phalaris minor*, *Galium tricornutum*, *Sinapis arvensis*, which are problems in wheat of different CO_2 ratios. Weed competition has caused a decrease in wheat growth in different CO_2 conditions. Weed growth was not affected by CO_2 in the non-competitive environment, while reductions were seen in the competitive environment. It has also been observed that herbicide sensitivity is lower in narrow-leaved weeds and increased in broad-leaved weeds.

Over the past few decades, significant transformations have been induced by changing climate in the weed flora of agroecosystems, worldwide, allowing

thermophile, late-emerging weeds, and some opportunistic weeds to become more abundant in some cropping systems. Increasing CO_2, as the most important greenhouse gas, affects plants by changing the species distribution, alteration in reproduction timing and length of growing seasons. Climate change directly influences arable weeds through raising the temperature and changing the precipitation pattern (Peters et al 2014).

Jabran and Doğan (2015) examined the effect of normal and 2 times dose CO_2 ratio on the growth of *Lolium perenne* and *Medicago sativa*. As a result of the trial, L. with increased CO_2 application positive relationship between age-dry weight and chlorophyll content of perenne plants was determined. *M. sativa*, however, the overall CO_2 increase was not affected by age and dry weight.

a b

Figure 14

a) *Medicago sativa*, **b)** *Lolium perenne* **(**Anonymous, 2019h)

Jabran et al (2015) evaluated the effect of ambient (current level of CO_2 in the atmosphere) and simulated (double of normal CO_2) CO2 levels on the invasive weed species *Potentilla recta* L. The invasive weed species was grown under normal (~400 ppm) and elevated (~800-850 ppm) CO_2 in a controlled glasshouse. The data about fresh weight, dry weight, number of leaves, plant height and chlorophyll index were recorded. The studies indicated that the elevated CO_2 levels increased the growth of *P. recta*. The high levels of CO_2 increased the fresh weight, dry weight, plant height and number of leaves of *P. recta* compared with ambient CO_2 while chlorophyll index was not affected.

Tursun et al (2018) conducted a study to determine the reactions of some weeds (*Amaranthus retroflexus, Portulaca oleracea, Physalis angulata, Sorghum halepense*) to different CO_2 concentrations and different temperatures under greenhouse conditions. As a result of the study, parallel to the increase in CO_2, even if there is some positive growth in plants, they stated that the increase in environmental temperature would negatively affect crops and agriculture.

6. Conclusion and Recommendations

Studies have shown that the increased CO_2 concentration associated with climate change can have positive reactions to the growth of cultivated plants such as corn, cotton, soybean, wheat, and rice (Alberto et al 1996; Ziska & Bunce 1997; Reddy et al 1999; Ziska 2000; Ziska & Goins 2006; Patel et al 2008; Zhu et al 2008; Erbs et al 2009). However, there are also findings that reactions to changes in weeds may be higher than in cultured plants (Ziska & Bunce, 1993; Ziska & Bunce 1997; Ziska 2002; Pandey et al 2003). Therefore, it is a fact that changing conditions will affect weed-crop competition. Changes in the methods of management weeds will be inevitable.

Determination of the adaptation potentials of weeds to climate changes should be one of the priority objectives of weeds science (Neve et al 2009). However, it has not yet been fully revealed how factors such as temperature, amount of CO_2, light and water in field conditions affect weed growth and the effectiveness of herbicides. Therefore, detailed studies on this subject are needed to reach a final judgment.

It is known that climate change can significantly affect the growth, reproduction, distribution, competitiveness, etc. of invasive plants. It also suggests that the species in question will increase, especially in agricultural areas, and become a bigger problem (Ziska & Teasdale 2000; Ziska et al 2004; Ziska 2008). Therefore, invasive plants need to be dealt with again and more carefully in the context of the possible impacts of climate change.

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