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The Effect of Microbial Fertilizer Applications on Grape Yield, Quality and Mineral Nutrition of Some Early Table Grape Varieties

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ABSTRACT

In this study, a commercial microbial fertilizer (Bio fertilizer) containing 3.5×10^7 cells/mL of *Chlorella vulgaris* algae with a pH ranging from 3.5 to 5.5 was used. Four applications of microbial fertilizer; 1) control (no fertilizer), 2) leaf treatment, 3) soil treatment, 4) soil plus leaf treatment were performed in the experiment. The effects of the treatments on grape yield and cluster, berry and juice characteristics of 4 years old Trakya ilkeren, Yalova incisi and Prima grape varieties were investigated. In addition, the effects of these applications on macro and micro element contents of leaf samples were examined during the veraison. Microbial fertilizer application was done 5 times starting with the shoot length of 20cm and including the veraison time. The highest yield (6076 g /vine, 3038 kg/da), bunch weight (300.1 g) and 100 berry weight (622.6 g) as well as other berry characteristics and maturity index (60.21) values were obtained from the Yalova incisi variety. It has been determined that the most suitable fertilizer application was soil+leaf application with the highest yield (4059 g/vine, 2030 kg/da) and bunch weight (249.7 g). It has been observed that soil application caused earlier maturation of the grapes. The content of nutrients in the leaf samples was different in terms of varieties except nitrogen and manganese. The highest K content was found in Trakya ilkeren; while highest Ca, Mg and Fe were found in Yalova incisi and highest P, Fe and Zn were in the Prima variety. There were no significant differences in leaf N, P, Mn and Zn contents between fertilizer applications. For the other elements, the highest values were obtained from leaf application followed by soil plus leaf applications.

1. Introduction

For feeding the growing world population, researchers have been struggling to increase the amount of crops that can be obtained from the unit area by using the concentrated drugs and fertilizers. This effort brought along some adverse effects on human health. In order to influence this negative outcome, researchers have accelerated their efforts in organic farming since 1980s. In organic farming, increasing the soil fertility and plant nutrition are the most effective factors on yield and quality. It is seen that in this cultivation form, there is a very limited amount of organic fertilizer resources to be used for increasing the soil fertility or plant nutrition. For this reason, efforts are being made to increase the amount of organic fertilizers used in the plant nutrition.

The most important tool used to improve soil fertility and crop yield is fertilization. Mineral fertilizers and other chemicals not only have negative effects on the environment, but also affect the fruit content, causing the harmful residues in the fruit (Mostafa, 2008). Biofertilizers are very safe for people, animals and the environment. They have capacity to reduce soil pollution, salinity and fertilizing costs by reducing the use of mineral fertilizers.

Recently, the efforts of researchers on the possibility of using some microalgae species in organic farming are remarkable. As a related preparation, *Chlorella vulgaris* of microalgae species has been widely commercialized and tested in different plant groups (Özdemir et al., 2016). It is thought that *C. vulgaris* could be used as a nitrogen source in agriculture instead of traditional fertilizers. However, it has been determined that the number of studies conducted on the

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use of microalgae as bio-fertilizer in the world and in Turkey is low.

C. vulgaris extract contains 50-60% protein and is the one of the most efficient chlorophyll resource in the nature. This microorganism contains growth regulators, polyamines, vitamins as well as nitrogen and elements including phosphorus, potassium, calcium,sulfur, zinc, iron, manganese, copper, molybdenum and cobalt. In gardens, it is used to increase vegetative growth, yield and fruit quality (Abd El Moniem and Abd Allah, 2008).

In recent years, the use of organic fertilizers instead of mineral fertilizers has become attractive due to the high cost of mineral fertilizers and harmful effects. Organic fertilizers increase the activity and number of microorganisms in the soil, improve the water holding capacity of the soil and soil structure (Abd El-Moniem et al., 2008, Sönmez and Yılmaz, 2017, Gougoulias et al., 2018). Bio-fertilizers that are thought to be used instead of chemical fertilizers, consist of organisms that enrich the nutrient capacity of soil and plants. The main sources of bio fertilizers are bacteria, fungi and cyanobacterias (Bileva, 2013, Uysal ve ark., 2015). In this study, it was aimed to determine the effect of *C. vulgaris*, which is rich in protein content in green algae group, on the yield and quality of grapes as microbial fertilizer.

2. Materials and Methods

This study was carried out in 2017 at the Research and Application vineyard of Horticulture Department of Faculty of Agriculture of Çukurova University. In the study, 3 years old Trakya ilkeren, Yalova incisi and Prima grape varieties were used. In the research, the effect of a commercial microbial fertilizer (Bio fertilizer) with a pH of 3.5 to 5.5 and containing $3.5x10^7$ cells/mL of *Chlorella vulgaris* algae was tested.

Applications of microbial fertilizer were made 5 times including the first one, in the average of bud burst time (30 March), the second one, before full bloom (27 April), the third one, in the berry set period (11 May), the fourth one, when the berries were about 5 mm in diameter (01 June) and the fifth one in the veraison time (19 June).

In the context of applications, 1) control (no fertilizer), 2) from leaf, 3) from soil, 4) from soil plus from leaf were made in the experimented. In leaf applications, 500 cc/100 L water and in soil applications 2 L/da doses were applied. In control application, only water was applied to the leaves and soil at the same time.

In order to determine the effect of the application on the yield and quality characteristics, 5 clusters were taken from each application and three replicates and the yield, cluster weight, length, width and size, 100 berry weight, 100 berry volume, berry length, width and size were determined. In addition, total soluble solids (TSS), acidity, pH and maturity index were examined.

In order to determine the effects of the applications on plant nutrition, leaf samples were taken during the fall period. For each application, leaf samples from different clusters were washed twice in with tap water followed by twice washing with with pure water. Leaves were dried on coarse filter paper followed by drying at 65 °C for 72 hours. Dried leaf samples were ground by agate mill and made ready for analysis.

Macroelements N, P, K, Ca, Mg and microelements Fe, Zn, Mn contents were determined:

Nitrogen (N): Nitrogen in the leaf samples was determined according to the Kjeldahl method as reported by Bremner (1965).

Phosphorus (P): Total phosphorus was determined using the Shimadzu model UV 1201 spectrophotometer according to vanadomolibdophosphoric yellow colour method (Kacar, 1972).

Potassium (K): Total potassium was determined using an Eppendorf Elex 6361 fluorimeter.

Calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn) and manganese (Mn) contents of the leaves were determined by Atomic Absorption Spectrophotometer.

Variance analysis was performed according to the split plots experimental design with three replicates using JMP statistical programmer based SAS, and least significant difference test (LSD) was used for separation of means of different treatments at 5% significance level. While microbial fertilizer application (totally 4) was used as a sub-plot, varieties (totally 3) considering main plots were arranged in the blocks.

3. Results and Discussion

The effect of the applications on the yield and cluster properties was given in Table 1. Yalova incisi (6076 g/vine; 3038 kg/da) gave the highest value in terms of yield but, in Trakya ilkeren (1890 g/vine) was the lowest value. The highest cluster weight (300.1 g), cluster length (19.19 cm), cluster width (11.16 cm) and cluster size (215.0) values were obtained from Yalova incisi.

It was determined that the yield (4059 g/vine), bunch weight (249.7 g) and bunch width (10.86 cm) obtained after the application of microbial fertilizer to soil+leaf was higher than that of the other applications. It has been determined that the application of microbial fertilizer on the cluster length and cluster size was not significant.

The effect of the applications on berry properties was shown in Table 2. As it can be seen from the Table, Yalova incisi grape variety showed best results in all parameters examined about the berry characteristics; while Prima variety gave the lowest values. In terms of microbial fertilizer applications, the effects of applications on 100 berry weight, length, width and size were not statistically significant.

Table 1
Effect of applications on yield and cluster characteristics [x]

Source of Variance	Yield (g vine^{-1})	Cluster Weight (g)	Cluster Length (cm)	Cluster Width (cm)	Cluster size
Variety					
Trakya ilkeren	1890 c	189.0 b	14.12 c	11.55 a	163.1 b
Yalova incisi	6076 a	300.1 a	19.19 a	11.16 a	215.0 a
Prima	2359 b	157.2 c	17.27 b	8.53 b	147.6 b
LSD 5%	251.7	17,5	1,46	0.69	22.4
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Application type					
Control	2946 c	191.3 c	16,41	10.23 ab	167,9
Soil	3305 b	205.2 bc	17,09	9.99 b	170,2
Foliar	3457 b	215.6 b	17,48	10.56 ab	183,3
Soil+Foliar	4059 a	249.7 a	16,47	10.86 a	179,5
LSD 5%	290.7	20.2	NS	0,8	NS
P	<0.0001	<0.0001	0.5039	0.1481	0.5614
Interaction					
LSD 5%	503.4	35.0	NS	1.38	NS
P	<0.0001	<0.0001	0.0985	0.0131	0.0585

[x] Mean separation within columns by LSD multiple test at 0.05 level, NS: Nonsignificant

Table 2
Effect of applications on berry characteristics [x]

Source of Variance	Weight of 100 berries (g)	Volume of 100 berries (mL)	Length (cm)	Width (cm)	Size
Variety					
Trakya ilkeren	299.3 b	280 b	18.98 b	15.79 b	301.1 b
Yalova incisi	622.6 a	563 a	25.52 a	19.11 a	488.0 a
Prima	250.7 c	235 c	16.72 c	15.70 b	262.6 c
LSD 5%	36.4	42	1.95	0.54	34.2
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Application type					
Control	372,4	353 ab	19,75	16,8	337,7
Soil	377,3	336 b	19,93	16,67	342,3
Foliar	400,8	357 ab	21,78	17,06	373,9
Soil+Foliar	413	393 a	20,16	16,93	348,3
LSD 5%	NS	49	NS	NS	NS
P	0.1754	0.1289	0.2499	0.6034	0.2595
Interaction					
LSD 5%	72.81	84	NS	1.07	68.4
P	0.0019	0.0260	0.1764	0.0009	0.0197

[x] Mean separation within columns by LSD multiple test at 0.05 level, NS: Nonsignificant

The effect of fertilizer application on berry volume was found to be significant and the highest value was obtained from soil+leaf (393 mL) application. It was determined that Trakya ilkeren and Prima entered into medium berry group in terms of berry weight and volume, while Yalova incisi was introduced into large berry group (Çelik, 2011).

When the effect of microbial fertilizer on thevarieties was examined, the highest TSS (17.75%) was found in Trakya ilkeren; however, the highest acidity value was determined in Trakya (0.406 g/100 mL) and Prima (0.404 g/100 mL) varieties which entered the same statistical group. The effect of pH on the application was not significant (Table 3). The highest maturity index value was obtained from a variety of Yalova incisi (60.21). The effect of application type of microbial fertilizer on acidity, pH and maturity were not significant (Table 3).

The effect of the applications on the macro and micro element content of the leaf samples taken during the veraison was presented in Table 4.

The effect of varieties and microbial fertilizer application on the N content of the leaves was not significant. In terms of P content, the difference was found to be insignificant in terms of the way it was applied in the level of varieties. Considering K, Ca and Mg contents of the leaves, the differences between varieties and the effect of the application of bio fertilizer were statistically significant. The highest P, Ca and Mg were determined in Yalova incisi variety, while highest K was obtained in Trakya ilkeren. The highest K, Ca and Mg contents were obtained from leaf applications.

Varietal effect on micro element content was not significant in Mn, but it was found to be important in Fe and Zn contents. The highest Fe content from Yalova incisi and Prima; Zn content from Prima variety were obtained. The effect of fertilizer application on Mn and Zn contents was found to be insignificant. The highest Fe content was obtained from Leaf and Soil+Leaf application.

Table 3
Effect of applications on must characteristics [x]

Source of Variance	TSS (%)	Acidity (g 100 mL^{-1})	pH	Maturity index
Variety				
Trakya ilkeren	17.75 a	0.406 a	3,77	44.22 b
Yalova incisi	14.91 c	0.249 b	3,82	60.21 a
Prima	16.44 b	0.404 a	3,75	41.30 b
LSD 5%	0.71	0.03	NS	3.41
P	<0.0001	<0.0001	0.1438	<0.0001
Application type				
Control	15,87	0.339 b	3.74 b	47.52 b
Soil	16,62	0.336 b	3.82 a	51.73 a
Foliar	16,59	0.378 a	3.76 ab	47.45 b
Soil+Foliar	16,38	0.358 ab	3.78 ab	47.60 b
LSD 5%	NS	0.03	0.07	3.93
P	0.2230	0.0273	0.2241	0.0897
Interaction				
LSD 5%	1,41	0,05	0,13	6,81
P	0,0043	0,0063	0,0001	0,0003

[x] Mean separation within columns by LSD multiple test at 0.05 level, NS: Nonsignificant

As a result of evaluation of the varieties and fertilizer application types, there were differences in terms of limit values (Jones et al., 1991) (Table 4), the content of P and K were deficient; N, P, Ca and Mg values were found to be within the limit values of sufficient and excessive. Nitrogen in Prima and Ca and Mg in Yalova incisi variety was determined as sufficient. It has been determined that the values of K, Ca and Mg contents in case of Biofertilizer applied by foliar application were in the excess group. It has been found that Fe was excessive in the Prima variety, but in the other two varieties, it was in sufficient amount (Jones et al., 1991).

Table 4
Effect of applications on macro and micro element contents of leaves [x]

Source of Variance		Macro elements (%)					Micro elements (ppm)		
		N	P	K	Ca	Mg	Fe	Mn	Zn
Variety									
Trakya ilkeren		2.22	0.20 b	0.28 a	2.26 b	0.45 b	151.0 b	40.6	31.9 c
Yalova incisi		2.1	0.21 b	0.22 b	3.14 a	0.64 a	169.7 a	47	41.3 b
Prima		2.37	0.25 a	0.18 b	2.16 b	0.42 b	176.6 a	38.9	48.6 a
LSD 5%		NS	0.02	0.05	0.52	0.11	13.3	NS	6.4
P		0.2190	0.0002	0.0012	0.0012	0.0009	0.0018	0.3349	<0.0001
Application type									
Control		2.24	0.21	0.22 b	2.15 b	0.43 b	154.3 b	44.3	41.7
Soil		2.26	0.21	0.22 b	2.49 ab	0.47 b	164.6 ab	42.6	40.5
Foliar		2.35	0.23	0.29 a	2.90 a	0.60 a	173.4 a	42.9	42.5
Soil+Foliar		2.06	0.24	0.18 b	2.55 ab	0.52 ab	170.7 a	38.9	37.8
LSD 5%		NS	NS	0.06	0.61	0.13	15.3	NS	NS
P		0.4297	0.0854	0.006	0.1133	0.0702	0.0767	0.8614	0.5756
Interaction									
LSD 5%		NS	NS	0.1	1.05	0.22	26.6	23.5	12.8
P		0.2032	0.8054	0.0002	0.0430	0.0256	0.0214	0.0081	0.0402
Limit Values	Lack	1.50-1.99	0.22-0.29	1.00-1.29	1.50-1.99	0.20-0.24	50-59	25-29	18-24
	Enough	2.0-2.30	0.30-0.40	1.30-1.40	2.0-2.5	0.25-0.50	60-175	30-300	25-100
	Excess	>2.40	>0.40	>1.40	>2.50	>0.50	>175	>300	>100

[x] Mean separation within columns by LSD multiple test at 0.05 level, NS: Nonsignificant

4. Conclusions

Finally, the highest yield, bunch weight and 100 berry weight as well as other berry characteristics and maturity index values were obtained from the Yalova incisi variety.

The variety x fertilizer application-type interaction was significant in many properties. However, considering the overall averages, the most suitable fertilizer application was soil+leaf application for the highest yield and bunch weight. It has been observed that application from the soil causes some earlier maturation of the grapes. The contents of nutrients in the leaf samples were different in terms of varieties except N and Mn. The highest K content was found in Trakya ilkeren; Ca, Mg and Fe in Yalova incisi; P, Fe and Zn were in the Prima variety. There were no significant differences in leaf N, P, Mn and Zn contents between fertilizer applications. For the other elements, the highest values were obtained from leaf application followed by soil plus leaf applications.

It is thought that such bio-fertilizer applications should be tested for a longer time in order to identify more significant differences between applications.

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Research Article

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The Determination of Population Development and Infestation Rate of Mediterranean Fruit Fly (*Ceratitis capitata* (Wied)) in Peach Orchards in Meram (Konya) Province

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ABSTRACT

This study was carried out in 2017 and 2018 in Meram district (Konya) in order to determine the population development and infestation rate of the Mediterranean fruit fly (MFF) (*Ceratitis capitata* (Wied)) (Dip.: Tephritidae) in the peach orchards. In the study, traps called Decis Trap were used to catch the adults of the MFF. As a result of the study, adult population development determined different in two years, two population peaks occurred in 2017 and four times in 2018. The pest may give two to four generation in Meram district according to climatic conditions and years. The first adults of the MFF appeared in 2017 in the third week of August and were active for four months, and appeared in 2018 in the third week of July and were determined to be active in the nature for about five months. In addition to the results of the study conducted in the years 2017-2018, the infestation rates were 5% and 2% in Ekmekkoçu, 3% and 2% in Hasanköy, 96% and 96% in Hatıp, 94% and 100% in Karahüyük, 0% and 2% in Yenibahçe location, respectively. Farmers are advised to use Decis Trap at the beginning of July and to carry out other maintenance work in orchards, especially the destruction of the fruit falling on the ground.

1. Introduction

Mediterranean fruit fly (MFF) (*Ceratitis capitata* (Wied)) (Dip.: Tephritidae) is an external quarantine pest and has a zero tolerance in export. It causes economic losses in our country. The presence of a single infested fruit with this pest in export leads to the return of the whole product (Başpınar et al. 2009). *C. capitata* is a member of the Tephritidae family, order Diptera, which has more than 4500 species in the world (Liquido et al., 1990, Bayrak and Hayat, 2012). MFF is one of 118 species of fruit fly pests recorded in Turkey (Kütük et al., 2013). The most important hosts identified in our country are mainly citrus fruits, peaches, figs, persimmon and pomegranates, but it also causes damage in apricot, apple, pear, quince, plum and avocado (Alkan, 1953; Demirdere, 1961; İleri, 1961; Giray, 1966; Elekçioğlu, 2009; 2013). However, there is no serious damage to lemons (Kaygısız and Aybak, 2005).

One of the most suitable hosts of the MFF is peach fruits among many kind of fruits such as pepper, loquat, guava, orange, mandarin and feijoa (Medeiros et al., 2007). Estimated world production of peach and nectarines are 24.665.205 tons with 152.803-hectare total cultivated area. In Turkey, there are 771.459 tons' production from 46.299 ha cultivated area. Konya province is one of the leading provinces of peach and nectarines production. Meram district shares 25.7% of total production in Konya province (Anonymous, 2018).

Females of MFF lay eggs to the mature fruits at the time of maturity, where they leave brownish spots. The main damage caused by larval stage of the pest by feeding in the fleshy part of the fruit. This leads to the softening and rotting of fruits by the time. Infested fruits usually ripen ahead of time and poured to the ground. Infested fruits rot as a result of the development of microorganisms such as fungus and bacterial species (Anonymous, 2008; Elekçioğlu, 2009).

The presence of MFF in the Central Anatolia region of Turkey has been detected in Ankara and Kırşehir

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(Kansu, 1988; Kaya and İpekdal, 2018). Previous studies conducted by different researchers were related to population development and infestation rates of the pest, including, in pomegranate orchards (Yıldırım and Başpınar, 2011; Çardak and Demirel, 2014), in mandarin orchards; satsuma variety (Akyol, 2014), in persimmon fruit orchards (Kılıç, 2015), in pomegranate and persimmon fruit orchards, in fig, peach and avocado orchards (Tiring and Satar, 2017), in orange orchards (Çatak, 2017), in citrus orchards (Gürbüz, 2018). However, there is no study on the current status of the pest in Konya province.

In this study, it was aimed to determine the population development, infestation rates and some biological characteristics of MFF in peach orchards in Konya province.

2. Materials and Methods

2.1. Materials

The basic materials of this research were peach orchards located in Meram district of Konya province and MFF population in these orchards. Decis trap (Bayer CropScience) containing 0,015g Deltamethrin + 7.8g Ammonium acetate + 0.5g Chloro hydra tetrimethyl amine + 0.03g + 1.5g Diamineopentane was used for mass trapping of the pest.

2.2. Methods

2.2.1. Selecting Trial Orchards

Five peach orchards with late-pruning varieties selected for determining population development of the pest. Details of the orchards are given in Table 1.

Table 1
General properties of the trial orchards

Location	Orchard age (Year)	Variety	Orchard size (ha)	Coordinates	
Ekmekkoçu	15	Monroe	0.2	37˚82934000	32˚49852200
Hasanköy	12	Monroe	0.6	37˚81058500	32˚47958700
Hatıp	9	Monroe	1.2	37˚76671000	32˚11560000
Karahüyük	14	Monroe	0.5	37˚77437910	32˚44906390
Yenibahçe	9	Monroe	1.2	37˚75861900	32˚47456200

2.2.2. Population Development of Mediterranean fruit fly

Five Decis type traps for per 0.1 hectar were hung on August 6th in 2017 and July 13th in 2018 in each orchard. The traps were hung 1.5-2 m high from the ground in the south-east direction of the trees. Trap controls were performed twice a week until the first adult was captured, and once a week after the first adult was captured, the number of captured adults was recorded. The same traps used till harvesting.

2.2.3. Infestation Rates of Mediterranean fruit fly

Infestation rates of MFF in peach orchards determined by sampling infested fruits at harvesting time. Twenty-five peach trees selected in each orchard and four fruits collected from those trees. Collected fruits number was 100 fruit from each orchard. Abbott formula was used to determine infestation rates for each orchard (Abbott, 1925).

3. Results

3.1. Population Development of Mediterranean fruit fly

Population development of the pest has been determined in five locations in Meram district, Konya. Population development of *C. capitata* in 2017 and 2018 in Ekmekkoçu location is given in Figure 1.

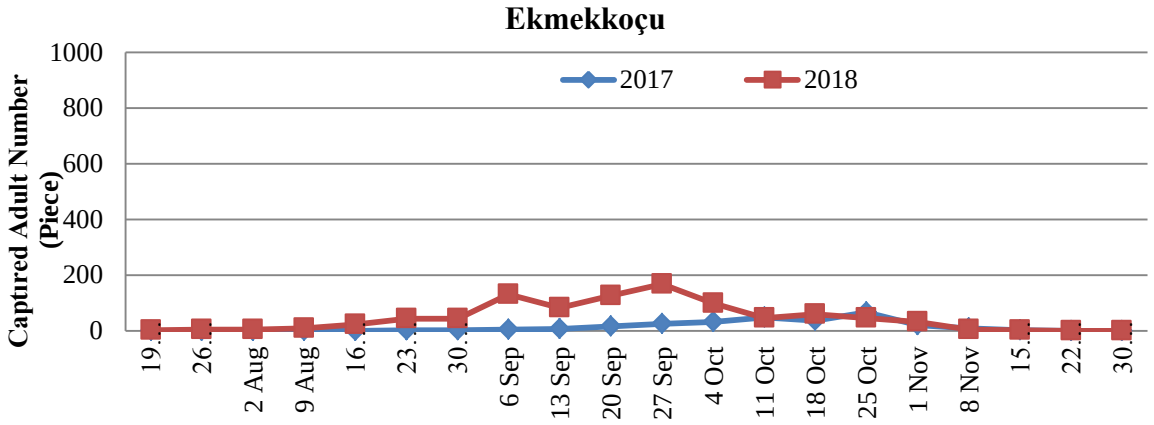

Figure 1
Two years' population development of *Ceratitis capitata* in peach orchard in Ekmekkoçu location.

In Ekmekkoçu location, in 2017, the adults of the pest were first captured on 20 August. The pest has been determined to be active from the end of August until the middle of November (Figure 1). When the

data is examined, it is seen that there are two peaks of population. The first peak reached 47 adults per week on October 8, and the second peak on October 22 with 66 adults per week. During the entire flight period, an average of 261 adult MFF were caught in the traps.

However, population was more intense in 2018; the first adult in the traps was caught on July 19th. Pest was determined as active from mid-July to the last week of November. Population peak was also three time in season (Figure 1). The first peak was 130 adults / week on the 6th of September, the second peak on the 27th of September with 168 adults / week, and the third peak on October 18 with 60 adults / week. During the entire flight period, an average of 912 adult individuals was caught in traps.

In 2018, the number of adults caught in traps increased three-fold compared to 2017. When the population curves are examined, the date of emergence, the active period and the different peaks they create may be considered as a result of climate change as well as many ecological factors.

Population development of *C. capitata* in 2017 and 2018 in Hasanköy location is given in Figure 2.

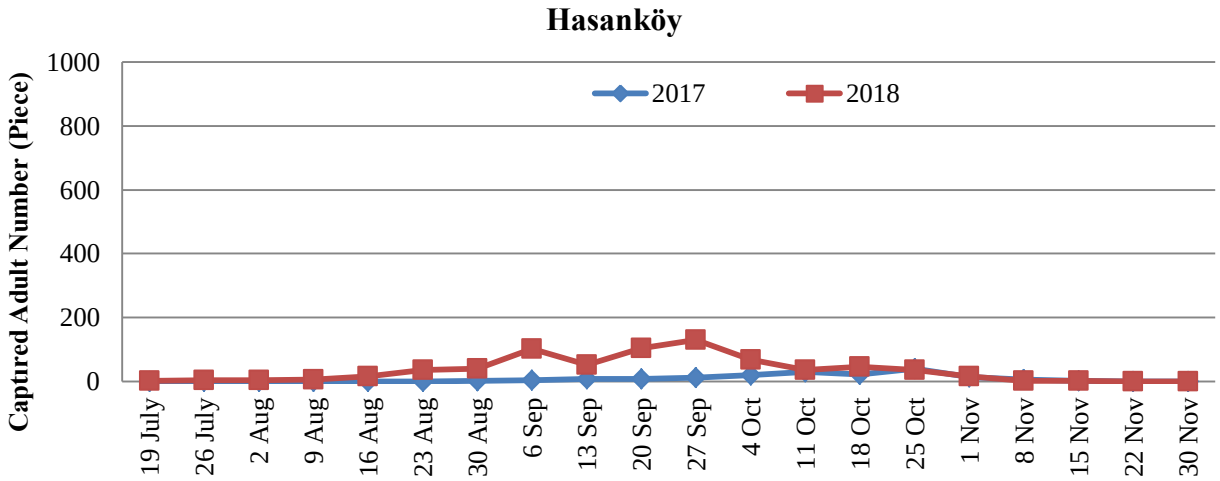

Figure 2
Two years' population development of *Ceratitis capitata* in peach orchard in Hasanköy location.

In Hasanköy location, in 2017, the adults of the pest was first caught in traps on 23 August. Pest activity was determined from the last week of August to 15 November (Figure 2). When the number of captured adults is examined, it is seen that there are two peaks. The first peak point was 29 adults / week on 8 October and the second peak on October 22nd, 41 adults / week. During the entire flight period, 169 median MFF were caught in the traps.

The adults of the pest were first caught on July 19th in 2018. Pest activity was from mid-July to the last week of November and it was three peaks of population. The first peak was 101 adults / week on the 6th of September, the second peak on September 27th, 130 adults / week, the third peak on October 18, 47 adults / week. An average of 696 adults was caught in the traps during the entire flight period (Figure 2).

It was detected that, emergence and population density are different in 2017 and 2018 years and this may be considered as the winter months was more temperate in 2018 comparing to 2017. It is believed that the farmer used intensive insecticide to avoid any risk during the season and to collect the harvest residues in the garden at the end of season may affect pest population development.

Figure 3 shows population development of *C. capitata* in 2017 and 2018 in Hatıp location.

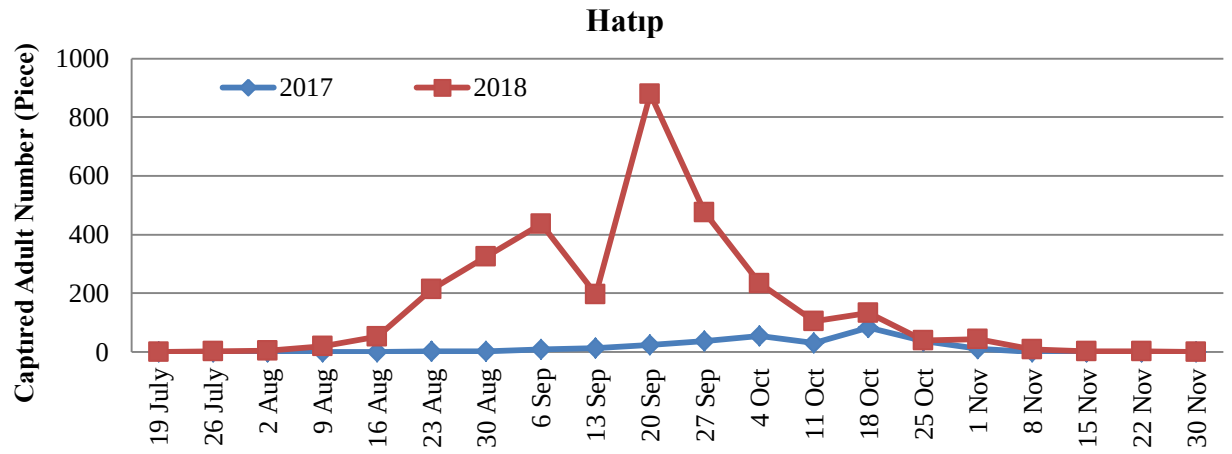

Figure 3
Two years' population development of *Ceratitis capitata* in peach orchard in Hatıp location.

In Hatıp location, in 2017, the adults of the pest were first captured on 23 August. Pest active period was determined from the last week of August until 8 November. When the number of adults is examined, it is seen that there are two peaks. The first peak occurred on October 8th, 55 adults / week, the second peak on October 22nd, 83 adults / week. During the entire flight period, an average of 307 adult MFF was caught in the traps (Figure 3).

But, in 2018, the pests were first caught in the traps on 26 July. Pest activity was from mid-July to the last week of November. When the data is examined, it is seen that there are four peaks in 2018. The first peak point was 436 adults / week on September 6th, the second peak was 878 adults / week on September 20th, the third peak on October 18th, 133 adults / week and finally on November 1st, 43 adults / week. During the entire flight period, 3169 adult individuals were caught in the traps (Figure 3).

In Hatıp location, the total number of adults in 2018 is 10 times higher than the total number of adults in 2017. The owner of the garden has applied tillage, pruning and bordeaux mixture in the garden in 2017, but, did not applied any chemicals during season against pests. In the 2018 season, he did not apply any procedures to the garden. Therefore, it is thought that *C. capitata* population is higher than other gardens. In addition, many harmful pests also were seen in these infested fruits.

Figure 4 shows population development of *C. capitata* in 2017 and 2018 in Karahüyük location.

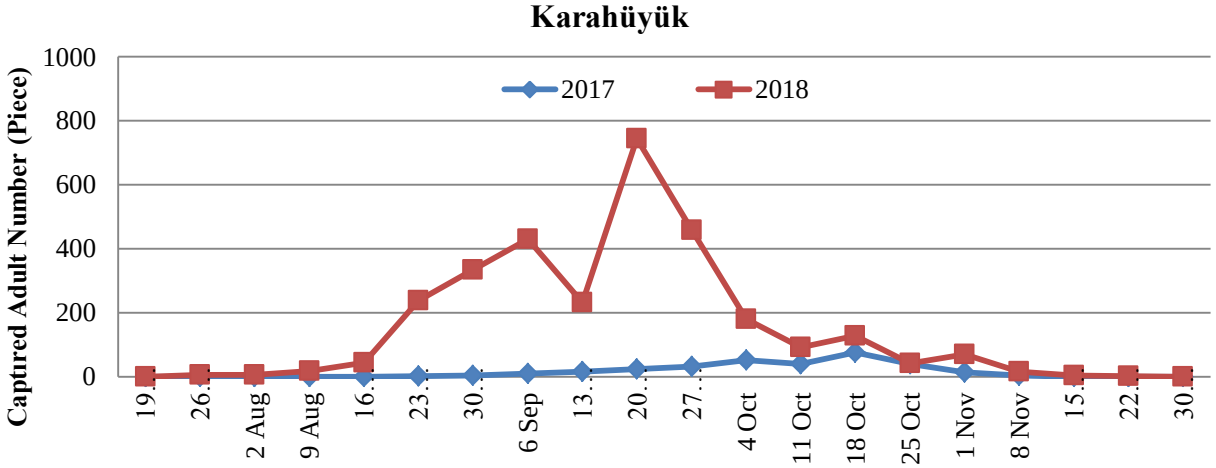

Figure 4
Two years' population development of *Ceratitis capitata* in peach orchard in Karahüyük location.

In Karahüyük location, in 2017, the adults of the pest were first captured on 23 August. Pest active period was from the last week of August until November 8th. When the number of adults is examined, it is seen that there are two peaks. The first peak was 52 adults/ week on October 8th, and the second peak on October 18th with 76 adults / week. During the whole flight period, 307 adult MFF were caught in the traps (Figure 4).

In 2018, the pests were first caught in the traps on 26 July. Pest was determined as active from mid-July to 22 November. Population peaks were four peaks in 2018 season. The first peak was 430 adults / week on the 6th of September, 743 adults / week on the second

peak on September 20th, 128 adults / week on the third peak on October 18th and last peak on the 1st of November, 70 adults/week. An average of 3034 adult individuals was caught in traps during the entire flight period (Figure 4).

In this location, the total number of adults in 2017 is less than the number of 2018. Application procedures were in Karahüyük location the same with Hatıp location, the owner of the garden did not apply even its primary preventive controls in both years. In 2018 season, the garden was left without harvesting.

Population development of *C. capitata* in 2017 and 2018 in Yenibahçe location is given in Figure 5.

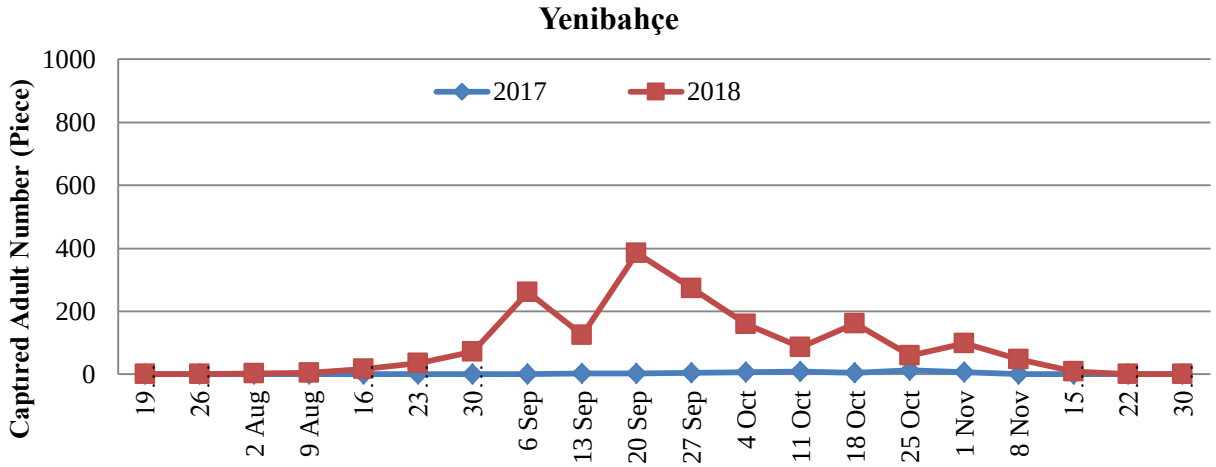

Figure 5
Two years' population development of *Ceratitis capitata* in peach orchard in Yenibahçe location.

In Yenibahçe location, the adults of the pest were first caught on August 30 in 2017. It was determined that pest was active from the last week of August until November 22nd. When the number of adults is examined, it is seen that there are two peaks. The first peak was 9 adults / week on October 8th, and the second peak on October 22nd, 14 adults / week. During the entire flight period, an average of 56 adult MFF was caught in the traps (Figure 5).

In 2018, the pests were first caught in the traps on 26 July. Pest activity prolonged from mid-July to 22 November. When the number of adults is examined, it is seen that there are four peaks. The first peak point was 261 adults / week on 6 September, the second peak on 386adults / week on September 20, the third peak on October 18, 161 adults / week, and finally on November 1, 99 adults / week. During the entire flight period, an average of 1807 adult individuals was captured in the traps (Figure 5).

Numerous ecological factors are thought to be effective for population curve of the pest. Furthermore, the low population in 2017 can be attributed to the fact that in 2016, the farmer made maintenance work regularly and especially the destruction of fruit residues at the end of harvest.

Infestation Rates of Mediterranean fruit fly

The rate of infestation of fruits by MFF in Meram district is given in Table 2.

Table 2
Ceratitis capitata infestation rate in Meram in 2017-2018.

Location	Infestation Rate (%)	
	2017	2018
Ekmekkoçu	5	2
Hasanköy	3	2
Hatıp	96	100
Karahüyük	64	100
Yenibahçe	0	2

Harvest was performed in the first week of September in Hasanköy, Ekmekkoçu and Yenibahçe location in 2017. Owners of the gardens, in order not to take the risk, they applied chemicals to their gardens in addition to the warnings of the technical staff of Meram District Directorate of Agriculture. Although unnecessary applications were made, the chance of success against the pest has increased when the pesticides are applied on time. In these locations, the rate of infestation in 2017 was determined as 0-5%. The owner of the garden in the Hasanköy location in 2016 and in 2017 destroyed fruit debris in the garden after harvesting, and the owner of the garden in the Yenibahçe location destroyed it only in 2016. For this reason, infestation rates in these orchards were observed as highly lower than others. Infestation in Hatıp location was 96% and 94% in

Karahüyük location in 2017. Both gardens have been maintained in 2017 early spring, but not applied any control against disease and pests in the production season.

Harvesting was done in Hasanköy, Ekmekkoçu and Yenibahçe location in 2018, 5-10 days early compared to 2017, and the rate of infestation was determined in 2% of all three gardens. Harvest dates are thought to be 5-10 days early in 2018 with the increase in temperature compared to 2017 and the shift of phenological periods to early. In Hatıp and Karahüyük locations, the infestation rate in 2018 was 100% in both gardens. Due to the proximity of the gardens in Hatıp and Karahüyük locations, the infestation rate and population changes were similar. Both gardens were left without harvesting in 2018.

4. Discussion

The MFF, which is the main detrimental factor in the loss of citrus fruits, has begun to cause significant and economic damage in different hosts in recent years. One of these hosts is peach.

In this study, the population development and infestation rates of MFF in the peach orchards in the district of Meram (Konya) in the locations of Ekmekkoçu, Hasanköy, Hatıp, Karahüyük, Yenibahçe, were determined to be active in the peach areas from mid-July to the end of November for about five months.

It was determined that the pest does not cause harm in the early peach varieties. Tiring and Satar (2017) found that early peaches in Balcalı (Adana) did not cause any damage due to harvesting in the first week of May.

As a result of the study conducted in Konya, depending to the climatic conditions in the peach orchards, the pest formed 2 to 4 peak in the season. Tiring and Satar (2017) reported that this pest has 7-8 generations in avocado, fig and peach orchards in Balcalı (Adana), Başpınar et al. (2009) detected 4-5 generations in the province of Aydin in citrus orchards, Kızılyamaç (2016) determined 3-7 generations at different elevations; Kasap and Aslan (2016) reported, 5-6 generations in the persimmon and 6-7 generations in the pomegranate orchards in Adana province. As a result of all these studies, it was stated that the pest has a large number of generation in different hosts.

The highest point of the population with the increase of temperatures reached in September-October. The highest number of adults in 2017 and 2018 was in Hatıp location, number of captured adults was 106 adults / week on October 22, and 878 adults / week on September 20, respectively. Akyol and Demirel (2014) reported that captures of the adults in traps in the satsuma mandarin orchards in Hatay were maximum number in September. The reason for the high population density in Hatıp location is that the orchards are located close to each other which may be host of the pest, and that the garden is neglected and not sprayed in the season.

In general, it was determined that the pest increased in 2018 compared to the previous year. This is due to the fact that the climate conditions are a little more moderate, the farmers do not spray against increasing pest populations and the number of host increases.

As a result of the study, the highest infestation rates were determined as 96 to 100% in Hatıp location, and 94 to 100 in Karahüyük location, in 2017-2018, respectively. Yıldırım and Başpınar (2011) found that the infestation rate of pomegranate orchards during harvest time was 2.20%. Although Demirel (2014) reported that the infestation rates in pomegranate orchards was between 3-43.5% according to varieties of pomegranate. Kasap and Aslan (2016) indicated that the infestation rates in pomegranate was 1.35% in date was 5.2% in Adana province.

The importance of the chemical application for the MFF is understood from the loss in the gardens that are left without harvesting. In peach gardens, the damage rate of the pest may reach up 100% if the control tactics not applied. It is recommended that our farmers need to use Decis traps widely, and if they do not use it, they should fight with chemical at least twice on the dates proposed by the technical staff.

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Research Article

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The Effect of Knife Clearance on the Machine Performance in Disc Type Silage Machines *

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ABSTRACT

In this study, active knife and fixed knife of single-row disc silage machine has three different clearance C_1, C_2 and C_3 (1, 3 and 5 mm) and it is tried in three different working speed V_1, V_2 and V_3 (1.8, 2.5 and 3.7 km / h) and PTO speed (540 min-1) and machine's fuel consumption (l/h), average power consumption (kW), field energy consumption (kW/da), product energy consumption (kW/t), field working capacity (da/h), product working capacity (t/h) and Chopping size distribution characteristics of the fragmented material were determined.

It has been found that knife-counter knife clearances smaller than 3 mm (1 mm) and larger (5 mm) have a negative effect on machine performance in general. In terms of fuel and power consumptions, the most suitable combination of work was C_2V_1, and in terms of field-product energy consumption, C_2V_3 combination was found to be optimal. The highest field-product working capacity was achieved at the V_3 working speed. In terms of silage mincer size, all working combinations gave the appropriate shredding length distribution; especially the 1st knife-counter knife clearance (1 mm) was determined to give a more suitable Chopping size distribution in terms of animal feeding. In the second clearance (3mm), both the energy consumption and the Chopping size distribution were positive.

1. Introduction

Due to the high population growth rate of Turkey must be seeking solutions to meet the increasing need for animal protein. This problem can be solved by increasing meat and milk production. High quality and highly efficient fodder products are needed for this. With the shrinkage of agricultural areas, the possibility of raising high yielding forage products is reduced. As it emerged in the deficit, especially in the winter in other countries of the world are taking advantage of silage in Turkey (Evrenosoğlu, 2006).

One of the most important and critical stages of silage making is the harvest of the product. Because for good quality silage, the harvest should be carried out quickly and the silo should be filled as soon as possible. In order to achieve this, a good organization of the harvesting of tractors, machinery and agricultural trolleys is required. In our region, where maize silage has been widely used, two-line four-row machines have been used instead of single-row maize silage machines in recent years and their use has shown a tendency to spread. (Evrenosoğlu, 2006).

Depending on the increased importance of the silage in Turkey is increasing day by day the number of foragers. According to statistics, Turkey in 2012 Total corn silage machine 19988 and 3917 pieces of grass silage machine for a total of 23905 units, while in 2017 total maize 27998 and 5541 grass, including 33539 total foragers is located (Anonymous, 2017). Maize silage machines have a maximum theoretical capacity of 50 t/h for approximately 75% moisture and 12.7 mm shredded corn products. For grass fodder as a silage feed product, 60% of this capacity value can be taken. According to this result, the theoretical capacity of the grass silage machines as silage feed product chopper is determined as 30-35 t/h (Zeytinoğlu, 1998). It is recommended that the most suitable piece size for silage

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* This study is summarized from the Master Thesis of Mustafa Ahmed Jalal AL-SAMMARRAİE.

material is 10-20 mm for cattle group and 10 mm for a small group of cattle (Altınok and Bozkurt, 2000).

As the working speed of the machine decreases and the speed of the chopper knives increases, the product is more chopped and finely chopped. Conversely, the size of the shredded vegetable material is long. (Ayık, 1997).

Increasing the working speed in silage machines increases power consumption, field, and product working capacities while reducing field and product energy consumption. Sample values for this are shown in Table1.

Table 1
The results obtained in the silage corn harvest (Bilgen and Sungur, 1992)

Working speed (km / h)	Field Working Capacity (da/h)	Product Working Capacity (t/h)	Power Consumption (kW)	Field Energy Consumption (kWh / da)	Product Energy Consumption (kWh / t)
2.70	1.25	6.20	27.8	22.24	4.48
3.64	1.68	8.36	36.2	21.55	4.33
4.75	2.19	10.91	45.6	20.82	4.18

Knife geometry (thickness, twist angle and sharpening angle), knife sharpness, knife type, number of the knife, the diameter of the mincer unit, knife peripheral velocity, rate of feed and position of the counter knife the optimum design parameters such as those need to be selected correctly. In addition, factors such as type, thickness, height, moisture, maturity, plant angle of inclination and compressive pressure of the plant to be mined also affect the requirement of energy. (Persson, 1987).

The power requirement of the silage machines depends on the operation conditions of the machine, the variety of plants and the characteristics of the chopper. The total power requirement in a silage machine consists of 4 elements. These are (Güner, 1998);

a. The power required for the tractor to move.
b. Power takes off the power requirement of the silage machine.
c. The power for meeting the movement of the silage machine.
d. The power required to tow the agricultural cart.

In the preparation of the silage, the first stage is to cut the corn plant from the body and cut it to the appropriate size. The minced corn is ready for silage. The size and shape of the Shopping during the chopping of corn is important for the quality of the product. The tool or active element which is used for cutting and chopping the corn plant and performing the basic cutting process is called a knife. The knives apply a shear force to the body-to-material or material to be cut and the cutting takes place in a functional knife; knife tip and knife wing (Ergül, 2015).

When the chopper knife is well known, the sheer force is also low, since the friction force on the knife is low. When cutting with a sharp knife, forces perpendicular to the movement of the knife are formed on the body of the plant and this provides a sufficiently strong cut to break up the plant (Ergül, 2015).

If there is enough space (clearance) between the cutting knife and the counter knife and the knives are sharp, the plant will be cut by the cutting force effect. Even if there is enough clerance the knife will be cut off if the knife is blind. This is undesirable and it is desirable that the end of the knife is not always large at a certain tip angle. For this reason, silage maize harvesting machines have a sharpening system used as the knife becomes larger (the tip angle is larger) (Ergül, 2015).

The shredding piece is composed of knife and counter knife. The distance between the two knives should not be less than 0.5 mm and should not exceed 1 mm. If this range is more than 1.5 mm, the required power increases by 100% (Güner, 1998).

In this study, the active knife and counter knife clerance of the disc silage machine with three different working speeds and the effects on machine performance and work quality were investigated.

2. Material and Method

In the study, the first product silage corn plant (Zea mays indentata) was used as plant material. Some properties of the silage maize plant, which is the test material, are given in Table 2.

Table 2
Some Physical Properties of Corn Plant Silage Harvesting

Property	Value
Average Stubble Height (mm)	183.07
Average plant height (mm)	2553
Average Plant Weight (g)	872.46
Row spacing (mm)	700
Plant diameter (mm)	27.6
Field yield (kg/da)	4493.7
Plant moisture level (%)(wb)	70.56

The trials were conducted in 2018 at the Research and Application Centre of the Faculty of Agriculture, Selcuk University. The experiments were arranged according to randomized plots and they were designed with three replications.

Some technical features of the silage machine used in the study are shown in Table 3. The trial-type machine is a hanging type, single-row disc maize silage

machine. The machine takes its movement from the PTO. The silage material is to be cut with the cutting disc knives on the two feeders of the machine. The extruded material is compressed between the feeding drums and transferred to the mincing knives. The chopper knives are 12 pieces and are attached to a disc which is located in the hood. Chopper unit is a radial knife type and consists of a knife and counter knife. The conveying of the mater-years to the trailer with the transmission pipe by means of the air flow generated by the chopper knives and launching wings. There are sharpening stones on the body of the hood to sharpen the curved bi-pebbles. The material transmission pipe is controlled by the hydraulic cylinder driven by the hydraulic pump on the machine.

Table 3
Technical information of the silage machine

Structural Properties	Values
Total length (mm)	max. 3900, min. 2800
Overall width (mm)	2420
Overall height (mm)	max. 3445, min. 3240
Weight (kg)	660
Control device	Hydraulic
PTO speed	540 min $^{-1}$
Drive	transmission
Wheel size (mm)	400 * 8 16 PR
Number of Drum (pcs)	2
Number of the bottom cutter	2 pieces
Knives	
Chopping process	
Number of knives	12
Knife hardness	60.3 HRC
Number of Blowing Wings	6

Datum brand Series 420 PTO 1800 Nm model torque meter was used to measure the torque and torque of the tractor. The data received from the torque meter connected to the spindle is transferred to the computer via the data logging system.

In the study, fuel was measured by PLS software of a mechanical type liquid flow sensor of Sea YF-S401 to measure the fuel consumption in the combinations.

In order to determine the starting and ending points during the experiments, a tape meter was used.

During the harvest, the plant moisture was dried in an oven. Also measuring calipers, precision scales, time measurements 0.1 seconds precision stopwatch, etc. Ancillary tools were used.

Within the scope of Agricultural Machinery and Technology Engineering Department; New Holland TD110D tractor equipped with fuel gauge, PTO torque meter, and speed sensors.

The experiments were carried out in C1, C2 and C3 (1, 3 and 5 mm) in two clearances of 1 mm and larger, which is the clearance of the cutter knife (active) and counter knife (fixed) of the silage machine widely used in the application, three different working speed V_1, V_2 and V_3 (1.8, 2.5 and 3.7 km / h) and the fixed PTO speed (540 min-1). Adjusting the distance between the active and fixed knife is done by means of spring washers. The working speed has been chosen in the range used in the application and different working speeds have been achieved the different gears in order to keep the PTO speed constant.

In this study; plant height, plant height, moisture content, stubble height, plant weight, green product yield (field yield), unit area of the silage machine and product business success, PTO force, working speed, unit field, and product energy consumption, fuel consumption, and material chopping length were measured. Then, these values were averaged. Plant samples were taken from the stubble neck determined in experiments in different parts of the field and their dry matter contents and moisture contents were determined in the laboratory. Arın (1982) used the method of determining the moist yield of the field. The moisture content was determined on a wet basis at 105 $^{\circ}$C for 48 hours. Field working capacity of silage machines (Sa, da/h); The following correlation was calculated with the help of the actual working speed (V, km/h), work width (B, m) and time utilization coefficient (K). PTO speed power consumptions of silage machines were determined by benefitting from rotation moment and cycle number. Field and product energy consumptions were determined with the help of maximum PTO speed power consumption, field and product working capacities. Field working capacity of silage machines (Sa, da/h) was calculated from the following correlation with the help of the actual working speed (V, km/h), work width (B, m) and time utilization coefficient (K).

$$\mathbf{Sa = B. V. K}$$

The coefficient of time-utilization coefficient of 0.50-0.75 recommended by ASAE was K = 0.70. Product working capacity (Sü, kg/h); field yield (S, kg/da), field working capacity (Sa, da/h) was determined by multiplying.

$$\mathbf{Sü = Sa. S}$$

The fuel consumption was measured continuously with L/h with the fuel gauge connected to the tractor fuel equipment and recorded under PLC control. After each trial combination, the silage samples were taken and the samples were then measured with the help of 0.01 digital caliper. The PTO power consumption of the silage machines is determined by using the torque and the number of revolutions. Field and product energy consumption; the maximum PTO power consumption is determined with the help of field and product business achievements.

Statistical analyses were performed on the data obtained from all applications. LSD test was applied to the significant averages via the MSTAT-C package program. (Düzgüneş et al., 1987; Anonymous, 1991).

3. Results and Discussion

In order to evaluate the quality of minced meat, chopping size distribution was discussed. In Table 4, Chopping size distributions are given.

Table 4
Chopping size distributions due to knife-counter knife clearance.

Working speed	Clearance	The chopping size distribution of Chopping (%)									
		0-5	5-10	10-20	20-30	> 30	< 20	The average value of less than 20 mm	> 20	< 30	The average value of less than 30 mm
V_1	C_1	1.82	47.27	36.36	10.91	3.63	85.45	82.09	14.54	96.36	95.83
	C_2	27.27	29.09	27.27	14.54	1.82	83.63		16.36	98.17	
	C_3	7.01	36.84	33.33	15.78	7.01	77.18		22.79	92.96	
V_2	C_1	19.64	39.28	28.57	8.93	3.57	87.49	86.73	12.5	96.42	96.37
	C_2	14.54	36.36	36.36	9.09	3.63	87.26		12.72	96.35	
	C_3	12.72	40	32.72	10.91	3.63	85.44		14.54	96.35	
V_3	C_1	20.37	33.33	37.03	7.41	1.85	90.73	88.58	9.26	98.14	97.57
	C_2	12.72	40	36.36	7.27	3.63	89.08		10.9	96.35	
	C_3	7.01	43.85	35.08	12.28	1.75	85.94		14.03	98.22	

When examined in Table 4, the number of pieces less than 20 mm obtained in each aperture is greater than the number of parts. With the increase of the knife-counter knife clearance, the Chopping size distribution of small particles of 20 mm decreases. As the working speed of the machine increases, the product is more chopped and finely chopped. In terms of the silage making technique, the average size of Chopping size distribution of less than 20 mm and 30 mm was 82.09%, 95.83%, at the working speed of 1.8 km/h, respectively, 86.73%, 96.37% at the working speed of 2.5 km/h, respectively, 88.58%, 97.57% at the working speed of 3.7 km/h. In silage making, it is required that the Chopping sizes should be less than 20 mm in a bovine feed. The length of the effect affects the compression rate of the plants in the silo, the consumption of the animals and the yield of the animal products. In general, small-fragmented plants have been reported to be better silage and more consumed by animals (Anonymous 1999; Altınok and Bozkurt, 2000). The effect on chopping size distributions of the working speed and product working capacity was found to be not significant. With the increase in working speed and product working capacity, it decreases more than 40 mm depending on the machine type (Kafadar, 1997).

Results of the variance analysis on the power consumption values obtained from the experimental combinations Table 5, LSD test results are given in Table 6.

Table 5
Power Consumption Variation Analysis

Variation Resources	Degree of Freedom	Average of squares	F Value
Working speed	2	2.57	4.25*
Knife-Counter Knife Clearance	2	1.03	1.7
Working speed X Knife-Counter Knife	4	0.13	0.23
Failure	18	0.6	
General	26		

According to the results of variance analysis, the effect of the change on the power consumption was found to be statistically significant ($P < 0.05$). In addition, the knife-counter knife clearance and working speed interaction were found to be insignificant.

Table 6
Power Consumption LSD test Results.

Clearance, Speed , and Clearance x Averages of speed interaction (%)				
C(mm) \ V(km/h)	V1	V2	V3	Average
C1	9.71	10.59	11.23	10.51
C2	9.48	10.09	10.49	10.02
C3	10.33	10.68	11.01	10.67
				LSD =0.76
Average	9.84^{b}	10.45^{ab}	10.91^{a}	
		LSD=0.76		
		LSD=1.33		

When Table 6 is examined, the smallest power consumption value depending on the machine working speed is at V_1, followed by V_2 and V_3 respectively. The smallest power consumption value connected to the knife-counter knife opening (clearance) is observed at the C_2 clearance, followed by the C_1 and C_3 clearance, respectively (Table 6). The increase in the average power consumption of the clearance from 1 mm to 3 mm decreased by 4.66%. It also increased of clearance from 3 mm to 5 mm and the average power consumption increased by 6.48%. The 100% increase in working speed increased the average power consumption by 10.87%.

The highest power consumption was obtained with 11.23 kW in the C_1V_3 combination, while the lowest power consumption was obtained in combination with 9.48 kW in C_2V_1. Both the increase and decrease of the knife-counter knife clerance increased the power consumption. It was also seen that the power consumption increased with the increase in the speed of progress. Similarly, Bilgen and Sungur (1992) stated that an increase in working speed increases the power consumption. In addition, power consumption is increasing due to the increasing material volume along with the working speed (Kafadar, 1997). During the experiments the moisture content of the product was 70.56%. Increased moisture content also increases the amount of power needed (Ülger, 1982).

The results of the variance analysis applied to the fuel consumption values obtained from the experimental combinations are given in Table 7 and the results of LSD tests are given in Table8.

Table 7
Fuel Consumption Variation Analysis.

Variation Resources	Degree of Freedom	Average of Squares	F Value
Working speed	2	7.17	22.88*
Knife-Counter Knife Clearance	2	9.98	31.83*
Working speed X Knife-Counter Knife	4	1.3	4.15*
Failure	18	0.31	
General	26		

According to the results of variance analysis, the effect of knife-counter knife clearance, working speed and knife-counter knife clearance and working speed interaction on fuel consumption was found to be significant ($P < 0.05$).

Table 8
Fuel Consumption LSD test Results.

Clearance, Speed, and Clearance X Average of Speed Interaction (%)				
V(km/h) / C(mm)	V1	V2	V3	Average
C1	6.68^{cd}	7.39^{bc}	8.61^{ab}	7.56^{b}
C2	5.69^{d}	6.4^{cd}	8.57^{ab}	6.89^{b}
C3	8.79^{ab}	8.89^{ab}	9.18^{a}	8.95^{a}
				LSD =0.55
Average	7.05^{b}	7.56^{b}	8.79^{a}	
	LSD=0.55			
	LSD=0.95			

LSD test according to the Fuel Consumption values (Table 8), the lowest average fuel consumption value related to the machine working speed was determined at V_1 speed and this value was followed by V_2 and V_3 respectively. The lowest average fuel consumption value depending on the knife-counter knife clearance is observed at the C_2 clerance while this value follows the C_1 and C_3 knife-counter knife clerances, respectively (Table 8). The fuel consumption values obtained at the V_1 and V_2 speeds and the C_1 and C_2 clerances are statistically similar, while the V_3 speed and the C_3 clearance are in different groups. The average increase of the clerance from 1 mm to 3 mm was found to increase the fuel consumption by 8.86% while the increase of 3 mm to 5 mm increased the average fuel consumption by 29.89%. An increase of 100% in the working speed increased the average fuel consumption by 24.68%. In general, it is seen that fuel consumption changes in parallel with the increase and decrease of power consumption. The average of the total fuel consumption in each span was 7.05 l/h, 7.56 l/h and 8.79 l/h respectively. The average fuel consumption varied between 9.18-5.69 l/h. The highest fuel consumption was obtained in the combination of C_3V_3 with 9.18 l/h, while the lowest fuel consumption was obtained at the C_2V_1 combination with 5.69 l/h. When the power consumption and fuel consumption are evaluated together, it is seen that the smallest values are obtained in the combination of C_2V_1 and other values in the other units.

The results of the variance analysis on field energy consumption values obtained from the experimental combinations are given in Table 9 and the results of LSD tests are given in Table 10

Table 9
Field Energy Consumption Variation Analysis.

Variation Resources	Degree of Freedom	Average of Squares	F Value
Working speed	2	59.42	98.72*
Knife-Counter Knife Clearance	2	0.76	1.27
Working speed X Knife-Counter Knife	4	0.15	0.26
Failure	18	0.6	
General	26		

According to the results of variance analysis, the effect of the change in working speed on energy consumption was significant (P <0.05). In addition, the knife-counter knife clearance and the working speed of progression were found to be insignificant.

Table 10
Field Energy Consumption LSD Test Results

Clearance, Speed, and Clearance X Average of Speed Interaction (%)				
V(km/h) / C(mm)	V1	V2	V3	Average
C1	11.01	8.64	6.19	8.61
C2	10.75	8.24	5.79	8.26
C3	11.71	8.72	6.07	8.83
				LSD=0.76
Average	11.16[a]	8.53[b]	6.02[c]	
	LSD=0.76			
	LSD=1.32			

Field energy consumption considering the results, the lowest acceptable area energy consumption rate due to the machine working speed was determined at the V_3 speed, followed by V_2 and V_1, respectively. The lowest acceptable area energy consumption ratio due to the knife-counter knife clerance is observed at the C_2 clerance, followed by the C_1 and C_3 clerances, respectively (Table 10). It is seen that the increase in the energy consumption of clerance from 1 mm to 3 mm, decreasing the energy consumption by 4.06% and increasing the average energy consumption by 6.9% from 3 mm to 5 mm. The 100% increase in the working speed reduced the average energy consumption by 46.05%.

Ergül (2015) says that the knife-counter knife clerance increases the power and energy consumption associated with it, and as a result, there is enough clerance between the cutting knife and the counter knife, and if the knives are sharp, the plant will be cut off under the effect of shear force. If there is not enough clerance between the knife or the cutter knives are blunt, the knife will break the plant with the effect of the force instead of cutting. In the cutting of the plant by cutter knife, spent force is lower than the force used in cutting. Because of the small working width of the machine used in the trials (0.70 m) the energy consumption of the field increased. The large working width of the machine reduces the energy consumption per unit area (Kanofojski ve Karwowski, 1976).

The results obtained from the experiments on the product energy consumption variance analysis Table 11, LSD test results are given in Table 12.

Table 11
Product Energy Consumption Variation Analysis.

Variation Resources	Degree of Freedom	Average of Squares	F Value
Working speed	2	2.94	98.75*
Knife-Counter Knife Clearance	2	0.03	1.27
Working speed X Knife-Counter Knife	4	0.007	0.26
Failure	18	0.02	
General	26		

According to the results of variance analysis, the effect of the change in working speed on the product energy consumption was found to be significant (P <0.05). In addition, the knife-counter knife clearance and the working speed of progression were found to be insignificant.

Table 12
Product Energy Consumption LSD Test Results.

Clearance, Speed, and Clearance x Average of Speed İnteraction (%)				
V(km/h) / C(mm)	V1	V2	V3	Average
C1	2.45	1.92	1.38	1.92
C2	2.39	1.83	1.29	1.84
C3	2.61	1.94	1.35	1.97
				LSD=0.17
Average	2.48[a]	1.90[b]	1.34[c]	
		LSD=0.17		
		LSD=0.29		

Product energy consumption considering the results, the lowest acceptable product energy consumption rate due to the machine working speed was determined at the V_3 speed, followed by V_2 and V_1, respectively. The lowest acceptable product energy consumption ratio due to the knife-counter knife clerance is observed at the C_2 clerance while this ratio follows the C_1 and C_3 clerances, respectively (Table 12). It is seen that the increase in the energy consumption of the clerance from 1 mm to 3 mm, decreasing the energy consumption by 4.16% and increasing the average energy consumption by 7.06% from 3 mm to 5 mm. The 100% increase in the working speed reduced the average energy consumption by 45.96%.

When the field-product energy consumption is examined together, the results vary with the power consumption. The highest field-to-product energy consumption was obtained in the combination of C_3V_1 and 2.61 kW/t, 11.71 kW/da, while the lowest field-to-product energy consumption was obtained in 5.79 kW/da, 1.29 kW/t in combination with C_2V_3. It was seen that the increase in knife-counter knife clearance and mean values increased with decreasing. By increasing the working speed, field-product energy consumption was reduced. Bilgen and Sungur, (1992) stated that energy consumption and product energy consumption were reduced by increasing the working speed in silage machines.

Field-product working capacity of the machine used in silage making is given in Table 13.

Table 13
Field-product working capacity of the machine used in silage making

Working Speed (km/h)	Knife-Counter Knife Clearance (mm)	Field working capacity (da/h)	Product working capacity (t/da)
V_1	C_1 C_2 C_3	0.88	3.96
V_2	C_1 C_2 C_3	1.23	5.5
V_3	C_1 C_2 C_3	1.81	8.15

One of the factors affecting field and product working capacity is the progress rate and the other is the working width. With the increase in both the working speed and the working width, the field-product working capacity is increasing. According to these values, the highest field-to-product working capacity was achieved at 1.81 da/h, 8.15 t/h at the V_3 working speed, while the lowest field-to-product working capacity was obtained at 0.88 da/h, 3.96 t/h at V_1 working speed. Increasing the working speed in silage machines and increasing the product working capacity. It is also natural to increase the product working capacity depending on the increasing working speed. Because the feed rate will increase depending on the feed rate, the success of the product will increase (Bilgen and Sungur, 1992). Field and product working capacity of silage machines increased as working speed and work width increased. Field-product energy, power and fuel consumption decreased inversely proportional to the field and product working capacity (Kafadar, 1997).

4. Conclusion

In this study, active knife and fixed knife of single-row disc silage machine has three different clearance C_1, C_2 and C_3 (1, 3 and 5 mm) and it is tried in three different working speed V_1, V_2 and V_3 (1.8, 2.5 and 3.7 km / h) and PTO speed (540 min-1) and machine's fuel consumption (l/h), average power consumption (kW), field energy consumption (kW/da), product energy consumption (kW/t), field working capacity (da/h), product working capacity (t/h) and Chopping

size distribution characteristics of the fragmented material were determined.

1. For all working combinations, it was determined that the power consumption ranged from 9.48-11.23 kW. The average increase in power consumption of the knife-counter knife clearance from 1 mm to 3 mm decreased by 4.66% while it increased from 3 mm to 5 mm and the average power consumption increased by 6.48%. The 100% increase in the working speed increased the average power consumption by 10.87%.

2. It has been determined that fuel consumption varies between 5.69-9.18 l/h. The average increase of the clearance from 1 mm to 3 mm was found to increase the fuel consumption by 8.86%, while the increase from 3 mm to 5 mm increased the average fuel consumption by 29.89%. The 100% increase in working speed increased the average fuel consumption by 24.68%.

3. Field-product working capacity was found to vary between 0.88-1.81 da/h and 3.96-8.15 t/h

4. Field-product energy consumption has been determined to vary between 5.79-11.71 kW/da and 1.29-2.61 kW/t. In the field energy consumption, it was observed that the increase in the power consumption of the clearance from 1 mm to 3 mm decreased by 4.06% while the average area energy consumption increased by 6.9% from 3 mm to 5 mm. The 100% increase in the working speed reduced the average energy consumption by 46.05%. In the product energy consumption, it is seen that the increase in the energy consumption of the clearance from 1 mm to 3 mm, decreasing the energy consumption by 4.16 % and increasing the average energy consumption by 7.06 % from 3 mm to 5 mm. An increase of 100% in the working speed reduced the average product energy consumption by 45.96%.

5. In terms of silage mincing size, all working combinations gave the appropriate shredding length distribution, while a 1 mm clearance gave a more suitable Chopping size distribution in terms of animal feeding.

6. The power consumption was the most appropriate at C_2V_1 combination for fuel consumption. In terms of field-product energy consumption, the most appropriate was the combination of C_2V_3. The highest field-product working capacity was achieved at the V_3 working speed.

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Extending the Postharvest Quality of Peach Fruits by Salicylic Acid and MAP Treatments

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ABSTRACT

Postharvest salicylic acid (SA) treatments can decrease the fungal decay of horticultural crops by affecting the ethylene biosynthesis and inducing the systemic resistance during cold storage. In the present study, effects of SA and modified atmosphere packages (MAP) on the postharvest quality maintenance of fruits of peach cv 'J. H. Hale' were investigated. After harvest at commercial maturity, half lot of each of the fruits was subjected to 1 mM SA for 5 min and was packed with or without MAP. The remaining lot was not subjected to SA but was also stored with or without MAP. All the fruits were stored at 1°C and 90% relative humidity for 60 d. Weight loss, color of flesh and skin, firmness, total soluble solid, titratable acidity, total phenolic and total antioxidant analyses were performed with 15 d intervals to compare the effectiveness of treatments. SA treatment had positive influences on the postharvest quality maintenance of the fruits. In particular, the combined use of SA and MAP was more effective than their individual use in maintaining the firmness of the fruits, delaying the biochemical changes in the flesh and alterations in the skin color.

1. Introduction

The peach (*Prunus persica*) is one of the most popular fruits in the world because of its high nutrient level and pleasant flavor. Peach is the third most important deciduous fruit crop in the world (Farooq et al. 2018). The world production of peach and nectarine is 24.7 million tons and the largest producer of peach fruit is China, followed by the United States, Italy, Turkey, Chile, Japan, Australia, and Russia. According to 2017 statistical data, total amount of peach-nectarine production of Turkey is 771.459 tons (FAO 2019).

Peaches are highly perishable climacteric fruits with limited market life. They would suffer rapid ripening and deterioration processes after harvest and thus, have a limited postharvest life at room temperature. Cold storage is widely used to extend the market life and postharvest quality by delaying the metabolic changes which deteriorate fruits quickly if the fruit is subjected to an ambient temperature after harvest (Farooq et al. 2018). However, fruits exposed to 0-1°C for up to 2-3 weeks cold storage may cause chilling injury which is characterized by internal browning, mealiness, juicelessness, failure to ripen normally, leatheriness, and other imperfections related to the cell wall integrity and pectin metabolism (Awad 2013; Yenici and Akbudak 2014). Several other techniques used to improve the shelf life of peach are storage in controlled atmosphere, modified atmosphere packaging, heat treatment, chemical treatments and edible coatings (Farooq et al. 2018).

Salicylic acid (SA), a phenolic compound found in a wide range of plant species, exhibits a high potential in controlling the postharvest losses of horticultural crops. Postharvest SA treatments decrease the ethylene biosynthesis and action, induce the resistance towards disease, prevent oxidative stresses, support the fruit tolerance to chilling injury, decrease respiration rate, delay ripening and senescence, slow down the activity of cell wall degrading enzymes and maintain the crop firmness (Asghari and Aghdam 2010).

Modified atmosphere packages (MAP) have been commonly used in postharvest quality maintenance of horticultural crops. The use of MAP effectively extends the internal and external quality feature of the crops by restricting the respiration and ethylene biosyn-

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thesis. However, the effect of MAP on postharvest quality maintenance of the produces depends on genotypic structures of the species and cultivars as well as the maturity level, harvest quality and environmental conditions (Erkan ve ark. 2017).

In the present study, effects of SA and MAP on postharvest quality maintenance of fruits of peach cv 'J. H. Hale' were investigated.

2. Materials and Methods

The experiment was carried out during the growing seasons of 2016. Peach (*Prunus persica*) fruits of cv. 'J. H. Hale' were harvested at commercial mature stage (SSC at 9.20 and firmness at 25.50 N) in Karaman and transferred to postharvest laboratory of Department of Horticulture, Selcuk University within 3 hours of harvest. Fruits were sorted for uniform size and free from defects. Afterwards, fruits were randomly divided into four equal lots and each lot contained 120 fruits in three replicates. Two lots of fruits were immersed in 1.0 mM salicylic acid aqueous solutions for 5 min. Following the treatments, fruits were allowed to dry at room temperature. After SA treatment, the fruits of the first lot were packed with Xtend® MAPs (SA+MAP), while the others were directly placed into open plastic box (SA). Similar to untreated fruits, the first lot was stored in open plastic boxes without any application (as control) while the second was packed with MAPs (MAP).

After the treatments, all the fruits were stored at 0±1 °C and 90% RH for 60 days. Fruits were analyzed for skin and flesh color, firmness, soluble solid content (SSC), titratable acidity (TA), total phenols (TP) and total antioxidant activity (TAA) after harvest and 15, 30, 45, and 60 days of cold storage.

Fruit firmness was measured using a digital penetrometer (fruit pressure tester, model 53205; TR, Forlì, Italy). After removing the epidermis at two equatorial sites, an 8 mm probe was used to measure the fruits firmness and results were expressed in Newton (N).

Fruit skin and flesh color were determined using a Minolta CR400 colorimeter to obtain the following variables from two equatorial points of fruits: L* (lightness), C* (chroma) and h° (hue angle) (McGuire 1992).

Peach juice squeezed from fruit was analyzed for SSC using a refractometer (Atago, Tokyo, Japan) and results were expressed as SSC%. TA was determined by the titration of 5 mL juice with 0.1 N sodium hydroxide to an end point of 8.1, results were given as the percentage of mallic acid (Cemeroğlu 2007). SSC/TA (Maturity index) was calculated as soluble solid content/acid content.

Fruit extracts for total phenol and antioxidant activity were prepared using method described by Thaipong et al. (2006) with some modifications. Five grams of peach tissue was homogenized in 25 mL methanol using the Ultra-Turrax homogenizer (IKA, T18 digital, Staufen, Germany) for 5 min. The homogenates were kept at 4 °C for 14–16 h and then centrifuged at 8000 x g for 15 min at 5 °C. The supernatants were recovered and stored at -20 °C in dark color bottles until analysis.

Total phenolics were determined according to the method of Singleton et al. (1999) with slight modifications. The 0.1 mL extract, 6.0 ml distilled water and 0.5 ml Folin-Ciocalteu reagent were mixed and vortexed. The mixture were incubated for 3 min and then 20% sodium carbonate solution was added and volume was made up to 10 ml by adding distilled water. The solution was incubated at room temperature for 2 h and the absorbance was measured at 760 nm. The total phenolics content was calculated on the basis of the calibration curve of gallic acid and was expressed as mg 100 g^{-1} FW.

Antioxidant activity was determined by the ferric reducing ability antioxidant power (FRAP) according to the procedure described by Benzie and Strain (1996). For this, 150 µL of extract and 2.85 mL of the FRAP reagent was incubated at 30 °C for 30 min. After incubation, reaction mixture was measured at 593 nm on a UV-vis spectrophotometer. Standard curve was prepared using different concentrations of 1 mM trolox and expressed as µmol kg^{-1}.

The experiment was a completely randomized design with three replications and each replication contained 10 fruits. Data from analyzed parameters was submitted to analysis of variance using JMP statistical software version 5.1 (SAS Institute Inc., Cary, NC, USA). Sources of variation were treatments, storage time and their interaction. Means were compared by Student's t-test at a significance level of 0.05

3. Results and Discussion

As illustrated in Fig. 1, firmness of the fruits gradually decreased during the prolonged cold storage. However, MAP and SA+MAP treatments significantly maintained the fruit firmness in comparison to control and SA fruits. Initial firmness value of peaches were 25.5 N. At the end of the storage period, the highest firmness value was obtained from SA+MAP treatment (19.8 N), followed by MAP and SA treatment (17.4 and 11.8 N, respectively). On the other hand, fruits of control treatment showed the lowest firmness value (9.2 N). Similar results were also obtained by Awad (2013) who reported that 0.5, 1.0 and 1.5 mM SA significantly inhibited the decrease of firmness in peach fruits.

Physiological effects of SA on the delaying the fruit softening was highlighted by Asghari and Aghdam (2010) who explained that SA inhibits the cell wall and membrane degrading enzymes such as polygalacturonase, lipoxygenase, cellulase and pectinemethylesterase. Results indicated that combined treatment was more effective than SA or MAP alone in delaying the softening during the storage period. This result was in agreement with Bal (2016) who reported a delaying

effect of SA plus MAP on the firmness of nectarine cv. Fantasia.

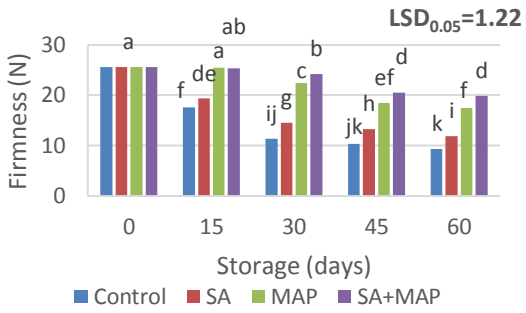

Figure 1
Changes in firmness values of peach fruits during the prolonged cold storage. Means not connected by same letter are significantly different at 5% level

Changes in total phenolics content of peach fruits in response to the different treatments during the prolonged cold storage was shown in Figure 2. Total phenolics content at harvest were 136.45, while it ranged from 135.96 (MAP) to 140.63 (control) at 60th day of storage. In general, a slight increase occurred in total phenolics content during the storage, but the effect of postharvest treatment on this decrease was insignificant. This result was in agreement with Lu et al. (2011) who reported that SA did not affect total phenolics content.

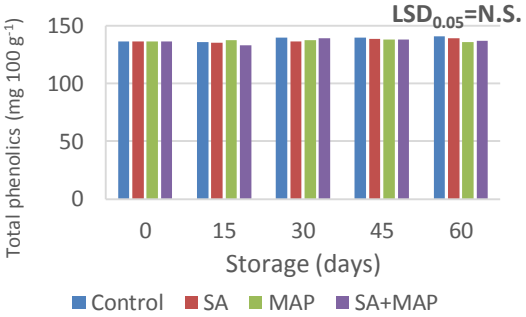

Figure 2
Changes in total phenolics of peach fruits during the prolonged cold strage. Means not connected by same letter are significantly different at 5% level

After 15 days storage, antioxidant activity of peach fruits underwent a remarkable and significant decrease in all the treatments (Fig. 3). However, antioxidant activity degradation rate was significantly delayed by SA+MAP treatment. Among the treatments, SA+MAP maintained the highest antioxidant activity (26.05 µmol kg^{-1}), while it was lowest in control fruits (13.20 µmol kg^{-1}). In SA+MAP treated fruits, 50% more antioxidant activity was found as compared to the control fruits. As widely known, exogenously applied SA enhance the efficiency of antioxidant system in plants (Khademi and Ershadi 2013).

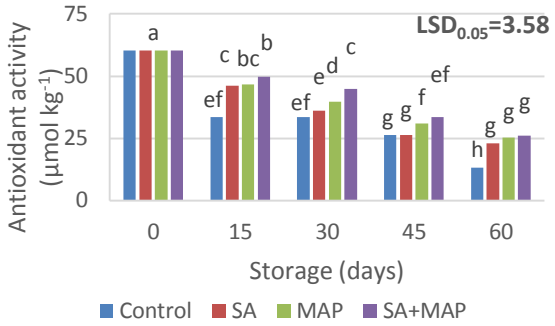

Figure 3
Changes in antioxidant activity of peach fruits during the prolonged cold storage. Means not connected by same letter are significantly different at 5% level

Changes in the fruit skin color related values during storage were shown in Table 1. Significant decrease in the fruit skin L* value was recorded with the prolonged storage time. At harvest, L* value of fruit skin was 66.87. At the end of the storage, the highest L* value was obtained from the fruits of the SA+MAP treatment (55.63), while the lowest value was measured in the control fruits (51.92). The chroma (C) value of the fruit skin also showed a significant decrease along with the prolonged storage time. At the beginning of the storage, C value of fruit was 46.02 while, this value ranged from 35.84 (control) to 38.71 (SA) at the end of the storage. Initial Hue angle values of the fruit skin was 74.04°. During the storage, the Hue angle significantly decreased probably due to the ripening process of fruits. At the end of the storage, SA+MAP combination was the most effective treatment with a significant delay as compared to control or single application of SA or MAP. Finally, Hue angle values of fruit skin ranged from 55.07° (control) to 66.32° (SA+MAP).

Table 1
Changes in L*, C and Hue angle values of peach skin during the prolonged cold storage [x].

Treatments	Storage (days)				
	0	15	30	45	60
	L*				
Control	66.87^{a}	60.95^{bc}	59.88^{cd}	58.72^{de}	51.92^{h}
SA		60.95^{bc}	58.67^{de}	56.88^{ef}	55.28^{fg}
MAP		61.44^{bc}	58.33^{de}	55.25^{fg}	54.75^{g}
SA+MAP		62.53^{b}	61.44^{bc}	58.02^{de}	55.63^{fg}
	C				
Control	46.02^{a}	44.40^{ab}	40.43^{c-f}	37.92^{fgh}	35.84^{hi}
SA		44.10^{ab}	41.63^{b-e}	41.39^{b-e}	38.71^{e-h}
MAP		35.75^{hi}	41.82^{bcd}	33.53^{i}	36.15^{ghi}
SA+MAP		43.74^{ab}	42.20^{bc}	39.03^{e-h}	37.43^{fgh}
	Hue angle				
Control	74.04^{a}	70.60^{cd}	64.88^{g}	58.99^{i}	55.07^{j}
SA		71.19^{bcd}	67.60^{ef}	62.37^{h}	57.69^{i}
MAP		71.61^{bc}	70.00^{d}	66.63^{ef}	64.89^{g}
SA+MAP		72.40^{b}	68.12^{e}	66.41^{fg}	66.32^{fg}

[x] Means not connected by same letter are significantly different at 5% level. $LSD_{0.05}$ L* = 1.93, C= 3.07, Hue= 1.59

Changes in L*, C and hue angle of fruit flesh color during the cold storage were illustrated in Table 2. Just similar to the findings on skin color, all the color values measures in the study markedly decreased during the cold storage and the decreases were statistically significant. Initial L* value of peach flesh was 66.85. The decrease in L* values due to browning of flesh was highest in the control fruits (46.12) during the prolonged storage. At the 60th storage day, the highest L* values was measured from the fruits of SA+MAP (51.81). Chroma value (C) indicates the purity or intensity of color. C value of peaches at harvest was 43.14. After 60 days of storage, C value ranged from 36.89 (control) to 24.97 (MAP). At the end of the storage, SA+MAP treatment was found as the most effective treatment for delaying the decrease in the Hue angle values, while the highest change was found in control fruits. The highest Hue angle value was found in fruits of SA+MAP (62.48) and was followed by SA (60.36), while the lowest value was obtained from control (54.29) and the fruits of MAP (54.22). Browning in fruit flesh is commonly seen in peach fruits during the cold storage due to cold injury (Lurie and Crisosto 2005). Previous studies on peach, plum and pomegranate indicated that SA have positive effects on preventing the flesh browning (Wang et al. 2006; Sabır 2017; Sayyari et al. 2009; Sharma and Sharma 2016).

Table 2
Changes in L*, C and Hue angle values of peach flesh during the prolonged cold storage [x].

Treatments	Storage (days)				
	0	15	30	45	60
	L*				
Control	66.85^{a}	61.09^{b}	52.91^{e}	49.68^{fg}	46.12^{h}
SA		60.12^{bc}	58.70^{cd}	53.53^{e}	47.66^{gh}
MAP		60.37^{bc}	58.88^{c}	53.68^{e}	48.55^{g}
SA+MAP		61.79^{b}	58.24^{cd}	56.67^{d}	51.81^{ef}
	C				
Control	43.14^{a}	39.92^{b}	38.64^{bc}	30.49^{g}	36.89^{cde}
SA		39.45^{b}	35.95^{de}	36.93^{cde}	28.90^{gh}
MAP		33.45^{f}	39.70^{b}	36.61^{cde}	24.97^{i}
SA+MAP		34.80^{ef}	38.64^{bc}	37.55^{bcd}	27.41^{hi}
	Hue				
Control	76.43^{a}	72.38^{c}	61.64^{hi}	60.36^{ij}	54.29^{k}
SA		72.50^{c}	71.51^{cd}	67.07^{f}	60.36^{ij}
MAP		72.76^{c}	69.88^{e}	63.26^{g}	54.22^{k}
SA+MAP		74.64^{b}	70.17^{de}	68.82^{e}	62.48^{gh}

[x] Means not connected by same letter are significantly different at 5% level. $LSD_{0.05}$ L* = 2.15, C= 2.50, Hue= 1.55

SSC and SSC/TA displayed an overall increment while TA decreased across the treatments during cold storage (Table 3). Initial SSC value was 9.20% in peach fruits. At the end of the storage, the highest SSC was observed in SA (13.07%), while the least value was recorded in SA+MAP combination (11.47%). The increased amounts of SSC over the storage period could be due to weight loss and increased fruit juice concentration (Moreno et al, 2008). SA+MAP had positive effect on maintaining the SSC content of the peach fruit. Although certain researchers reported that single use of SA treatment had no effect on SSC of several fruits like grape Ranjbaran et al. (2011) and persimmon (Khademi et al. 2012).

At the beginning of the storage, TA was 0.635% and this value significantly decreased with the increase in storage period. After 60 days of storage, TA levels were 0.281%, 0.335%, 0.360% and 0.414% for control, SA, MAP and MAP plus SA, respectively. Previous studies indicated that SA treatment alone had no significant influence on TA of fruits over the storage time (Sayyari et al. 2009; Ranjbaran et al. 2011). In the present study, combined use of SA with MAP significantly prevented the decline in TA during the storage.

During storage, SSC/TA values tended to increase in various levels according to the treatments. At the end of the 60 d storage duration, the highest SSC/TA value was determined in control fruits (45.03). During the storage period, it was determined that postharvest treatments effectively delayed the increase in SSC/TA value compared to control.

Table 3
Changes in SSC, TA and SSC/TA values of peach during the prolonged cold storage [x].

Treatments	Storage (days)				
	0	15	30	45	60
	SSC				
Control	9.20^{j}	10.47^{gh}	11.80^{c}	12.73^{ab}	12.67^{ab}
SA		10.67^{fg}	11.27^{de}	12.50^{b}	13.07^{a}
MAP		9.93^{i}	10.60^{fgh}	11.47^{cd}	11.47^{cd}
SA+MAP		9.87^{i}	10.13^{hi}	10.93^{efg}	11.00^{def}
	TA				
Control	0.635^{ab}	0.613^{b}	0.440^{e}	0.298^{hi}	0.281^{i}
SA		0.670^{a}	0.511^{d}	0.342^{gh}	0.335^{ghi}
MAP		0.609^{bc}	0.526^{d}	0.361^{fg}	0.360^{fg}
SA+MAP		0.598^{bc}	0.555^{cd}	0.417^{e}	0.414^{ef}
	SSC/TA				
Control	14.56^{i}	17.15^{h}	26.80^{e}	42.89^{a}	45.03^{a}
SA		15.90^{hi}	22.07^{f}	36.58^{c}	39.04^{b}
MAP		16.32^{hi}	20.14^{fg}	31.81^{d}	31.87^{d}
SA+MAP		16.52^{hi}	18.26^{gh}	26.23^{e}	26.57^{e}

[x] Means not connected by same letter are significantly different at 5% level. $LSD_{0.05}$ SSC= 0.53, TA= 0.05, SSC/TA= 2.38

4. Conclusions

This study was performed to reveal the effects of SA and MAP on the postharvest quality maintenance of fruits of peach cv 'J. H. Hale'. Immersing the peach fruits in 1.0 mM SA aqueous solutions for 5 min had positive influences on postharvest quality maintenance of the fruits. However, combined use of SA and MAP was more effective in maintaining the firmness, delaying the biochemical changes with flesh and skin color than their single use. Therefore, storing the peach fruits in MAP after SA immersion could be recommended for postharvest cold storage.

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Research Article

Estimation of Variance Components for Birth and Weaning Weights in Holstein-Friesian Calves by using WOMBAT software

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ABSTRACT

The aim of this study was to determine the variance components for birth and weaning weights in Holstein calves. In this purpose, a total of 675 calf birth weight and 295 weaning weight records of Holstein calves raised at Kuzucu Dairy Cattle Farm in Ereğli, Konya Province were used for estimation of phenotypic and genetic parameters for calf birth weight and weaning weight. Phenotypic and genetic parameters were estimated by WOMBAT program using a Single Trait Animal Model (STAM). The model constitutes of additive direct effect, maternal genetic effect (only for Model II) and errors as random effects, birth type, sex of calf, season of birth, year of birth and age of dam as fixed effects. Least square mean of calf birth weight was determined as 34.992 ± 0.572 kg. The direct heritability (h_a^2) of calf birth weight was calculated as 0.180±0.109 in Model I and the direct heritability (h_a^2) and maternal heritability (h_m^2) of calf birth weight were calculated as 0.154±0.096 and 0.141±0.106 in Model II, respectively. The effect of calving season, birth type, sex and age of dam on birth weight of calf were significant (P<0.01), but not calving year (P>0.05). As for calf weaning weight, least square mean was determined as 74.250 ± 1.775 kg. For calf weaning weight, the direct heritability (h_a^2) in Model I was calculated as 0.104± 0.126 and the direct heritability (h_a^2) and maternal heritability (h_m^2) in Model II were calculated as 0.104± 0.127 and 0.00002±0.341, respectively. The effect of calving year (P<0.05), birth type (P<0.05), sex (P<0.01) and birth weight (P<0.01) on weaning weight of calf were significant, except for calving season and age of dam (P>0.05) Furtermore, estimated breeding values (EBVs) estimated by BLUP (Best Linear Unbiased Prediction) for calves, sires and dams were found to be in general with the range of -3.245 to 2.577, -2.607 to 2.631 and -1.714 to 1.747 for birth weight and -2.969 to 2.274, -2.650 to 2.376 and -1.456 to 1.301 for weaning weight, respectively.

1. Introduction

Birth weight is one of the most critical traits for livestock. There are significant fluctuations in the weight of a calf over its first week of life. Therefore, it is important to weigh calves as soon as possible. Ideally, birth weight should be measured within 24 hours of birth (Anonymous 2019). In other words, birth weight as the initial criterion of post-natal period is important for growth and development. According to other viewpoint, although birth weight is commonly used as the initial reference point with regard to the development of an individual animal, it represents, in fact, the culmination of the most dynamic growth and development processes in mammalian biology in prenatal period (Holland and Odde 1992).

Offsprings with higher birth weight have a higher life force and at the same time, they start early yields than others in later periods. Therefore, the correct assessment in the ongoing process depends on the correct measurement of birth weight of calves. Especially, breeders interested in EBVs of birth weight (Estimated Breeding Values) for the sustainability of the farm, should keep records of the birth weights. This practice is extremely important both for calf management and for the sustainability of the farm such as survivability, incidence of diseases, milk and other yields and reproductive performance (Linden et al 2009).

Holland and Odde (1992) stated that calves with lower birth weight may have less vigor, tolerance to cold-stress, resistance to pathological agents, or the ability to overcome parturitional stresses during adap-

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tation to extrauterine life. But, calves that are over weighted at birth may cause varying degrees of dystocia, leading to increased birth asphyxia, metabolic and respiratory acidosis, depressed immunoglobulin absorption, and increased susceptibility to disease. Rahbar et al (2016) stated that extreme birth weights are important for calving ease of the dams and neonatal survival of the calves (Johason and Berger 2003) and increased calf birth weight (CBW) is associated with dystocia, stillbirths, and calf mortality, were all associated with lower calf and cow performance, which can lead to economic losses (Meijering 1984).

Factors affecting birth weight in calves are genetic such as breed and genetic abnormalities and environmental factors such as age of dam, type of birth, dam's size, maternal effect, dam's condition, sex, gestation period, year and season of calving (Kertz et al 1997; Akbulut et al 2001; Bakır et al 2004; Bilgiç & Alıç 2004; Koçak et al 2007; Koçak et al 2008; Linden et al 2009; Zülkadir et al 2010; Kaygısız et al 2012; Şahin et al 2017).

Genetic selection in dairy cattle is applied to traits that are measured during the animal's productive life, mostly those recorded during early productive life as genetic evaluations are best calculated from unbiased, early data (Coffey et al 2006). The second important criteria after birth weight is the weaning weight. The breeding goal is generally to increase the number of calves weaned per cow per lactation. MacNeil (2005) stated that the phenotypic ratio of a calf's weaning weight to its dam's weight is thought to be an indicator of efficiency of the cow.

To know the effects of environmental factors in evaluating the economically important traits and then standardization according to statistically significant ones is required. Afterwards determination of the selection type according to parameter estimation increases the success in the population. From this perspective, the objective of this study was to investigate the variance components for birth and weaning weights in Holstein calves in a herd.

2. Materials and Methods

In this study, a total of 675 birth weight and 295 weaning weight records of Holstein calves raised in intensive conditions at the Kuzucu Dairy Farm in Ereğli, Konya Province, Turkey. Data was recorded between 2017-2019. Analyses were carried out with the records of 675 calves having 31 sires and 587 dams for birth weights, and 295 calves, 22 sires and 282 dams for weaning weights, respectively. Cows were artificially inseminated.

Statistical analyzes were performed in Minitab 16.1.1 with GLM procedure and Tukey comparison test (Minitab, 2010). The effects of calving season, calving year, birth type, sex and age of dam for birth weight, in addition, birth weight as a covariate for weaning weight was included in the analysis by using least squares method. Differences between subgroups of the factors were tested with Tukey test and statistically significant factors were included in the Wombat models.

Genetic analyses were undertaken with Wombat for birth weight and weaning weight of calves. Birth weight trait was handled as covariate in weaning weight. Heritability of these traits were estimated by using Single Trait Animal Model (STAM) of Wombat according to Meyer (2010). Also, the estimated breeding values predicted by BLUP (Best Linear Unbiased Prediction) of Wombat were determinated. The full model in the analysis is included the fixed effects of calving season (from spring to winter), calving year (from 2017 to 2019), birth type (single and twin), sex (male and female), age of dam (from 2 to 6) and the real traits to right of birth weight (BW), birth weight (BW) as a covariate for weaning weight (WW).

Variance components were estimated using the following statistical model.

$$\mathbf{Y = Xb + Zu + e} \qquad \text{(Model I)}$$

$$\mathbf{Y = Xb + Zu + Wm + e} \qquad \text{(Model II)}$$

where,

Y = a vector of observation,

b = a vector of fixed effects consisting of calving season, birth type, sex and age of dam for birth weight and fixed effects consisting of calving year, birth type, sex and birth weight as a covariate for weaning weight,

u = a vector of animal direct additive genetic effects,

m = a vector of random maternal genetic effects,

e = a vector of random error.

X, Z and W = incidence matrices relating observations to fixed effects and random effects, respectively.

To estimate direct (h_a^2) and maternal (h_m^2) heritabilities, the following equation were used:

$$h_a^2 = \sigma_a^2/(\sigma_a^2 + \sigma_e^2) \qquad \text{(Model I)}$$

$$h_a^2 = \sigma_a^2/(\sigma_a^2 + \sigma_m^2 + \sigma_e^2) \qquad \text{(Model II)}$$

$$h_m^2 = \sigma_m^2/(\sigma_a^2 + \sigma_m^2 + \sigma_e^2) \qquad \text{(Model II)}$$

where;

σ_a^2 = additive genetic variance; σ_m^2 = maternal genetic variance and σ_e^2 = the random residual effect associated with each observation.

3. Results and Discussion

The least squares means ($\bar{X}$) and standard errors ($S_{\bar{x}}$) and R^2values of BW and WW are given in Table 1.

Table 1
The least squares means ($\bar{X}$) and standard errors ($S_{\bar{x}}$) and R^2 values of BW and WW

Factors	N	Birth Weight (kg) $\bar{X} \pm S_{\bar{x}}$	N	Weaning Weight (kg) $\bar{X} \pm S_{\bar{x}}$
	675	34.992 ± 0.572	295	74.250 ± 1.775
Calving season				
Spring	68	36.45 ± 0.765 ^{A}	41	74.63 ± 0.059
Summer	78	35.94 ± 0.794 ^{A}	19	72.81 ± 2.458
Autumn	229	33.89 ± 0.620 ^{B}	75	74.99 ± 2.156
Winter	300	33.69 ± 0.562 ^{B}	160	74.57 ± 1.726
P		*0.001*		*0.790*
Calving year				
2017	118	34.83 ± 0.690	118	74.59 ± 1.920 ^{ab}
2018	473	34.69 ± 0.531	147	76.35 ± 1.893 ^{a}
2019	84	35.45 ± 0.777	30	71.82 ± 2.183 ^{b}
P		*0.452*		*0.018*
Birth type				
Single	653	39.53 ± 0.323 ^{A}	290	77.99 ± 0.780 ^{a}
Twin	22	30.46 ± 1.038 ^{B}	5	70.51 ± 3.418 ^{b}
P		*0.001*		*0.032*
Sex				
Male	296	36.29 ± 0.598 ^{A}	125	75.75 ± 1.804 ^{A}
Female	379	33.69 ± 0. 602 ^{B}	170	72.76 ± 1.855 ^{B}
P		*0.001*		*0.001*
Age of dam				
2	305	32.92 ± 0.622 ^{B}	139	72.59 ± 1.901
3	147	35.16 ± 0.647 ^{A}	44	73.76 ± 2.077
4	93	35.72 ± 0.724 ^{A}	57	75.50 ± 1.964
5	78	35.87 ± 0.695 ^{A}	32	74.88 ± 1.968
6	52	35.28 ± 0.861 ^{A}	23	74.53 ± 2.363
P		*0.001*		*0.127*
BW		-		0.358±0.0896**
R^2		22.72		10.36

^{A,B}Means within a column with different superscripts differ significantly (P<0.01), ^{a,b}Means within a column with different superscripts differ significantly (P<0.05), **: P<0.01, R^2: The coefficient of determination

The least squares means of BW and WW were 34.992 ± 0.572 kg and 74.250 ± 1.775 kg, respectively. In literature, BW was found to be 36.9 ± 0.29 kg (Akbulut et al 2001), 36.79±0.068 kg (Bilgiç & Alıç 2004), 38.09±0.07 kg (Bakır et al 2004), 38.79 ± 0.171 kg (Koçak et al 2007), 38.75 ± 0.32 kg (Koçak et al 2008), 42.76±0.229 kg (Aksakal & Bayram 2009), 40.5 ± 5.8 kg (mean ± SD) (Johanson et al 2011), 38.71±3.56 and 37.53±2.09 kg at two farms (Kaygısız et al 2012). In general, the values reported in the literature are higher than than the least squares means reported for BW in this study. Also, WW was found to be 65.20 kg (Bayrıl & Yılmaz 2010) and 79.10 kg (Hızlı et al 2017). In this study, BW was significantly affected by calving season, birth type, sex and age of dam (P<0.01). Similar to these findings, some researchers stated that birth weight significantly affected by calving season (Akbulut et al 2001; Bilgiç & Alıç 2004; Bakır et al 2004; Koçak et al 2007; Aksakal & Bayram 2009; Kaygısız et al 2012) calving year (Akbulut et al 2001; Bilgiç &Alıç 2004; Bakır et al 2004; Koçak et al 2007; Koçak et al 2008; Kaygısız et al 2012; Şahin et al 2017), birth type (Bakır et al 2004; Aksakal & Bayram 2009; Şahin et al 2017), sex (Akbulut et al 2001; Bilgiç & Alıç 2004; Koçak et al 2007; Koçak et al 2008; Aksakal & Bayram 2009; Kaygısız et al 2012; Şahin et al 2017) and age of dam (Akbulut et al 2001; Koçak et al 2008; Zülkadir et al 2010; Şahin et al 2017). The effect of calving year (P<0.05), birth type (P<0.05), sex (P<0.01) and BW (P<0.01) on WW has been found to be statistically significant. Similarly, Hızlı et al (2017) stated that effects of calving year and sex on WW found to be statistically significant (P<0.01).Data structure, mean, standard deviation (SD), coefficient of variance (CV), minimum (MIN) and maximum (MAX) of BW and WW are given in Table 2.

Table 2
Data structure, mean, standard deviation (SD), coefficient of variance (CV), minimum (MIN) and maximum (MAX) of BW and WW

Traits	Birth Weight (kg)	Weaning Weight (kg)
Mean	37.52	78.36
SD	5.17	7.60
CV	13.78	9.70
MIN	18	62
MAX	52	105
No. of records	675	295
No. of valid records	675	295
No. of calf	675	295
No. of sires	31	22
No. of dams	587	282

Mean, standard deviation (SD), coefficient of variation (CV), minimum and maximum values of BW and WW were found to be as 37.52 kg, 5.17, 13.78, 18 kg, 52 and 78.36 kg, 7.60, 9.70, 62 kg, 105 kg, respectively. As a result of analysis by using Wombat program, estimates of variance components, heritabilities (h^2) according to two models for BW and WW are given in Table 3.

Table 3
Estimates of variance components, heritabilities (h^2) for BW and WW

Estimations	Traits	Birth Weight		Weaning Weight	
	Model	I	II	I	II
σ^2_a		3.78267	3.22677	5.52878	5.52874
σ^2_m		-	2.95247	-	0.00100
σ^2_e		17.2166	14.7725	47.5094	47.5086
σ^2_p		20.9993	20.9517	53.0382	53.0383
h_a^2		0.180±0.109	0.154±0.096	0.104± 0.126	0.104± 0.127
h_m^2		-	0.141±0.106	-	0.00002±0.341
Maximum log L		-1358.986	-1358.180	-730.955	-730.955
AIC		-1358.986	-1361.180	-732.955	-733.955
AICC		-1360.995	-1361.198	-732.975	-733.996
BIC		-1365.486	-1367.930	-736.621	-739.454
Penalty factor		3.250	3.250	2.833	2.833

σ^2_a = direct additive genetic variance; σ^2_m = maternal genetic variance, σ^2_e = temporary environmental variance, σ^2_p =phenotypic variance, h_a^2 = direct heritability, h_m^2 = maternal heritability, -2 log L= log likelihood, AIC & AICC and BIC: Akaike and Bayesian information criterions

Estimated variance components for calf weight at birth and weaning were given in Table 3 calculated according to two models; Model I: direct additive genetic effects and Model II: direct and maternal genetic effects. As a result of Model I for BW, direct additive genetic variance and phenotypic variance were found to be as 3.783 and 20.999, respectively, and direct heritability (h_a^2) was calculated as 0.180±0.109. As for Model II for BW, direct additive genetic variance, maternal genetic variance and phenotypic variance were found to be as 3.227, 2.953 and 20.952, respectively, so direct (h_a^2) and maternal (h_m^2) heritabilities were calculated as 0.154±0.096 and 0.141±0.106, respectively. In the same way, considering variance components, direct heritability (h_a^2) was calculated as 104± 0.126 in Model I and direct (h_a^2) and maternal (h_m^2) heritabilities were calculated as 0.104± 0.127 and 0.00002±0.341, respectively, for WW. When the information criteria were examined, it was found that the information criteria in the models within both traits had similar results.

In literature, Akbulut et al (2001) reported that heritability estimation belonging BW was found as 0.24 ± 0.177 for Holstein Friesian. Bilgiç & Alıç (2004) estimated heritability of BW in Holstein-Friesian calves as 0.07±0.041. Bakır et al (2004) reported that heritability was estimated for BW was 0.131±0.02 in Holstein-Friesian cattle. Heritability estimations (posterior mean ± SD) for direct effects and maternal effects were as 0.46 ± 0.04 and 0.10 ± 0.02, respectively, values reported by MacNeil (2005). Atıl et al (2005) found that direct heritability estimations for BW and WW are 0.28 and 0.13, respectively, while, maternal heritability estimations for the same traits are 0.14 and 0.06, respectively, for Friesian calves. Coffey et al (2006) reported that heritability of the BW and WW in Holstein-Friesian to be 0.53±0.12 and 0.79±0.09, respectively. Koçak et al (2007) determined heritability as 0.115 ± 0.0023 for BW in Holstein-Friesian calves. Aksakal & Bayram (2009) stated that heritability estimations for BW of calves of organic Holstein Friesian cattle production was 0.232 ± 0.110 kg. Khattab et al 2009 found that direct and maternal heritability estimations were as 0.21 and 0.13 for BW 0.29 and and 0.09 for WW in Holstein-Friesian in Egypt, respectively. The direct heritability estimation was 0.26±0.04, whereas the maternal heritability estimation was 0.08±0.01, for BW reported values in a Holstein herd reported values from

Johanson et al (2011). In Tahirova and Polatlı Holstein dairy farms, direct heritability estimations was found to be 0.15 and 0.04, while, maternal heritability estimations for the same traits are 0.56 and 0.002, respectively, (Kaygısız et al 2012). Şahin et al (2017) estimated direct heritability as 0.11±0.015 in Model 1, direct heritability as 0.10±0.025 and maternal heritability 0.09±0.039 in Model 4 for BW of Holstein calves in Tahirova dairy farm. Briefly, direct heritabilities of the BW was found to be in general with the range of 0.04 to 0.53, maternal heritabilities with the range of 0.002 to 0.56 in literature, and the findings in this study were similar with most of them. As for WW, direct heritabilities were found to be 0.13 (Atıl 2005), 0.29 (Khattab et al 2009) and 0.79 (Coffey et al 2006), and maternal heritability was found to be 0.09 (Khattab et al 2009). The findings of this study about WW in this study were similar to the values reported by Atıl (2005) and lower than Coffey et al (2006) and Khattab et al (2009) findings. The estimated breeding values (EBVs) are presented in Table 4, which were predicted in WOMBAT with BLUP.

Table 4
Maximum and minimum breeding values (BVs) with standard errors and accuracies of calves, sires and dams for BW and WW

	Birth Weight			Weaning Weight		
	CBVs	SBVs	DBVs	CBVs	SBVs	DBVs
Minumum	-3.245±1.614	-2.607±0.907	-1.714±1.899	-2.969±1.514	-2.650±0.880	-1.456±1.761
Maximum	2.577±1.716	2.631±1.589	1.747±1.857	2.274±1.613	2.376±1.507	1.301±1.736
Percentage of animal over the mean EBVs	43.41	48.39	50.60	42.81	54.84	50.77
Accuracy (%)	41.8 to 56.6	20.9 to 88.5	20.8 to 35.2	38.7 to 53.9	19.3 to 87.2	19.1 to 29.1
Accuracy ($\bar{X}$)	52.54	52.00	22.59	59.94	49.64	20.58

CBVs: Calf breeding values, SBVs: Sire breeding values and DBVs: Dam breeding values

When the Table 4 was evaluated, if it was possible, it was stated that success in selection and culling of animals for the next generation can be achieved by choosing animals with EBVs over the mean. It is also necessary to pay attention to accuracy of breeding values (BV) from calves, sires and dams for BW and WW. If there is a problem in regard to vitality because of low BW, a selection can be done towards high breeding value in order to increase of vitality in a herd or population. However, it is important to consider the both accuracy of breeding values and animals breeding values in this selection process. Thus, selection for the next generation would lead to higher genetic improvement in the herd or population.

Since calves are feed with milk in rearing system from birth to weaning, it can be said that the decrease of h^2 for WW may be due to maternal effect was not large influence for WW rather than BW. An alternative explanation for the low heritabilities of these traits might be due to luck of a proper mating program. According to these results, it can be expressed that family selection should be preferred to increase both BW and WW for this herd.

In recent years, dairy cattle breeders have shown an increasing interest in selection for economically important traits such as easy parturition and calf viability, which are not classical production traits. Since genetic selection could improve calving performance, it is important to include calving traits in genetic evaluations, although their implementation is not straightforward (Eaglen et al 2012). BW is also a critical quantitative trait that effects many economically traits. Hereby, BW is a sign of the calves' future development and growth rate, as well as an indicator of the calving ease. In this respect, it is one of the most fundamental herd management traits that should be focused on.

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Research Article

Some Reproductive Characteristics of Hasak and Hasmer Sheep: 1. Some Fertility Criteria

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ABSTRACT

In this study, Hasak and Hasmer ewes were used in order to determine the effects of age, year and breed on the conception rate, prolificacy, viability and productivity. The least-squares means for these parameters of all flock were found as follows; 87.27±0.01 %, 117.16±0.01 %, 87.06±0.01 % and 103.34±0.02 %, respectively. In addition, the effects of sex of lamb and birth type on viability were also studied. Except for prolificacy, effects of the age on these parameters were found to be not statistically significant. The maximum prolificacy was obtained with 6-years old ewes. Effect of breed was significant on the prolificacy (P<0.05) and conception rate (P<0.01). With regard to prolificacy, Hasmer ewes were superior to Hasak (120.90 % vs. 113.41 %). The year factor had a significant effect only on the prolificacy (P<0.05). Sex effect on the viability was not significant, but birth type effected viability significantly; single lambs being superior to twin ones.

1. Introduction

The primary objective in sheep breeding used in terms of many yields should be the quality fleece and meat production, because the sheep have lower chance to compete with cattle in terms of milk production. In the future, the primary target of the world's sheep breeding will be considered as meat production. When saying the meat production from sheep, the lamb meat must come to mind. More economical and much more lamb production is directly related to the traits of ration used in breeding activity and to the genotypic structures of both ewe and lamb.

Because the great majority of existing sheep are dual purpose and primitive looking breeds in Turkey, a significant number of researches/studies have been conducted in order to obtain new sheep types with superior yield traits over a century from the proclamation of the republic to the present**.** In the first study started in the mid-1930s and other studies that followed it, there were tried to develop sheep types with high yield and quality of fleece and with also good meat yields. Karacabey and Central Anatolian merino can be given as the examples of these studies. In 1986, a national project was initiated in order to develop the meat sheep breeding and six different breeds of rams and ewes were brought from UK, Germany and France. Crossbreeding was done in several government enterprises through these breeds (Tekin et al 2001).

Within the framework of the aforementioned national project, the German blackheaded Mutton Sheep (GBH), Hampshire Down (HD) and Lincoln (L) were brought to the Konya Livestock Research Institute in 1989 and the Merino (CAM, Central Anatolian Merino) sheep and GBH and HD included in this enterprise were crossbreed with native Akkaraman (AK) and Awassi breeds which are also included in this enterprise (Tekin et al 2001). HD, CAM and GBH crossbreds and HD, AK and GBH crossbreds have been raised indoors since 1997 and type fixation studies were inititaed through selection. As a result, the sheep named Hasmer (31.25% HD, 37.5% CAM and 31.25% GBH) and Hasak (31.25% HD, 37.5% AK and 31.25% GBH) were developed. When considering that the Central Anatolian Merino was obtained as a result of crossbreeding the German Mutton Merino (GMM) with Akkaraman in the previous years and that it has 20% genotype of the Akkaraman (Düzgüneş et al., 1983), the approximate genotype ratios in the Hasmer

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should be evaluated as 31.25% HD, 30.0% GMM, 7.5% AK and 31.25% GBH.

GBH and GMM originate in Germany and HD originates in UK. The common characteristics of these three breeds are to have meat type traits and to have high fleece yields (Özcan, 1990). The fertility rate in lamb meat production is also a very important factor. It is possible to breed more lambs in the sheep flock with high fertility rate and to produce more lambs in total. The fertility of these three breeds is satisfactory (the offspring can be obtained between 120 and 155 from hundred sheep) (Özcan 1990).

In the Official Gazette dated November 12, 2014 and numbered 29173, Hasak and Hasmer were registered as native breeds by the amendment made in the Communique (communique no: 2004/39)on the registration of domestic animal breeds and lines (Anonymous 2014).

Although there are some studies about yield traits related to Hasak and Hasmer breeds in literature, it is understood that studies on fertility have not been conducted sufficiently. The aim of this study was to determine the fertility traits of Hasak and Hasmer breed sheep raised in the Bahri Dağdaş International Agricultural Research Institute (BDIARI).

2. Materials and Methods

In this study, insemination, birth and records pertaining to lambs obtained in 2017-2018 years for 110 Hasmer and 170 Hasak sheep raised in the BDIARI Sheep Breeding Unit were used.

In the enterprise, sheep are fed based on the grazing during the day to the extent that the climate allows, and additional feed is given when they return to the sheep pen in the evening. However, it is paid special attention to the feeding of sheep at the end of the pregnancy when the energy and protein requirements are high and during the periods when the lactation milk yield is high.

The sheep are given the concentrated feed prepared in the institute and dry alfalfa grass of 400-500 g/per sheep in the last six weeks of the pregnancy and 800-1000 g/per sheep from lamb suckling period to the beginning of grazing.

Flushing is applied to the sheep during the mating season. The flushing application was started four weeks before the mating and continued for two weeks after the mating. For this purpose, four weeks before the insemination, the concentrated feed was started 100 g/per sheep in addition to roughage and this quantity was gradually increased to 500 g a week before the insemination. Additional feeding was also started in the rams about four weeks before the mating and continued for two to three weeks after the mating. Approximately 300-400 g of crushed grains per day was given to the rams when the mating was approached. At the time of insemination, 500 g of oatmeal and, apart from that, 150 g of soybean meal were given as protein supplement.

The inseminations were made between August and October through hand mating. The teaser ram is included in herd in the oestrus cycle of the sheep and the ewes with oestrus activity were determined and inseminated the breeding rams. The insemination dates and the numbers of rams and ewes were recorded. Births usually correspond to the months of January to March. The birth dates of ewes giving birth and the birth weights of the lambs (within 24 hours and with a sensitivity of 100 g), their sex and birth types were recorded. Lambs were weaned when they were three months old (in the 90th day).

In the study, the fertility parameters examined and the equations used in the calculation are as follows:

Conception rate, % = Number of pregnant sheep / the number of ewes exposed to the ram x100

Prolificacy, % = the number of lamb born / the number of ewes lambing x 100

Productivity of flock, % = the number of lambs weaned /Number of ewes exposed to the ram x 100

Viability, % = Number of lambs living in the ninetieth day / the number of lamb born x 100

The least squares method was used in the analysis of the factors for which the effects on fertility parameters were examined. The method was applied using Harvey's (1987) computer package program. Duncan test was used to determine the significance of the differences between the groups' averages. When applying the least squares method, the existence of the following models is accepted;

$Y_{ijl} = \mu + a_i + b_j + e_{ijl}$

The following equation is added to the model in order to analyse the effects of survival rate and sex and birth type

$Y_{ijkl\,(mn)} = \mu + a_i + b_j + c_k + d_l + s_m + e_{ijkl(mn)}$

$Y_{ijkl(mn)}$: The fertility record of any ewe (lamb in survival rate) expressed by the measure examined; i.e. for Prolificacy, i is the age, j is the year in which she gave birth, k is the breed and l is number of lamb she gave birth

μ : overall mean

a_i : the effect of year i=1,2 (2017-2018)

b_j: age of ewe j=2,3,4,5,6,7)

c_k: Type of birth k=1,2 (single, twin)

d_l : the sex of lamb l=1,2 (Male, Female)

Y_{ijkl}: i. year, j. age, k. type of birth, l. sex

e_{ijkl} : error

$e_{ijkl(mn)}$= the effect of error (it is accepted that the zero variance of the means of e's was σ_e^2).

Duncan's multiple range test using MSTAT-C Range Program (1989) was used to make comparisons among the subclass means.

3. Results and Discussion

The least-squares means with their standard errors and test of significance for conception rate, prolificacy, productivity and viability of Hasak and Hasmer sheep are shown in Table 1.

Table 1
Least-squares means and standard errors for conception rate, prolificacy, productivity and viability of Hasmer and Hasak sheep

Factors	Conception Rate, %		Prolificacy, %		Productivity, %		Viability, %	
Overall mean	642	87.27±0.01	571	117.16±0.01	645	103.34±0.02	648	87.06±0.01
Age of ewe's (b_j)		NS		**		NS		NS
2	151	85.77±0.02	132	107.59±0.03^{f}	152	101.18±0.04	140	82.05±0.03
3	144	88.09±0.02	133	110.65±0.03^{e}	149	100.89±0.04	146	87.65±0.03
4	119	91.27±0.02	106	121.69±0.03^{b}	115	109.94±0.05	127	92.68±0.03
5	92	85.61±0.03	81	118.49±0.04^{d}	92	102.96±0.05	93	87.93±0.03
6	56	89.23±0.04	50	125.26±0.05^{a}	56	106.42±0.07	63	82.41±0.04
7	80	83.62±0.03	69	119.27±0.04^{c}	81	98.66±0.05	79	89.64±0.03
Year(a_i)		NS		*		NS		NS
2017	310	88.71±0.02	278	113.86±0.02	311	101.84±0.03	308	88.41±0.02
2018	332	85.81±0.02	293	120.45±0.02	334	104.84±0.03	340	85.71±0.02
Breed-Genotype (c_k)		**		*		NS		NS
Hasmer	250	83.26±0.02^{a}	211	120.90±0.02^{a}	251	102.06±0.03	248	87.40±0.02
Hasak	392	91.27±0.01^{b}	360	113.41±0.02^{b}	394	104.63±0.03	400	86.72±0.02
Type of birth (d_l)								*
Single							488	90.88±0.01^{a}
Twin							160	83.33±0.02^{b}
Sex of lamb (s_m)								NS
Male							337	85.57±0.02
Female							311	88.56±0.02

Means followed by different letters within clases differ: * P<0.05; **P<0.01; NS, non-significant.

3.1. The Measures of Reproductive Performance

The least-squares mean for conception rate was 87.27±0.01 %. This rate was similar to 87.5 % for Akkaraman reported by (Yalçın & Aktaş 1976). However, this conception rate was higher than reported by (Yıldız & Denk 2006) for Akkaraman (85.19 %), and was lower than that obtained by (Özbey & Akcan 2000) for Akkaraman (93.0%), by Mohammadi et al (2013) for Makooei (93.0%), by (Öztürk & Pembeci 2016) for Akkaraman (91.44 %) and Büyüktekin & Öztürk (2018) for Akkaraman (91.27 %).

The average prolificacy for the flock of Akkaraman and Awassi was calculated as 117.16±0.01 %. This value was same to 117.00 % for Karacabey merino reported by Sezenler et al (2013), and was similar to that for Karakaş sheep (118.00 %) reported by Ülker et al (2004), but was lower than the prolificacy of Awassi (Öztürk & Pembeci 2016) and Akkaraman ewes (Büyüktekin & Öztürk, 2018), 129.27 and 135.0 % , respectively. Whereas, higher than 114.9 % value reported by Köycü (2017) for Kıvırcık.

The productivity was found as 103.34±0.02 % in the present study. This value is higher than the findings of Özcan et al (2002); (92.8 %) and (Büyüktekin & Öztürk 2018); (86.38 %) for the Akkaraman breed. In contrast, this value was lower than the productivity of Akkaraman (108.23 %) and Awassi (111.40 %) reported by (Öztürk & Pembeci 2016).

The lambs were weaned from milk at 90th days and the average viability was 87.06±0.01 %. This rate was similar to 87.8 % for Kıvırcık sheep raised in Aydın province, reported by Koç (2004). (Öztürk & Pembeci 2016), the viabilities of Akkaraman and Awassi lambs was found as 95.14 % and 95.97 % respectively, in the state farm of Tigem Gözlü. These rates were higher than the present study's finding. On the other hand, our finding about viability was higher than for viability of Kıvırcık lambs (83 %), reported by (Koyuncu & Akgün 2018).

The reasons for these differences are both genetic and environmental and genotype x environment interactions.

3.2. The Effect of the Studied Factors

Effects of Ewe Age

The age of dam (ewe) had a significant effect only on prolificacy of lambs in the present study (P<0.01), but did not affect conception rate, productivity and viability. The averages and standard errors of age groups and differences between groups were presented in Table 1.

The finding of this study about conception rate is in accordance with the reports of (Öztürk & Pembeci 2016). In contrast, (Büyüktekin & Öztürk 2018) were reported as significant. The prolificacy was affected by dam age. Similar findings have been reported by

(Thieme et al. 1999; Öztürk & Pembeci 2016; Büyüktekin & Öztürk 2018). According to (Öztürk & Pembeci 2016; Büyüktekin & Öztürk 2018) the effect of dam age on productivity was significant. These findings were not similar with the current study's result. But, (Vanlı & Özsoy 1988) reported that no significant effect on productivity for Awassi sheep. The dam age's effect on viability was reported as significant (Thieme et al., 1999; Ünal et al 2003; Öztürk & Pembeci 2016). (Ekiz & Altınel 2006; Koç 2004 and Büyüktekin & Öztürk 2018) have found the effect of main age to the living force to the lambs similar to the result of the Study.

Year

The factor "year" includes climatic, management, nutrition and husbandry elements, and it affect only prolificacy in the present study ($P<0.05$). Mohammadi et al (2013) in Makooei sheep, (Ozturk & Pembeci 2016) Akkaraman and Awassi breeds, and Büyüktekin & Öztürk (2018) in Akkaraman sheep have found that the effect of year factor on the prolificacy was important. There were no studies reporting the insignificant effect of the year factor.

Breed

As seen in the Table 1, it is concluded that Hasmer ewes were superior in terms of prolificacy than Hasak, in contrast Hasak ewes were superior in terms of conception rate than Hasmer, but there was no difference between the breeds with regard to the other criteria (productivity and viability). The same finding has been reported by Öztürk & Pembeci (2016) for Akkaraman and Awassi sheep in Konya. Prolificacy has been reported as the most appropriate measure for the comparison of sheep breeds in terms of reproductive performance (Köprücü 1975). According to this result it can be said that Hasmer has a higher reproductive efficiency than Hasak in conditions of BDIARI. This confirms the findings of (Pekel & Güney 1976). Because the differences among sheep breeds in respect of reproductive performance can be caused by the various environmental conditions, different selection purposes and also may be depended on changes of additive genes frequencies by chance and isolations.

Sex of Lamb

The viabilities of 337 male and 311 female lambs were 85.57±0.02 % and 88.56±0.02 %, respectively. Sex effect on the viability was not significant,. Koncagül et al (2013) for zom sheep, Aktaş et al (2014) for Akkara-man sheep, Öztürk & Pembeci (2016) for Akkaraman and Awassi sheep and Büyüktekin & Öztürk (2018) for Akkaraman sheep found that the effect of lamb sex on viability was insignificant. However, Pekel (1973) reported that male lambs had higher viability than females for Akkaraman and Awassi sheep

Type of Birth

The average viability of 488 single and 160 twin lambs were 90.80±0.01 % and 83.33±0.02 %, respectively. The difference between the averages is significant ($P<0.05$). This result is consistent with the literature in general (Ünal et al 2003; Öztürk & Pem-beci 2016). However, some researchers have reported the viability in favor of twin lambs (Özcan at al 2002; Ekiz & Altınel 2006; Büyüktekin & Öztürk 2018). The effect of lamb birth type on viability is related to ewe's pregnancy, the care of her young after birth, and her ability to produce enough milk. It is also related to the birth weight of the lamb.

4. Conclusion

For more meat production, high fertility is also required from the sheep. In this study, it is concluded that fertility of Hasak and Hasmer developed as meat-type (in the conditions in which care, management and feeding are considered to be relatively good) was not high. The new studies are needed in order to properly estimate the fertility of Hasak and Hasmer.

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Research Article

Influence of Mono-ammonium and Di-ammonium Phosphate on Phosphorus Use Efficiency of Maize and Bread Wheat Plants

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ABSTRACT

Phosphorus fixation in soils is a big problem, for that, it affects negatively on phosphorus use efficiency of the plant. The amount of phosphorus which had fixed depends on orthophosphate ions and some soil properties. The goal of two experiments [In the first maize (*Zea mays L.*) and the second bread wheat (*Triticum aestivum L.)*] to know the different influence of mono-ammonium phosphate [MAP $NH_4H_2PO_4$] and di-ammonium phosphate [DAP $(NH_4)_2HPO_4$] fertilizers when were applied in the soil at rates (0, 30, 60 and 90 mg P_2O_5 kg^{-1}) on phosphorus use efficiency under greenhouse condition. Completely Randomized Design (CRD) was arranged for both experiments in four replications in first experiment and three in the second.

Results cleared that plant dry weight (PDW, g pot^{-1}) and plant phosphorus uptake (PPU, mg P pot^{-1}) were increased with increasing doses of MAP and DAP fertilizers in both experiments according to control (0 ppm). Furthermore, apparent recovery phosphorus use efficiency (ARPUE, %) increased in DAP at maize and decreased in MAP at wheat trial when increasing phosphorus doses. All parameters had highly significantly affected by phosphorus. Also, fertilizers were a highly significant effect on PDW, PPU and agronomic phosphorus use efficiency (APUE) in maize and PPU in the wheat trial. Otherwise, interaction (F×P) had a highly significantly affected on PPU, physiological phosphorus use efficiency (PPUE) and ARPUE in wheat and APUE in maize. Additionally, PDW had a significant effect on interaction. When the MAP and DAP were increasing, that means increased PDW and PPU but MAP is better than DAP. Additionally, the results of the MAP in phosphorus use efficiency are better than DAP too.

1. Introduction

Phosphorus, nitrogen and potassium together are the most important elements as plant nutrients. Available phosphorus isn't enough in about 20% of Turkey agricultural soils (Sonmez and Ozbahce 2018). Phosphorus is primary for agriculture production, however, its use is not without entanglements. Attention to sustainable phosphorus use is no longer solely focused on reducing the detrimental environmental effect, but also explicitly linked to food and feed security (Schroder et al. 2010). Additionally, complete soil nutrients deficiency by chemical fertilization is very necessary for perfect nutrition to increase yield and decreased seed emptiness. Because soil nutrients deficiency reflected in vegetative growth and grain yield (Salvagiotti et al. 2017). Goos and Johnson (2001) stated that phosphorus fertilization very important for good establishing in spring wheat and it is very necessary for planting time in spite of the soil has a high level of phosphorus. No one can deny in the soil which phosphorus defective, phosphorus fertilizers are very essential to rise yield and yield component in cereal crops (Saeed et al. 2017). In that time the weak wheat production reasons in the world are poor phosphorus use efficiency (Ali et al. 2017; Hashmi et al. 2017). Noor et al. (2017) found that when phosphorus fertilizers are applied in calcareous and basic soil the sedimentation of phosphorus by Ca^{+2} and Mg^{+2} made phosphorus use efficiency less than 25% for that the availability of phosphorus be so limited. On the other way the importance of cereal crops in the world, wheat is the first and after rice, maize is a third as food and feed crops (Amanullah et al. 2009). In that time from now up to 2030 may use a double quantity of chemical fertilizers to save person production at the same level (Gilland 1993).

Irfan et al. (2018) found that when increased phosphorus quantity (0, 30, 60, 120 and 240 mg P2O5 kg-1) so significant ($p<0.05$) increased in plant phosphorus uptake and plant dry weight and in same time was

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significant ($p<0.05$) decreased agronomic P efficiency (APE), Physiological P efficiency (PPE) and phosphorus recovery efficiency (PRE) of wheat plant under greenhouse condition. In greenhouse condition, increasing phosphorus doses (0, 25, 50, 100, 150 and 200 mg kg^{-1}) that is to say, increased shoot dry weight, plant phosphorus uptake and physiology phosphorus uptake efficiency of two cultivars (Pasban-90 and MH-97) of bread wheat (*Triticum aestivum L.*) according to control (Akhtar et al. 2011). In that time, Saeed et al. (2017) stated that, in field condition in Faisalabad Pakistan in seasons 2014 and 2015 when increasing phosphorus doses (0, 50, 100, 150 and 200 kg P ha^{-1}) in the soil, plant dry weight and grain yield of maize (*Zea mays L.*) were increased. Addition to that increasing of phosphorus amount, that means increased on agronomic phosphorus use efficiency in 2015 season. In the other direction, in field condition the yield of maize plant had no significant effect and cleared a negative affected by increasing an amount of phosphorus (0, 23, 46, 69 and 92 kg P_2O_5 ha^{-1}) when applied with planting method (1 and 2 seed hill-1) and method of phosphorus application (Spot and strip) (Mazengia 2011). Khalili-Rad and Hosseini (2017) found that increased of phosphorus doses so were increased two wheat cultivars shoot dry weight. In the same way, increased the mono-ammonium phosphate (MAP) (0, 0.2, 0.4 and 0.8%) when applied as inorganic amendments fertilizer, that is to say, increased on plant dry weight depending on control (0) (Qayyum et al. 2017). Papadopoulos (1985) found that phosphorus doses (0, 15, 30 and 35 mg P Kg^{-1}) and different phosphorus fertilizers (mono-ammonium phosphate, di-ammonium phosphate and superphosphate) were significantly affected (5%) on P availability in calcaric soil and recovery of P (%), in addition to non-significantly affected on plant dry weight of barely.

Phosphorus fixation in soils is a big problem, for that, its effect negatively on phosphorus use efficiency of the plant. The amount of phosphorus which had fixed depends on orthophosphate ions and some soil properties. The use of mono-ammonium phosphate and di-ammonium phosphate as a phosphorus chemical fertilizer is very abundant in the agriculture sector. Which one from these is good in phosphorus use efficiency of the plant. To reply to that question two trials in maize and bread wheat purpose to explain the impact of mono-ammonium phosphate and di-ammonium phosphate on phosphorus use efficiency.

2. Materials and Methods

Two experiments were conducted in computer-controlled research greenhouse (Temperature was 25 ± 3 ˚C, solar radiation was 1750 ± 50 $kcal.m^{-2}$ and relative humidity was 60 ± 10%) of Soil Science and Plant Nutrition Department of Faculty of Agriculture, Selcuk University, Konya, Turkey. According to soil analysis, the soil which was used is poor in available phosphorus (<8 mg P kg^{-1}), and Sulphur (8.6 mg SO_4^{-2} kg^{-1}), slightly alkaline (pH 7.38), sandy clay loam (SCL) in texture and very poor in organic matter (Motsara and Roy, 2008). In addition to, saltless (EC 92 µS/cm), very limey (20%), insufficient nitrogen limit (5.70 mg N kg^{-1}), excess K (290 mg kg^{-1}) and Ca (8728 mg kg^{-1}), sufficient in Mg, (235 mg kg^{-1}), Zn (0.51 mg kg^{-1}), Mn 5.56 mg kg^{-1}) and Cu (1.12 mg kg^{-1}) and poor in Fe and B (2.31 and 0.45 mg kg^{-1}, respectively).

The factors of two experiments composed to fertilizers (F) as a first factor [Mono-ammonium phosphate (MAP) and Di-ammonium phosphate (DAP)] and Phosphorus (P) doses [0, 30, 60 and 90 mg P_2O_5 kg^{-1}] as a second factor. The dry soil was weighted in a pot (3 kg dry by oven) and before one day of planting MAP and DAP as a chemical fertilizer were applied and mixed to the soil, then the soil was transferred to the pot again. Ammonium nitrate (AN %33 N) as nitrogen (200 mg N kg-1) fertilization for two experiments was applied.

In addition to, two experiments, one was planted by bread wheat (*Triticum aestivum L.*) Bayraktar-2000 variety after vernalization for one month in three replicates (2×4×3= 24 treatments) and the second was planted by maize (*Zea mays L.*) Anti.cin 98 as popcorn variety in four replicates (2×4×4= 32 treatments). Two experiments were arranged in a Completely Randomized Design (CRD) in two factors. Two experiments were irrigated in the optimum stage until harvested.

Bread wheat and maize experiments were harvested after 2 and 2.5 months from planting respectively. After harvesting the samples were taken to the lab and dried in the oven in 70 ˚C till to stable weight and plant dry weight g/plot (PDW) was measured. After that plant samples were ground using an electric grinder and 0.2 g was weighted, then 5 ml HNO_3 + 2 ml H_2O_2 accompanied by high temperature (210 ˚C) microwave device (CEM MarsXp-ress) was dissolved and the volume was completed to 20 ml, thereafter the blue band (Whatman no 42) filter paper was used for filtering. Then total P (mg kg^{-1}) was measured by ICP device and after that plant phosphorus uptake mg P pot^{-1} was calculated. Additionally, phosphorus use efficiency (Agronomic phosphorus use efficiency (APUE), Physiology phosphorus use efficiency (PPUE) and Apparent recovery phosphorus use efficiency % (ARPUE)) was calculated according to Noor et al. (2017) equations:

- (APUE) = $\frac{\textbf{Fertilized (Phosphorus) Biomass} - \textbf{Unfertilized Biomass}}{\textit{Amount of applied } \textbf{P2O5}}$
- (PPUE) = $\frac{\textbf{Fertilized (Phosphorus) Biomass/plot} - \textbf{Unfertilized Biomass/plot}}{\textbf{Phosphorus uptake by plant in fertilizer/plot} - \textbf{Phosphorus uptake by plant in unertilizer/plot}}$
- ARPUE**(%)**= $\frac{\textbf{Phosphorus uptake by plant in fertilizer/plot} - \textbf{Phosphorus uptake by plant in unertilizer/plot}}{\textit{Amount of applied } \textbf{P2O5}} \times \mathbf{100}$

All results were statistically analyzed by Computer program Minitab (Minitab 16) and mean separation was performed by using LSD (Least Significant Difference) procedure.

3. Results and Discussion

3.1.Dry Weight and Phosphorus Uptake of Plants

The result cleared that phosphorus doses had a highly significantly affected ($p<0.01$) on plant phosphorus uptake (PPU) and plant dry weight (PDW) in both experiments (Table 3 and 4). The similar result that, plant phosphorus uptake and biological yield (t ha $^{-1}$) of maize in 2014 and 2015 seasons had a highly significant effect ($p<0.01$) by phosphorus (Saeed et al., 2017). In the same time, Khalili-Rad and Hosseini (2017) stated, that phosphorus had a significant effect ($p<0.05$) on total phosphorus and shoot dry weight of wheat. Moreover, (Mazengia 2011) who determined that phosphorus application had a non-significant effect on biomass yield of maize as the opposite result. Also, the effect of fertilizer was highly significantly ($p<0.01$) on PPU in two experiments and PDW in maize experiment, moreover in wheat trial fertilizer had non-significantly affected on PDW (Table 3 and 4). Similar results were found by Papadopoulos (1985) in calcaric soil that, different phosphorus source (mono-ammonium phosphate, di-ammonium phosphate and superphosphate) had a significantly affected on phosphorus availability in calcaric soil and in that time as opposite results that, different phosphorus source had a non-significantly affected on plant dry weight of barely. On the other hand, interaction (F×P) was a highly significant effect ($p<0.01$) on PPU in bread wheat trial and significantly affected ($p<0.05$) on PDW in maize. However, PDW in wheat and PPU in maize were non-significant affected by interaction (Table 3 and 4).

In these experiments while increased amount of phosphorus, PDW in maize trail at MAP in range 81 - 223% in addition to at DAP in range 26 - 119% and in bread wheat at MAP between 20 - 31% in addition to at DAP between 14 - 26% were increased depend on control (0 mg P_2O_5 kg^{-1}) (Table 1). Additionally, increased phosphorus doses, PPU in maize at MAP between 58 - 164% in addition to at DAP between 54 - 160% and in bread wheat at MAP in range 45 - 107% in addition to at DAP in range 34 - 210% were increased according to control (Table 1). In these researches, results explained that when applied different amount MAP (H_2PO4^-) and DAP ($HPO_4^{=}$) in the soil, PDW and PPU of wheat and maize had a high increased stage and MAP is better than DAP. The same results that, while increasing amount of phosphorus that means increased on barely plant dry weight at MAP between (10 - 13%) in addition to at DAP in range 9 - 13% and the phosphorus availability in Calcaric soil at MAP 146 - 592% in addition to at DAP in range 115 - 515% according to control (0 mg kg^{-1}) depending on control (0 mg kg^{-1}) (Papadopoulos 1985). Similar result too by Khalili-Rad and Hosseini (2017) in wheat and Saeed et al. (2017) in maize were found that when was increasing phosphorus amount, that means increased on a biological yield and phosphorus uptake. Opposite results stated that increasing in phosphorus amount that means decreased a biomass yield (Mazengia 2011).

The highest dose of phosphorus (90 mg P_2O_5 kg-1) had the largest average of PDW at MAP (27.68 g/pot) and at DAP (18.94 g pot^{-1}) in maize and at MAP (23.98 g pot^{-1}) and DAP (25.19 g pot^{-1}) in bread wheat (Table 1). In addition to the highest dose of phosphorus (90 mg kg^{-1}) too had the largest average of PPU at MAP (24.67 mg P pot^{-1}) and at DAP (21.08 mg P pot^{-1}) in maize and at DAP (34.40 mg P pot^{-1}). Additionally, the largest average of PPU in bread wheat at MAP (22.47 mg P pot^{-1}) by 60 mg P_2O_5 kg^{-1} dose (Table 1). In the other direction, the smallest mean of PDW at MAP (8.57 g/pot) and at DAP (8.65 g pot^{-1}) in maize farther at MAP (18.35 g pot^{-1}) and at DAP (20.00 g/pot) in wheat by control (0 mg P_2O_5 kg^{-1}) (Table 1). In addition to the smallest mean of PPU at MAP (9.35 g/pot) and at DAP (8.11 g pot^{-1}) in maize farther at MAP (10.85 g pot^{-1}) and at DAP (11.11 g pot^{-1}) in wheat by control (0 mg P_2O_5 kg^{-1}) too (Table 1).

Table 1
Plant Dry Weight and Phosphorus Plant Uptake of Bread Wheat and Maize

Treatments		Plant Dry Wheat (g pot^{-1})		Phosphorus Plant Uptake (mg P pot^{-1})	
Plants	Phosphorus doses (mg P_2O_5 kg^{-1})	Mono-ammonium Phos-phate (MAP)	Di-ammonium Phosphate (DAP)	MAP	DAP
Maize	0	8.57	8.65	9.35	8.11
	30	15.48	10.88	14.76	12.50
	60	21.60	13.89	20.38	15.70
	90	27.68	18.94	24.67	21.08
Bread Wheat	0	18.35	20.00	10.85	11.11
	30	21.93	22.89	15.69	14.93
	60	23.83	21.93	22.47	14.61
	90	23.98	25.19	16.89	34.40
Plants		Maize	Bread Wheat	Maize	Bread Wheat
Least Significant Different (LSD) Fertilizers (F) 5%		1.91	No Significant (N.S)	1.66	2.18
LSD 5% of Phosphorus (P)		2.70	2.58	2.34	3.08
LSD 5% of interaction (F×P)		3.82	N.S	N.S	0.75
Standard Error of F (SE±)		0.93	0.88	0.80	0.75
SE± of P		0.65	0.62	0.57	0.53
SE± of interaction F× P		1.31	1.25	1.14	1.06

3.2. Agronomic Phosphorus Use Efficiency, Physiology Phosphorus Use Efficiency and Apparent Recovery Phosphorus Use Efficiency of Plants

The result revealed that, Agronomic Phosphorus Use Efficiency (APUE), Physiology Phosphorus Use Efficiency (PPUE) and Apparent Recovery Phosphorus Use Efficiency (ARPUE) of maize and bread wheat were a highly significantly affected ($p<0.01$) by phosphorus doses (Table 3 and 4). Similar results by Irfan et al. (2018) and Akhtar et al. (2011) in wheat, Saeed et al. (2017) in maize and Papadopoulos (1985) in barely who were stated that Phosphorus had significantly affected on agronomic P efficiency (APE), Physiological P efficiency (PPE) and Phosphorus recovery efficiency (PRE). Also, the effect of fertilizer was highly significantly ($p<0.01$) on APUE and PPUE in maize and had significantly affected ($p<0.05$) on ARPUE in bread wheat. Moreo-ver, fertilizer had non-significantly affected on ARPUE in maize in addition to APUE and PPUE in bread wheat trial (Table 3 and 4). Similar results were found by Papadopoulos (1985) in calcaric soil that, different phosphorus source (mono-ammonium phosphate, di-ammonium phosphate and superphos-phate) had a significantly affected ($p<0.05$) on phos-phorus recovery (%) of barley. On the other hand, interaction (F×P) was a highly significant effect ($p<0.01$) on APUE in popcorn and ARPUE in bread wheat. But PPUE and ARPUE in popcorn addition to APUE and PPUE bread wheat were non-significant affected by interaction (Table 3 and 4).

So generally, phosphorus use efficiency (APUE, PPUE and ARPUE) of wheat and maize in MAP application is higher than DAP application. Papadopoulos (1985) who found that phosphorus recovery (%) of barely in MAP is better than DAP. In addition to, while increased amount of phosphorus that means APUE at DAP in range 12 - 53% and ARPUE at DAP too between 7 - 21% in maize trail were increased moreover, APUE in bread wheat at MAP between 23 - 48% in addition to at DAP in range 40-67% were decreased according to the small-est quantity of phosphorus (30 mg kg-1) (Table 2). The same result to maize and in that time opposite result for bread wheat was found by Saeed et al. (2017) who stated while phosphorus doses were in-creasing that means increased agronomic efficiency of maize. Moreover, the opposite result for maize and the same result for wheat that, increased of phosphorus quantity, decreased of Agronomic P efficiency (APE) of the wheat plant depending on the lowest amount of phosphorus (Irfan et al. 2018). Furthermore, PPUE in corn at MAP in range 8 - 10% also, in wheat at MAP between 13 - 42% in addition to at DAP in range 38 - 69% were decreased depending on the smallest quantity of phosphorus (30 mg P2O5 kg-1) (Table 2). Similar result found that increased in phosphorus amount, that means decreased in phosphorus physiological efficiency of maize (Saeed et al. 2017). As an opposite result, an increased amount of phosphorus that is to say physiology phosphorus use efficiency of wheat was increased (Akhtar et al. 2011). Also when phosphorus was ascending, ARPUE in maize at DAP between 7 - 21% were increased moreover in wheat at MAP in range 50 - 38% was decreased depending on the smallest amount of phosphorus (30 mg P2O5 kg-1) (Table 2). Similar result for wheat and the opposite result for maize was found by Papadopoulos (1985) stated that, increasing amount of phosphorus that means decreased phosphorus recovery (%) of barely at MAP between 62 - 47% and at DAP 56 - 65% accord-

ing to the smallest quantity of phosphorus (15 mg P kg-1).

The highest mean of APUE of maize at MAP was 60 mg P2O5 kg-1 dose (80.55) and at DAP was 90 mg P2O5 kg-1 dose (45.06) and of wheat was 30 mg P2O5 kg-1 dose (39.74) and (32.11) at MAP and DAP respectively (Table 2). Also, the highest mean of PPUE of maize was 90 mg P2O5 kg-1 dose (555) and (338) at MAP and DAP respectively in addition to of wheat was 30 mg P2O5 kg-1 dose (356) and (343) at MAP and DAP respectively too (Table 2). Furthermore, the highest mean of ARPUE of maize at MAP was 60 mg P2O5 kg-1 (14.04%) and at DAP 90 mg P2O5 kg-1 dose (11.00%) and of wheat at MAP was 30 mg P2O5 kg-1 dose (14.32%) and at DAP 90 mg P2O5 kg-1 dose (18.36%) (Table 2). In other direction, the smallest mean of APUE of maize at MAP was 90 mg P2O5 kg-1 dose (70.78) and at DAP was 30 mg P2O5 kg-1 dose (29.50) and of wheat at MAP was 90 mg P2O5 kg-1 dose (20.85) and DAP was 60 mg P2O5 kg-1 dose (10.74) (Table 2). Additionally, the smallest mean of PPUE of maize at MAP was 30 mg P2O5 kg-1 dose (504) and at DAP 60 mg P2O5 kg-1 dose (299) in addition to, of wheat at MAP was 60 mg P2O5 kg-1 dose (206) and at DAP was 90 mg P2O5 kg-1 dose (108) (Table 2). In addition to, the smallest mean of ARPUE of maize at MAP was 90 mg P2O5 kg-1 (9.36%) and at DAP 30 mg P2O5 kg-1 dose (9.06%) and of wheat at MAP was 60 mg P2O5 kg-1 dose (5.16%) and (4.95%) at MAP and DAP respectively (Table 2).

Table 2
Phosphorus Use efficiency of Bread Wheat and Maize

Treatments		Agronomic Phosphorus (P) Use Efficiency		Physiology P Use Efficiency		Apparent Recovery P Efficiency (%)	
Plants	Phosphorus doses (mg P2O5 kg-1)	Mono-ammonium Phosphate (MAP)	Di-ammonium Phosphate (DAP)	MAP	DAP	MAP	DAP
Maize	0	0.00	0.00	0	0	0.00	0.00
	30	76.83	29.50	504	312	13.77	9.06
	60	80.55	33.06	546	299	14.04	9.66
	90	70.78	45.06	555	338	9.36	11.00
Bread Wheat	0	0.00	0.00	0	0	0.00	0.00
	30	39.74	32.11	356	349	10.32	9.70
	60	30.42	10.74	206	218	5.16	4.45
	90	20.85	19.20	308	108	6.49	18.36
Plants		Maize	Bread Wheat	Maize	Bread Wheat	Maize	Bread Wheat
Least Significant Different (LSD) Fertilizers (F) 5%		7.70	No Significant (N.S)	117	N.S	N.S	2.35
LSD 5% of Phosphorus (P)		10.90	14.19	166	94	3.64	3.32
LSD 5% of interaction (F×P)		15.41	N.S	N.S	N.S	N.S	4.70
Standard Error of F (SE±)		3.73	4.86	57	32	1.25	1.14
SE± of P		2.64	3.44	40	23	0.88	0.80
SE± of interaction F× P		5.28	6.87	80	45	1.76	1.61

4. Conclusions

Phosphorus use efficiency of calcareous soil is very low. So increase of plant phosphorus use efficiency, that means decreased the use of phosphorus fertilizers. In these researches, while MAP and DAP fertilizers doses were increasing, highly significantly increased on PDW and PPU according to 0 mg P2O5 kg-1 dose, but MAP was better than DAP. Generally, while MAP and DAP fertilizers doses were increasing, at DAP APUE and ARPUE of popcorn were increased moreover, in bread wheat plant APUE at MAP and DAP in addition to, ARPUE at MAP were decreased and general MAP was better than DAP too. Also, when MAP and DAP fertilizers doses were increasing, that means in popcorn at MAP and in bread wheat at MAP and DAP PPUE was decreased and generally MAP was better than DAP too. Finally, when increased phosphorus doses, phosphorus use efficiency was decreased and MAP was better than DAP generally.

Table 3
Variance analysis of parameters of maize

Treatments	Degree Freedom	Mean square				
		Plant Dry Weight	Plant Phosphorus Uptake	Agronomic phosphorus use efficiency	Physiology phosphorus use efficiency	Apparent recovery phosphorus use efficiency
Fertilizers (F)	1	219.713**	69.205**	7265.287**	215804.30**	27.739 NS
Phosphorus (P)	3	316.518**	292.684**	6296.885**	364525.14**	252.512**
F×P interaction	3	31.368*	4.556 NS	1016.585**	24974.27 NS	20.091 NS
Error	24	6.864	5.154	111.484	25904.38	12.434
Total	31	-	-	-	-	-

(**) Highly significantly affected (1%), (*) Significantly affected (5%), (N.S) non-significantly affected

Table 4
Variance analysis of parameters of bread wheat

Treatments	Degree Freedom	Mean square				
		Plant Dry Weight	Plant Phosphorus Uptake	Agronomic phosphorus use efficiency	Physiology phosphorus use efficiency	Apparent recovery phosphorus use efficiency
Fertilizers (PF)	1	1.392 NS	31.271**	314.369 NS	14220.150 NS	41.627*
Phosphorus (P)	3	30.633**	229.228**	1301.929**	126798.422**	184.370**
F×P interaction	3	3.876 NS	174.178**	119.245 NS	15220.008 NS	56.919**
Error	16	4.687	3.343	141.753	6208.853	7.770
Total	23	-	-	-	-	-

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Effects of Bacteria and IBA on the Rooting of Bitter Orange (*Citrus aurantium* L.) and Trifoliate Orange (*Poncirus trifoliata* Raf.) Cuttings

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ABSTRACT

In this study, the effects of *Agrobacterium rubi* A-18 and *Bacillus* OSU-142 bacterial strains alone and in combination with 1000, 2000, 4000 ppm IBA on rooting of bitter orange and trifoliate orange citrus rootstock in softwood, semi-hardwood and hardwood cuttings were investigated. In the case of IBA solution, *Agrobacterium rubi* A-18 and *Bacillus* OSU-142 were prepared in solution at a concentration of $1x10^9$ bacteria / ml and applied to steel. Application is made in the mist propagation system, in the perlite are planted in the environment. Steels kept in the fogging environment for 3 months were removed at the end of this period and rooting rates (%), callus formation rates (%) and survival rates (%) were determined. According to the results of the research, the rooting rates of the steels taken at different periods were found to be low. The highest rooting rates of bitter orange softwood cuttings were 2000 ppm IBA + OSU-142 (6.67%), semi-hardwood cuttings OSU-142 (20.00%), and 4000 ppm IBA + OSU-142 (20.00%) in hardwood cuttings. It has been not rooting in trifoliate orange softwood cuttings, the highest rooting was in the case of semi-hardwood cuttings with 4000 ppm IBA + OSU-142 (26.67%), in hardwood cuttings 1000 ppm IBA + OSU-142, 2000 ppm IBA + OSU-142, 4000 ppm IBA + OSU-142, 1000 ppm IBA + A-18, 2000 ppm IBA + A-18 and 4000 ppm IBA + A-18 (20.00%). According to the cuttings pick-up period, the rooting rates of bitter orange are not different between the periods, in the trifoliate orange the hardwood cuttings were found to be higher. As a result, it can be said that plant growth promoting bacteria and IBA applications have no effect on rooting in the softwood, semi-hardwood and hardwood cuttings of the bitter orange and trifoliate orange citrus rootstocks, it can be said that studies on rooting in these rootstocks can be useful in different bacterial breeds

1. Introduction

Turkey is one of the rare countries where a combination of many types of fruit grown in the world. At present, Turkey is one of the most important producers of many fruit species besides being one of the most production of some fruit species in the world.

Citrus fruit is a young plant group. This group includes the species of citrus, which has a high economic value such as orange, mandarin, bergamot, grapefruit and lemon. They are produced economically and are extremely important for human health. Citrus fruits, which are considered as vitamin depots of winter months, are consumed widely as fruit juice besides their fresh consumption. As used in the fruits of these plants, fruit oils, leaves or flowers perfume fragrance used to give the essential oils are obtained. The production of citrus fruits grown between 40 degrees north latitude and 40 degrees south latitude in the world is continuously increasing.

Citrus fruits are native to China, Southeast Asia and India and can grow in tropical and subtropical climates. However, it is possible to grow commercially in regions where the temperature does not fall below -4ºC.

In Turkey, reaching about 5 million tons of citrus is done in coastal areas of the Mediterranean and Aegean regions of production. In Turkey, the most grown fruits after apples and grapes are also citrus fruits. Commercial sense in the production of Turkey is examined, as

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well as most types of citrus produced in the world, respectively, orange, mandarin, lemon and grapefruit.

The cultivation of citrus fruit, whose homeland is Southeast Asia, began in the US in the modern sense in the 19th century and spread rapidly. In the Northern Hemisphere, North and Central America and the Mediterranean countries are produced economically in the Southern Hemisphere, South America, South Africa and Oceania. The largest citrus producer countries in the world; Brazil, USA and China. Turkey is among the first 10 countries in the world citrus production (FAO, 2019).

Turkey is located in the northern border areas of the world citrus production. Which is quite old with a history of citrus production in Turkey after to develop rapidly and has been a significant increase in production from 1930. Turkey has very suitable areas for citrus cultivation in terms of ecological conditions. Turkey's amount of citrus production data for 2017 is 4 million 769 thousand 772 tons (TUIK, 2019).

The prevalence of foreign fertilization has led to vegetative propagation methods in many fruit species and varieties. Thus, it is possible to prevent the openings resulting from seed reproduction and to protect all the features of the variety. In vegetative reproduction; steel, dipping, root and bottom shoots or tubers with one or more of the replication methods are used, but in today's fruit, especially the method of reproduction with vaccination is more widely used (Rom, 1987; Hartmann, et al., 1990).

In the production of citrus species such as other fruit species, seed reproduction is not used directly. Since cuttings reproduction is not very successful in these species, the basis of production is based on reproduction. It is based on cultivation of different plants such as reproduction rootstock and scion on the same body. There are two elements, namely rootstock and scion, for reproduction. While the scion forms the crown of the tree, it forms the subsoil part of the rootstock tree and assists in the holding and transport of water and nutrients. Rootstocks in fruit cultivation are as important as the varieties that are inoculated on them. As a matter of fact, although a fruit rootstock is not expected to have the characteristics of a standard variety, rootstocks must have a good performance in the subsoil and special relations formed by the scion. The living part that undertakes primary responsibility in the life of the trees is the roots. Their relationship with the environment in which they spread in the soil is important in terms of the effect of the trees on their being healthy and efficient. In recent years, changes in fruit growing methods are possible with the use of appropriate rootstocks (Gülcan, 1991).

Rootstocks are classified as generative and vegetative rootstocks according to their production methods. Because of the generative way of opening up seed and rootstock production, rapid increase in the use of clone rootstocks has occurred in the production of fruit saplings in recent years. In the production of citrus fruit species, the use of clone rootstocks is becoming increasingly common in order to increase yield and quality and to provide tolerance for many abiotic and biotic stresses. The most common use of clonal rootstocks in the world is in citrus fruits.

Rootstocks used in fruit growing are divided into slices and clone rootstocks. In most of the fruit species, seedling rootstocks are used. The common drawback of almost all of them is that they show too many variations. This negatively affects the homogeneity of the development of the tree. Furthermore, it is known that heterogeneous developing seedlings have different behaviors in terms of rootstock mismatch and adaptation to the environment (Gülcan, 1991). Due to the opening in the seeds, seed levels on seedling rootstocks, growth forces, productivity, fruit characteristics, drought, cold, disease and pest resistance levels are heterogeneous and constitute the most important disadvantages of these rootstocks.

Different rootstocks are used in citrus sapling production. The most important ones are bitter orange and hybrids, trifoliate orange and hybrids, mandarin and mandarin analogues, lemons and relatives, limes and relatives, orange, citremon (trifoliate orange X lemon), citrumelo (trifoliate orange X grapefruit), sweet laym, grapefruit, yuzu, volkameriana, macrophylla, sitranges (trifoliate orange X oranges). Among these rootstocks, the most commonly used in Turkey are bitter orange and trifoliate orange (Mendilcioglu, 1999).

Bitter orange and trifoliate orange is used as rootstock for citrus experiencing difficulties of rooting cuttings. To solve the problem of rooting, indole acetic acid (De Klerk et al., 1997, Ahmad et al., 2005), some vitamins (Antonopoulou et al., 2005) are made such applications. In addition, it has been reported in many studies that it has recently been introduced as a solution to the problem of rooting with rhizobacteria that increase plant growth which has recently become widespread (Bassil et al., 1991; Larraburu et al., 2007; Teixeira et al., 2007; Ertürk et al., 2011; Arıkan et al., 2013).

In this study, the effects of Bacillus OSU-142 and Bacillus A-18 bacterial strains and indole butyric acid (IBA) applications were investigated on rootstocks of bitter orange and trifoliate orange, which are widely used as rootstock in citrus fruits.

2. Materials and Methods

This study was conducted between 2017 and 2018 in a heated greenhouse in Directorate of Agricultural Production Enterprise, Agricultural Extension and In-Service Training Center, Adana.

Materials

In this study, bitter orange (*Citrus aurantium* L.) and trifoliate orange (*Poncirus trifoliata*) rootstocks were used as materials. The citrus cuttings used in the study were obtained from Alata Horticultural Research Institute, Mersin.

Bitter orange (*Citrus aurantium* L.) has been the most widely used rootstock for oranges, mandarins, lemons and grapefruit in Mediterranean basin and other citrus producers countries. Bitter orange is widely used in heavy, drainage-poor soils because it shows moderate resistance to high soil pH. Bitter orange can grow on heavy soils, it is resistant to lime and tends to make pile root. Some lemon varieties and satsuma generally show good agreement with species and varieties other than mandarin. Trees grafted on bitter orange form a standard size crown. It is widely used in all Mediterranean regions. Easy to propagation. It is sensitive to the diseases of tristeza and mal-secco. Dwarfing is resistant to pore virus disease and root collar rot. Good resistance to frost. As it forms deep roots, it has good resistance to drought (Mendilcioğlu, 1999).

Trifoliate orange (*Poncirus trifoliata* Raf.) is a rootstock that shed its leaves in subtropic conditions. One of the important features is that it is cold resistant. The trifoliate orange tree is placed on the early fruit and affects the fruit quality in a positive way. Aegean and the eastern Black Sea region of Turkey is used as rootstock mandarin. Winter rootstocks are the most rootstocks. Resistant to root collar rot. Provides early yield. It is a suitable rootstock for orange and satsuma. It is not good to correspond with lemons, especially Kütdiken. Calcareous and salty soils can not withstand (Mendilcioglu, 1999).

In this study, *Agrobacterium rubi* A-18 and *Bacillus* OSU-142 bacterial strains which were determined to produce auxin by in vitro studies were used. Bacteria were obtained from Yeditepe University Faculty of Engineering, Department of Genetics and Bioengineering.

Methods

Cuttings from citrus rootstocks were prepared as softwood in July (2017), semi - hardwood in October (2017) and hardwood in January (2018). The cuttings used in the research were obtained from the trees from the Alata Horticultural Research Institute, Mersin. Cuttings are prepared with 4 leaves, 2 leaves-free, top 2 leaves were planted. These cuttings alone and in combination with 1000, 2000 and 4000 ppm IBA *Agrobacterium rubi* A-18 and *Bacillus* OSU-142 bacterial strains were applied. Applications to cuttings are given below.

1. Control
2. 1000 ppm IBA
3. 2000 ppm IBA
4. 4000 ppm IBA
5. OSU-142
6. A-18
7. OSU-142 + A-18
8. 1000 ppm IBA + OSU-142
9. 2000 ppm IBA + OSU-142
10. 4000 ppm IBA + OSU-142
11. 1000 ppm IBA + A-18
12. 2000 ppm IBA + A-18
13. 4000 ppm IBA + A-18

Prepared cuttings was prepared by rapid immersion in IBA solution and bacterial strains were prepared in suspension at a concentration of 1x109 bacteria / ml (Pırlak and Baykal, 2011). The applied cuttings were placed in the mist prooagation unit with temperature of 25 ° C, 90-95% relative humidity and perlite. Cuttings held in the mist propagation environment for about 3 months were removed at the end of this period, rooting rates (%), callus formation rates (%) and survival rates (%) were detected (Bhusal et al., 2001). While the survival rates of the stripped cuttings were determined, it was examined whether the tissue beneath the steel shells were alive and also the sections were taken from the eyes on the steel and these eyes were considered alive when they kept the green color.

Statistical Analysis

Trial; two factors (applications, cuttings retrieval period) according to the her competely randomized design, three replicates and 5 steel in each repetition have been established. The data obtained were subjected to arc sinus (angle) transformation and evaluated by SPSS statistical program and Duncan Multiple Comparison Test was applied.

3. Results and Discussion

The effects of applications on the cutting rooting of bitter orange

The effects of plant growth promoting bacteria and IBA applications on the rooting of softwood, semi-hardwood and hardwood cuttings in bitter orange were found to be statistically significant (Table 1). During the rooting period, most of the softwood cuttings were unable to maintain its viability. In the control application, the viability ratio decreased by 33.33% compared to the control in most of the applications, and the viability rates were higher in the 1000 ppm IBA + OSU-142 (40%) and 2000 ppm IBA + OSU-142 (53.33%) applications. The lowest viability rates were found in 13.33% and 4000 ppm IBA and OSU-142 applications. In parallel with the viability rates, the callus formation ratio in softwood cutting is also low. The callus formation rate, which was 13.33% in the control, decreased to 6.67% in the 4000 ppm IBA application and in the other applications was the same or higher than the control. The highest callus formations were 1000 ppm IBA + OSU-142 and 4000 ppm IBA + A-18 (33.33%) and 2000 ppm IBA + OSU-142 (53.33%). The applications did not have a positive effect on rooting in softwood cuttings, but only in 2000 ppm IBA + OSU-142 rooting 6.67%.

Most of the semi-hardwood cuttings remained alive in the rooting environment. In most of the applications, the viability rate was found to be 100% and only 80% in OSU-142 application was statistically different from other applications (Table 1). Similarly, callus formation is also high in semi-hardwood cuttings. The hig-

hest callus formation occurred in 1000 ppm IBA and OSU-142 + A-18 (100%) and the lowest in 2000 ppm and 4000 ppm IBA applications (73.33%). Although the viability and callus ratios were high in semi-hardwood steels, no rooting occurred in applications other than OSU-142 (20%).

The viability rates of hardwood steels were generally low. While all of the cuttings were dying, viability rates increased slightly due to bacterial and IBA applications except 1000 ppm IBA and 4000 ppm IBA + A-18. Differences between applications are statistically significant. The highest viability rates were found in 4000 ppm IBA + OSU-142 and 1000 ppm IBA + A-18 applications (53.33%). Callus formation is also low in hardwood cuttings. Similar to the viability rates, callus did not occur in the control and the callus ratios increased slightly due to the applications other than 1000 ppm IBA and 4000 ppm IBA + A-18. The most effective applications on callus formation were 4000 ppm IBA + OSU-142 and 1000 ppm IBA + A-18 (40.00%). Rooting rates in hardwood cuttings have not reached satisfactory levels. While rooting did not occur in the control application, slaughtering effects of bacteria and IBA applications were limited and low rates of rooting occurred in only 5 applications. The highest rooting rate was 4000 ppm IBA + OSU-142 with a rate of 20.00% (Table 1).

When the effects of bacterial and IBA applications on citrus rootstock according to steel intake periods are examined, it is seen that the differences between the effects of the applications on the viability and callus formation are statistically significant and the effects on rooting are insignificant (Table 1). There are big differences in the vitality rates of steels according to periods. The highest viability ratio was obtained in semi-hardwood cuttings (96.41%), followed by softwood (27.69%) and hardwood cuttings (19.49%). Similarly, in the callus ratios, semi-hardwood cuttings are higher than others (89.23%). The callus ratio was found to be 21.54% in softwood cuttings and 16.92% in hardwood cuttings. At the time of the three cuttings pick-ups, rooting rates were very low and no statistical difference was found between the periods.

Table 1
The effects of applications on the cutting rooting of bitter orange

	BITTER ORANGE								
	SOFTWOOD CUTTINGS			SEMI-HARDWOOD CUTTINGS			HARDWOOD CUTTINGS		
	Viability rate (%)*	Callus formation rate (%)	Rooting rate (%)	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)
Control	33.33 ab**	13.33 bc	0.00 b	100.00 a	86.67 abc	0.00 b	0.00 c	0.00 c	0.00 b
1000 ppm IBA	26.67 bc	26.67 ab	0.00 b	100.00 a	100.00 a	0.00 b	0.00 c	0.00 c	0.00 b
2000 ppm IBA	26.67 bc	26.67 ab	0.00 b	100.00 a	73.33 c	0.00 b	20.00 b	20.00 ab	0.00 b
4000 ppm IBA	13.33 c	6.67 c	0.00 b	100.00 a	73.33 c	0.00 b	26.67 b	26.67 a	6.67 b
OSU-142	13.33 c	13.33 bc	0.00 b	80.00 b	80.00 bc	20.00 a	20.00 b	20.00 ab	0.00 b
A-18	20.00 bc	20.00 bc	0.00 b	93.33 a	86.67 abc	0.00 b	20.00 b	20.00 ab	0.00 b
OSU+A-18	26.67 bc	13.33 bc	0.00 b	100.00 a	100.00 a	0.00 b	13.33 b	6.67 cd	0.00 b
1000 ppm IBA+OSU-142	40.00 ab	33.33 ab	0.00 b	100.00 a	93.33 ab	0.00 b	13.33 b	13.33 bc	6.67 b
2000 ppm IBA+OSU-142	53.33 a	53.33 a	6.67 a	93.33 a	93.33 ab	0.00 b	13.33 b	13.33 bc	0.00 b
4000 ppm IBA+OSU-142	26.67 bc	13.33 bc	0.00 b	100.00 a	93.33 ab	0.00 b	53.33 a	40.00 a	20.00 a
1000 ppm IBA +A-18	20.00 bc	13.33 bc	0.00 b	93.33 a	93.33 ab	0.00 b	53.33 a	40.00 a	6.67 b
2000 ppm IBA +A-18	26.67 bc	13.33 bc	0.00 b	100.00 a	93.33 ab	0.00 b	20.00 b	20.00 ab	6.67 b
4000 ppm IBA +A-18	33.33 ab	33.33 ab	0.00 b	93.33 a	93.33 ab	0.00 b	0.00 c	0.00 c	0.00 b
LSD	19.63	28.72	10.09	20.18	26.35	20.18	19.6	18.13	21.25

Table 1 (Continuation)
The effects of applications on the cutting rooting of bitter orange

	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)
SOFTWOOD CUTTINGS	27.69 b	21.54 b	0.51
SEMI-HARDWOOD CUTTINGS	96.41 a	89.23 a	1.54
HARDWOOD CUTTINGS	19.49 c	16.92 b	3.59
LSD	11.26	13.17	Ö.D.

*Statistical analysis have been carried out using arc sin values.
** Values shown in different letters in the same column are different at 0.05 (Duncan test)

The effects of applications on cutting rooting of trifoliate orange

The effects of plant growth promoting bacteria and IBA applications on the rooting of softwood, semi-hardwood and hardwood cuttings with trifoliate orange rootstock are given in Table 2. The effects of applications on viability, callus formation and rooting were found to be statistically significant.

Trifoliate orange softwood cuttings showed low viability at the end of rooting time. The differences between the effects of the applications on the viability of softwood cuttings were not statistically significant. Similarly, callus formation rates in softwood cuttings are also low. In the control group, no callus was formed in the cuttings, but in some applications a low callus was formed. The maximum callus formation was determined as 20.00% in 2000 ppm IBA + OSU-142 and 13.33% in 4000 ppm IBA + OSU-142 applications. Rooting did not occur in any application, including control in trifoliate orange softwood cuttings.

A large part of the trifoliate orange rootstock semi-hardwood cuttings kept alive in the rooting environment. The highest viability rates were found to be 1000 ppm IBA (100%) and control (93.33%). Similarly, callus formation rates are also high in semi-hardwood cuttings. The highest callus formation rate was found to be 1000 ppm IBA (100.00%) and control application (93.33%). Although the viability and callus ratios were high in semi-hardwood cuttings, the rooting rates were far behind them. While rooting did not occur in the control, in 6 applications (1000 ppm IBA, 2000 ppm IBA, A-18, OSU-142 + A-18, 2000 ppm IBA + OSU-142 and 4000 ppm IBA + OSU-142) rooting at different rates occurred. The maximum rooting was determined as 4000 ppm IBA + OSU-142 with a rate of 20.00% (Table 2).

The effects of bacterial and IBA applications on the viability of trifoliate orange hardwood cuttings were found to be close to each other. While the effects of all the applications were in the same group with the control, the lowest viability rate was determined as 4000 ppm IBA + OSU-142 with 40.00% and the highest with 66.67% and 4000 ppm IBA + A-18. The effects of the applications on the callus formation rate in cuttings are more pronounced than the viability ratios. Callus formation with 26.67% in the control group, 4000 ppm IBA, A-18, OSU-142 + A-18, 2000 ppm IBA + OSU-142, 1000 ppm IBA + A-18, 200 ppm IBA + A-18 and 4000 ppm IBA + A-18 showed a statistically significant increase compared to the control. The highest callus rate was found in 4000 ppm IBA + A-18 application (60.00%). Applications increased the rate of rooting in hardwood cuttings compared to the control except for OSU-142 and OSU-142 + A-18. 20.00% of the most rooting practices are 1000 ppm IBA + OSU-142, 2000 ppm IBA + OSU, 4000 ppm IBA + OSU-142, 1000 ppm IBA + A-18, 2000 ppm IBA + A-18 and 4000 ppm IBA + A-18 (Table 2).

The effect of applications on the viability, callus formation and rooting were found to be statistically significant. The viability ratios of the cuttings were found to be significantly different according to the periods and the highest viability was found in semi-hardwood cuttings (76.41%) and the least in softwood cuttings (8.72%). The average viability of hardwood cuttings was found to be 52.82%. The highest callus formation was determined in semi-hardwood (75.38%), followed by hardwood cuttings (42.56%) and softwood cuttings (5.13%). In rooting rates, hardwood cuttings ranked first with 12.81%, followed by semi-hardwood with 6.67% and softwood cuttings with 0.00%. A large part of the trifoliate orange rootstock semi-hardwood cuttings kept alive in the rooting environment. The maximum viability rates are 1000 ppm IBA (100%) and control (93%).

In this study, the effect of plant growth- promoting bacteria and IBA applications on the rooting of bitter orange and trifoliate orange rootstocks in softwood, semi-hardwood and hardwood cuttings were found to be low. The highest rooting rates were 2000 ppm IBA + OSU-142 (6.67%), in semi-hardwood cuttings OSU-142 (20.00%), 4000 ppm IBA + OSU-142 (20.00%) in hardwood cuttings; trifoliate orange softwood cuttings, non-rooting, semi-hardwood cutting 4000 ppm IBA + OSU-142 (26.67%), hardwood cuttings 1000 ppm IBA + OSU-142, 2000 ppm IBA + OSU-142, 4000 ppm IBA + OSU-142, 1000 ppm IBA + A-18 was detected in 2000 ppm IBA + A-18 and 4000 ppm IBA + A-18 (20.00%) applications (Table 1, 2). Similar results were obtained in a study of M9 apple rootstock cuttings and it was determined that bacteria and IBA applications had no effect on rooting (Pırlak and Baykal, 2009).

Due to its many advantages, cutting reproduction is widely used in fruit growing as in most plant species. Among these advantages, a small part of the body in a small area with a large number of homogenous plants, cheap, quick and easy to be counted. Furthermore, in this replication method, soil-borne diseases are less

likely to cross plants. Despite all the positive properties of cuttings reproduction, the biggest obstacle to its use is the inability of the steel to root due to the very low regeneration capabilities of some species (Rugini and Fedelli, 1990; Webster and Looney, 1996). The low rate of rooting in citrus rootstock cuttings are related to species characteristics. The rooting ability of the cutting in the fruit species varies greatly between different species and varieties within these species. According to this, species are classified as very easily rooted, hard-rooted and very hard-rooted. Citrus species in this grouping are often among the hard-rooted (Hartmann, et al., 1990). As a matter of fact, positive results have been obtained in studies that investigated the effects of bacterial applications in genetically rooting species (Nagarajan et al., 1989; Bassil et al., 1991; Jacob and Handam, 1992; Hatta et al., 1996; Ercişli et al., 2000; Ercişli et al., 2001; Eşitken et al., 2001; Ertürk et al., 2011; Sarmast et al., 2012; Arıkan et al., 2013; Kınık and Çelikel, 2017).

In general, the reproduction of citrus fruits, which are replicated by cuttings, has not been achieved so far except for lemons (Cooper, 1935). In the study which investigated the effects of IBA and Paclobutrazol on the rooting of Valencia orange varieties, the highest rooting (19.6%) was obtained from 500 ppm IBA + Paclobutrazol application (Habermann et al., 2006). In the study which examined the effects of IBA applications on cutting rooting in different citrus rootstocks, it was not detected in trifoliate orange, Carrizo citrange, Cleopatra mandarin, Citrumelo 1452 rootstocks and rooting in different IBA applications (Uzun and Seday, 2011). The effects of IBA and cycloposphamide on the rooting of rough lemon (*Citrus jambhiri*) cuttings were examined in the study and the highest rooting rate (8.2%) was obtained with the use of IBA and cycloposphamide (Singh et al., 1988).

Table 2
The effects of applications on the cutting rooting of trifoliate orange

	TRIFOLIATE ORANGE								
	SOFTWOOD CUTTINGS			SEMI-HARDWOOD CUTTINGS			HARDWOOD CUTTINGS		
	Viability rate (%)*	Callus formation rate (%)	Rooting rate (%)	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)
Control	6.67**	0.00 c	0.00	93.33 ab	93.33 ab	0.00 b	53.33 abc	26.67 c	0.00 b
1000 ppm IBA	6.67	0.00 c	0.00	100.00 a	100.00 a	13.33 ab	60.00 ab	33.33 bc	6.67 ab
2000 ppm IBA	13.33	6.67 bc	0.00	86.67 bc	86.67 bc	13.33 ab	46.67 bc	33.33 bc	13.33 ab
4000 ppm IBA	6.67	6.67 bc	0.00	66.67 d	66.67 d	0.00 b	46.67 bc	46.67 ab	13.33 ab
OSU-142	6.67	6.67 bc	0.00	66.67 d	60.00 d	0.00 b	53.33 abc	33.33 bc	0.00 b
A-18	6.67	6.67 bc	0.00	86.67 bc	86.67 bc	13.33 ab	53.33 abc	53.33 a	13.33 ab
OSU+A-18	6.67	0.00 c	0.00	80.00 cd	80.00 cd	6.67 ab	60.00 ab	46.67 ab	0.00 b
1000 ppm IBA +OSU-142	6.67	0.00 c	0.00	66.67 d	66.67 d	0.00 b	46.67 bc	33.33 bc	20.00 a
2000 ppm IBA +OSU-142	20.00	20.00 a	0.00	73.33 cd	73.33 cd	13.33 ab	53.33 abc	53.33 a	20.00 a
4000 ppm IBA +OSU-142	13.33	13.33 ab	0.00	66.67 d	66.67 d	26.67 a	40.00 c	33.33 bc	20.00 a
1000 ppm IBA +A-18	6.67	0.00 c	0.00	66.67 d	66.67 d	0.00 b	60.00 ab	53.33 a	20.00 a
2000 ppm IBA +A-18	6.67	6.67 bc	0.00	66.67 d	60.00 d	0.00 b	46.67 bc	46.67 ab	20.00 a
4000 ppm IBA +A-18	6.67	0.00 c	0.00	73.33 cd	73.33 cd	0.00 b	66.67 a	60.00 a	20.00 a
LSD	Ö.D.	24.72	Ö.D.	22.16	21.09	25.99	15.57	15.95	27.47

Table 2 (Continuation)
The effects of applications on the cutting rooting of trifoliate orange

	Viability rate (%)	Callus formation rate (%)	Rooting rate (%)
SOFTWOOD CUTTINGS	8.72 c	5.13 c	0.00 c
SEMI-HARDWOOD CUTTINGS	76.41 a	75.38 a	6.67 b
HARDWOOD CUTTINGS	52.82 b	42.56 b	12.82 a
LSD	18.92	12.83	1.91

*Statistical analysis have been carried out using arc sin values.
** Values shown in different letters in the same column are different at 0.05 (Duncan test)

4. Conclusions

As a result, the effects of IBA and bacterial applications on rootstocks of bitter orange and trifoliate orange citrus fruits were investigated in this study. This study mainly focuses on the effects of plant growth promoting bacteria, which are used as an alternative to steel rooting in recent years. It can be investigated in new studies whether rooting rates will increase by testing different races of these bacteria and combinations with different growth regulators.

5. Aknowledgement

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Agronomic Characteristics of Domestic and Abroad Originated Lentil Genotypes

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ABSTRACT

This research was established under the ecological conditions of Nevşehir in the Central Anatolia Region, whereby lentil agriculture is practiced in Turkey. Research was carried out in order to reveal the important features of indigenous and exotic lentil genotypes which may be the basis for future breeding studies. A total of 220 domestic and foreign originated lentil genotypes and 4 varieties (Pul Mercimek, Yerli Kırmızı, Çağıl, Fırat-87) as standard were grown. Field trial was established on April 10, 2017 according to the Augmented trial design with 5 blocks. According to the results of the research, following ranges were determined; 50% flowering days 46.5-82.00 days, vegetation length 79.85-120.85 days, plant height 17.68-43.99 cm, number of pods per plant 9.21-440.62 pieces, weight of 1000 seed 12.92-78.31 g, seed yield 0.19 -35.88 g plant^{-1} were determined. As a result; the lentil genotypes were found on the morphological and agricultural characteristics of our selected varieties. These superior genotypes can be used as material in breeding studies for future programs.

1. Introduction

The rapid increase in the world population the decrease in production resources in line with this increase, the inability to use the technology in a favorable and efficient way, the negative environmental conditions and the regional domestic and foreign wars bring the problems of hunger and nutrition among the most important problems of humanity. To solve these problems, nutrient sources should be rich in properties such as energy, protein, vitamins and mineral substances and studies which increase nutrition, production and consumption of these foods should be carried out. In addition, due to the high costs of raising animal products, and because of the fact that their deterioration is quick and difficult to store and conserve, especially developing countries tend to plant herbal products which have higher amount of vegetable protein that can be stored for a longer period (Erkal 1981; Ceyhan et al 2014; Kahraman & Önder 2018). Edible legumes both have a rich structure in terms of nutritional elements, amino acid contents and cheaper than animal products significantly increased the importance of these plants (McPhee et al 2012; Kahraman 2016).

Lentil plants which have an important place in edible seed legume in terms of their values and properties with 23-31% protein content, vitamins A, B, C and K, as well as calories from soybeans (Akçin 1988; Ceyhan et al 2012). In addition, threonine and lycine amino acids, which are found in lentil plant proteins have an important role in human nutrition and these amino acids are almost closer to the values of beef (Aydoğan et al 2003). Lentil; high protein content and quality compared to cereals, 23-31% protein content, and rich in vitamins and minerals, and thereby improving amino acid balance when consumed alongside cereals (Baysal 1988; Pellet 1988; Özkaya et al 1998; Önder & Kahraman 2008), it is a legume having an important place in eliminating people's hunger due to high fiber content (Trowell et al 1985; Önder & Kahraman 2009).

Lentil is one of the oldest edible legumes that have an important place in both human and animal nutrition and its resistance has been known in agriculture dates back about 8000 years (Pellet 1988). The amount of nitrogen that is bound to soil symbiotically in edible seed leguminous plants varies according to plant spe-

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cies. This amount of lentils is about 8.4 kg da^{-1} (Sepetoğlu 2002; Önder et al 2013). Lentil; as it increases soil fertility, it is preferred to have an important place in animal nutrition since it contains the least cellulose in the stalk and straw compared to other plants (Aydoğan et al 2003; Kahraman 2017).

While no many issues encountered of lentil varieties in Turkey, major problems are faced in the supply of seed to be used. In the production of lentils in Fırat-87, Çağıl, Yerli Kırmızı and Pul Mercimek a variety of indigenous local village varieties are common, and the seeds of these varieties are absent or inadequate. The producer produces his own seed with the varieties in his hand, and local varieties are used in these places under the absence of these varieties. It is known that local varieties show very large genetic variability and are very well adapted to the changing conditions of the region (Lázaro et al 2001; Ceyhan & Kahraman, 2013; Kahraman et al 2015; Harmankaya et al 2016). However, due to their productivity stability, mechani-zation and other problems, production and yield values change continuously and sometimes become risk factors. Nevertheless, producers prefer these local varieties in small and especially stony areas. By evaluating the foreign origin varieties in terms of country and region, it is necessary to bring more modern varieties instead of old or local varieties, to create variability and to benefit from improved varieties with efficiency and other characteristics.

Lentils have an important part in human nutrition both in our country and in the world. The main purpose of this study is to determine the physiological characteristics (yield components) which have a positive effect on plant yield and to select the most efficient ones in domestic or foreign genotypes.

2. Materials and Methods

This research is a part of MSc thesis and was carried out in the farmer's fields in the Karapınar village of Acıgöl district of Nevşehir province, 220 indigenous and exotic lentils from Selcuk University, Faculty of Agriculture, and Field Crops Department were used as material. The origin of the 220 genotypes used in the experiment is shown in Table 3. As standard varieties; Fırat-87, Çağıl, Yerli Kırmızı, Pul Mercimek were used.

Table 1
Soil analysis of the experimental area.

Soil parameters	0-20 cm
Water at saturation (%)	45
Total salt (%)	0.001
Soil pH	7.05
Lime (%)	1.58
Plant available phosphorus (kg da^{-1})	17.26
Plant available potassium (kg da^{-1})	78.35

The study was planned as 5 blocks according to the Augmented trial design, and 4 standard cultivars of 44 genotypes + 4 rows of each were made to each block.

The length of each row is 1m, the distance between the rows is 40 cm, and the distance on the row is 5 cm (20 seeds per row) and the cultivation was by hand. In the light of this information, the length of our experiment [44 x 0.4 m] + [(4 standard x 4 rows) x 0.4m] = 26m length, 7m wide area including space, the total area was planted to 182 m^2 for the trial.

Regional climate data is presented in Table 2. While the average temperature was 17.3^{0}C for many years, it was 18.16 ^{0}C in 2017. When the average total rainfall was 31.04 mm according to the data of many years, it was determined as 27.58 mm in 2017. When the relative humidity was 51.74% for many years, it was determined at 49.02% in 2017.

In the analysis, it was determined that the soil structure was a sandy-loam and the soil reaction was neutral (pH: 7.05). The lime value was around 1.58% and very low range. In addition, it was found that there was no salt (0.001%) problem, and phosphorus (17.26 kg da^{-1}) and potassium (78.35 kg da^{-1}) were generally sufficient in the area of the experimental field (Table 1).

In the field where the experiment was established, it was plowed with rock plows with the beginning of autumn rainfall, and in early spring (in March) the crowbar + harrow was drawn. On 10 April 2017, the cultivation of the experiment was done by hand while the soil was mellowness. 20 kg da^{-1} DAP (Di-ammonium Phosphate: 18% N, 46% P) fertilizer was applied in all the tested blocks.

The trial area was surrounded by wire around the external damage. In order to avoid confusion in the lines, each row and block is indicated by labels. Sprinkler irrigation system was established as an irrigation system and irrigation was done according to water demand and precipitation regime of the plant. According to the weed population, weed was taken by hand 3 times in April and May, and observation checks were conducted by hand while fighting regularly with weeds. When 90% of the plants in the block are ready for harvest (when the color of the leaves was yellow and the lower leaves begin to fall off, when the pods and seeds are hardened), the seeds of the next plants were harvested manually so that the seeds of each plant were packaged separately and then they were mixed after waiting without heating.

On the 220 lentil genotypes; the values of 50% flowering days, vegetation length, plant height, number of pods in the plant, 1000 seed weight, seed yield were evaluated. Observations and measurements were made according to TTSMM (Ministry of Food, Agriculture and Livestock Seed Registration and Certification Center Directorate) (TTSM 2018).

Table 2
Climate data of the province of Nevşehir Acıgöl District of the vegetation period.

Months	Monthly average temperature (^{0}C)		Monthly total rainfall (mm)		Monthly average relative humidity (%)	
	Long time (30 years)	2017	Long time (30 years)	2017	Long time (30 years)	2017
April	10.1	10.1	50.1	38.9	57.8	50.3
May	14.6	14.4	57.9	33.5	56.0	55.3
June	18.6	19.3	33.9	32	51.7	53.0
July	21.8	23.9	8.4	12	46.6	37.4
August	21.4	23.1	4.9	21.5	46.6	49.1
Total Average	17.3	18.16	155.2	137.9	51.74	49.02

Table 3
The origin of lentil genotypes used in the research, local name.

ACCESS NO	ORIGIN	LOCAL NAME	ACCESS NO	ORIGIN	LOCAL NAME
PI 620882	CHİNA	LE-00-01	PI 533693	SPAİN	VERDİNA
PI 320936	FSU	DAGHESTANICA	PI 612310	PAKİSTAN	W6 19112
PI 320950	ARMENİA	ASTARAKSKAJA MESTNAJA	PI 612307	BULGARİA	8,60E+287
PI 345553	FSU	IRANSKAJA 6	PI 612282	SYRİA	HAREM 10
PI 343029	UKRAİNE	NEW MOOM	PI 612305	BULGARİA	84205001
PI 606604	BULGARİA	NASLADA	PI 631395	SYRİA	ALI DAYI
PI 319366	MEXİCO	LENTEJAS	PI 612300	TURKEY	WJK94-T51
PI 612280	SYRİA	EL-SUEYDA 8	PI 638619	SYRİA	GACHSARAN
PI 636683	ARMENİA	ARM 170	PI 612284	SYRİA	SAFEETA 12
PI 612287	SYRİA	VAN WİLSON 16	PI 308608	SYRİA	BALADI
PI 612299	TURKEY	WJK94-T50	PI 308611	SYRİA	NORTHERN RED
PI612285	SYRİA	HOMS 14	PI 606587	PAKİSTAN	LENTİL #2
PI 606603	NEPAL	MASURO (DHEAL)	PI 490289	FRANCE	MARIETIE
PI 643448	SYRİA	KEF	W6 27754	USA	1048-8R
PI 312175	MEXİCO	LENTEJA	PI 345640	FSU	ZELENAYA AHUN.
PI 636553	TURKEY	MP-10	PI 606637	CZECHOSLOVAK	LENKA
PI 635040	SYRİA	OZBEK	PI 379368	SERBİA	IVANKOVSKA
PI 636685	USA	ILL 9843	PI 543069	PAKİSTAN	MASOOR 9-6
PI 631396	SYRİA	IDLİB-2	PI 477290	PAKİSTAN	
PI 533691	SPAİN	LENTEJA VERDİNA	PI 606606	BULGARİA	STONKA-1
PI 312176	MEXİCO	LENTEJA	W6 27781	USA	PARDİNA
PI 606607	BULGARİA	STONKA-2	PI 577239	BULGARİA	STELA
PI 477298	PAKİSTAN	9+6	PI 345631	FSU	PENZENSKAYA 14
PI 636515	BULGARİA	N 440	PI 308609	SYRİA	HOMSI/KORDI
PI 612286	SYRİA	DOMMA 15	PI 339265	TURKEY	YERLİ KUQUK
PI 320949	FSU	TADJIKSKAJA 95	PI 612312	NEW ZEALAND	TİTORE
PI 343029	FSU	PETROV'S JUBILEE	PI 486127	USA	
PI 636685	USA	ILL 7502	PI 577238	BULGARİA	JANA
PI 357225	SERBİA	SVETI NIKOLSKA	PI 557499	USA	PALOUSE
PI 606589	SPAİN	LENTEJA PARDİNA DE LEON	PI 577237	BULGARİA	NASLADA
PI 606585	BULGARİA	NASLADA	PI 564719	USA	BENEWAH
PI 357224	MACEDONİA	LOKALNA EDRA	PI 298921	ITALY	ALTAMURA
PI 612281	SYRİA	HURAN 9	PI 477922	USA	TEKOA
PI 533692	SPAİN	CASTELLANA	PI 606643	UKRAİNE	KROKHMAL #6
PI 592998	SYRİA	ILL 5588	PI 379369	SERBİA	VELESKA
PI 320954	HUNGARY	SLOVENIAN KRAYODA	PI 344077	TURKEY	ILL 602
PI 606590	SPAİN	LEREN	PI 343026	FSU	TADZIR'S 95
PI 606638	CZECHOSLOVA-KİA	PLAJEVSKAJA	PI 612279	SYRİA	EDLAB 7
PI 339286	TURKEY	ALACA	PI 606646	UKRAİNE	NARJADNAİA
PI 634209	USA	PENNELL	PI 345635	ARMENİA	RISOVAYA
PI 518261	INDİA	MASOUR LENTİLS	PI 518733	BRAZİL	CNPH 84- 123
PI 577236	BULGARİA	OBRAZTZOV CHIFLIK 7	PI 612274	BULGARİA	SADOVO 1
PI 343023	UKRAİNE	NATIONAL 03	PI 565081	SPAİN	SPANISH BROWN
W6 27758	USA	CDC ROBİN	PI 601750	USA	LOLITA
W6 27782	USA	PENNELL	PI 345636	FSU	STEPNAYA 244
PI 368646	SERBİA	GRADSKA		FRANCE	ANICIA
PI 379370	MACEDONİA	PRILEPSKA	PI 345637	TAJİKİSTAN	TADZHIKSKAYA 95
PI 606639	GERMANY	STEPNAJA 244	PI 619099	USA	MASON
PI 612275	SYRİA	ALEPPO 1	PI 577235	BULGARİA	MIZIA
PI 343027	FSU	ASTARAR'S LOCAL	PI 368651	SERBİA	BRODSKA
W6 27756	USA	964A-46	PI 298924	ITALY	TIPO TURCHE NO.2
PI 636687	USA	ILL 9938	PI 606640	ALBANİA	963
PI 606641	SYRİA	ILL 5684	PI 339275	TURKEY	SULTANI
PI 606658	PAKİSTAN	PAK 20	PI 357227	MACEDONİA	LOKALNA S.
PI 533689	SPAİN	CASTELLANA	PI 620880	SYRİA	S114

Table 3 (Continuation)
The origin of lentil genotypes used in the research, local name.

PI 606648	ITALY	MOUNTAİN LENTİL #1	PI 345638	ARMENİA	TALINSKAYA 6
PI 311107	GUATEMALA	LENTOJA	PI 477299	PAKİSTAN	18+10
PI 494067	CHİLE		PI 476366	FSU	TALLINSKAJA 6
PI 612309	ALBANİA	VENDREZHA	PI 606586	PAKİSTAN	LENTİL #1
PI 368649	SERBİA	SITNA	PI 370481	SERBİA	EDRA
PI 345625	FSU	ILL 605	PI 343025	FSU	NOVOURENSK 3565
PI 606659	CANADA	INDIAN HEAD	PI 560159	USA	WH 2040
PI 533690	SPAİN	PARDINA	PI 508091	USA	EMERALD
PI 612308	NEW ZEALAND	W6 17279	PI 476367	FSU	PENZENSKO 14
PI 343022	UKRAİNE	STEPPE 244	PI 605356	SYRİA	BARIMASUR-4
PI 655566	TAJİKİSTAN	TJK2006:001	W6 27780	USA	MİLESTONE
PI 298923	ITALY	TIPO TURCHE NO.1	PI 368648	SERBİA	SITNA
PI 543070	PAKİSTAN	MASSOOR 18-10	PI 379372	SERBİA	GRADECKA
PI 547039	USA	WA8649041	PI 605355	SYRİA	BARIMASUR-2
PI 612276	SYRİA	ALEPPO 2	PI 339267	TURKEY	KIRMIZI
PI 612301	JORDAN	JORDAN 3	PI 547038	USA	WA8649085
PI 308610	SYRİA	KURD	PI 345552	FSU	DAGESTANSKAJA
PI 368645	SERBİA	SITNA	W6 27760	USA	GİZA-9
PI 644221	SYRİA	TESHALE	PI 636514	BULGARİA	N377
PI 368650	MONTENEGRO	PLASNICKA	PI 345625	UKRAİNE	LUNA 09
PI 518732	BRAZİL	CNPH 84-122	PI 508090	USA	BREWER
PI 612278	SYRİA	REEHA 6	W6 27759	USA	ESTON
PI 612306	BULGARİA	ZİMNA LESTA	PI 339292	TURKEY	SIYAH
PI 655571	GEORGİA	9092	PI 486288	FRANCE	DUPUY
PI 606660	SYRİA	FRENCH 3	PI 635041	SYRİA	KAFKAS
PI 620879	BULGARİA	NADEJDA	PI 620881	SYRİA	S119
PI 339270	TURKEY	AKCA MERCİMEĞİ	PI 320953	GERMANY	SCHWARZE LINSE
PI 606642	RUSSİAN	PENZENSKAİA	PI 345628	FSU	NOVAYA LUNA
PI 577240	RUSSİAN	TADJIKSKAYA 95	PI 641205	TAJİKİSTAN	TJK04:20-113
PI 643449	SYRİA	HALA	PI 27767	USA	ILL 8006 BM4
PI 368647	MACEDONİA	DUKATINSKA	PI 606650	SPAİN	SPANISH BROWN
PI 339266	TURKEY	YERLİ KUQUK	PI 343024	FSU	PETROV'S 4/105 PETROVSKAYA
PI 518731	BRAZİL	CNPH 84-021	PI 345634	FSU	ZELENOZERNAYA
PI 612311	PAKİSTAN	W6 19113	PI 606649	ITALY	MOUNTAİN LENTİL 2 PETROVSKAYA
PI 515969	ARGENTİNA	PRECOZ	PI 345633	FSU	JUBILEINAYA
PI 592997	SYRİA	ILL 5582	PI 477920	USA	CHILEAN 78
PI 643450	SYRİA	RACHAYYA	PI 345632	FSU	PETROVSKAYA 50
PI 543068	PAKİSTAN	MASOOR VM-3	PI 636542	TURKEY	KAYI 91 PETROVSKAJA
PI 641202	USA	ILL 9918	PI 476368	FSU	YUBILEJNAJA
PI 606647	ITALY	CASTELLUCCİO LENTİL	PI 543067	PAKİSTAN	MASOOR DL-6
PI 477923	USA	BREWER	PI 606591	IRAN	LINE (HC393)
PI 643451	SYRİA	ALEM TİNA	PI 477300	PAKİSTAN	18+12
PI 641201	HUNGARY	B92-129	PI 477921	USA	REDCHIEF
PI 643452	SYRİA	ASSANO	PI 513253	PAKİSTAN	MASSAR
PI 561105	TURKEY	TU86-16-07	PI 606605	RUSSİAN	TADJISKUYA
PI 612303	JORDAN	JORDAN 2	PI 298922	ITALY	TIPO CASTELLUCCIO
PI 561087	TURKEY	TU85-083-01	PI 345627	UKRAİNE	NARIADNAYA 03
PI 612302	JORDAN	JORDAN 1	PI 339263	TURKEY	SULTANI
PI 612277	SYRİA	SULMİAH 5	PI 302398	JORDAN	ILL 486
PI 606661	SYRİA	FRENCH 4	PI 643453	SYRİA	SALIANA
PI 636684	ARMENİA	ARM 417	PI 476369	FSU	PETROVSKAJA
PI 547037	USA	WA8649090	PI 345630	FSU	NOVOURENSKAYA
PI 612283	SYRİA	EL-GHAB 11	PI 543920	USA	CRIMSON KRASNOGRADSKA-
PI 612304	BULGARİA	NPO-2	PI 345626	UKRAİNE	YA 460
PI 345629	FSU	NOVOURENSKAYA 3565	PI 606588	TURKEY	TU86-16-02
PI 518734	BRAZİL	CNPH 84-125	W6 27757	USA	BREWER
PI 631397	SYRİA	MEYVECI 2001	PI 634208	USA	MERRİT
PI 543066	PAKİSTAN	WKP-88-3		SERBİA	SITNA
PI 357226	SERBİA	LOKALNA SITNA		SERBİA	GRADECKA

3. Results and Discussion

The results of the variance analysis of the standard varieties used in the study are given in table 4 and the lowest and highest values for these standard varieties and genotypes are given in Table 5. As seen in Table 4, variance analysis of standard varieties was statistically significant at 1% probability limit ($p < 0.01$) in terms of all examined properties and it was determined that it was important at 5% probability limit ($p < 0.05$) in terms of vegetation length.

In terms of grain yield, in terms of yield, standard varieties were obtained from Çağıl with 188.80 kg da^{-1} and Pulse Lentil with 62.05 kg da^{-1}. In terms of geno-

types used in the experiment, the highest seed yield was obtained from the genotype ASTA-RAKSKAJA MESTNAJA of 35.88 g / plant and the lowest seed yield was determined with genotype

TJK2006:001 of 0.19 g / plant. These results show that high yielding genotypes can be used to increase seed yield in future breeding studies. In the studies, seed yield between 75-258.3 kg / da (Alıcı 1997), 49.6-95.5 kg / da (Kaçar & Azkan 1997), between 156.5-247.4 kg / da (Türk & Atikyilmaz 1998), 89.1 -252.9 kg / da (Koç 2004) between 88.40-128.16 kg / da (Ölmez 2011), between 72.82-186.16 kg / da (Öktem 2016) and the highest seed yield in the studies between 258.8 kg / ha (Bozdemir & Önder 2009), 206.3 kg / da (Biçer & Şakar 2011) and 200.5 kg / da (Köse et al 2017) was observed. According to these results, similarities and genotypes were found.

Table 4
Analysis of variance of the properties examined in the research

Source of DF variation	Seed Yield	Thousan of seed weight	Plant height	Number of pods per plant	Vegetation length	%50 Flowering days
Standard	3	**	**	**	*	**

*: p<0.05; **: p < 0.01

In the same way, the highest weight of one thousand of seed 41.98 g with Pul Mercimek variety, 31.88 g with Çağıl standard varieties were determined. When the genotypes were examined, the highest weight of one thousand of seed was obtained from genotype MASON of 162.31 g and lowest from genotype 9+6 of 12.92 g. The highest standard varieties were been identified from genotypes of course seeds. This result showed that there are probably successful genotypes in increasing the weight of one thousand seeds in breeding studies. In the conducted studies, weight of one thousand seeds between 38-50 g (Russell 1994), 24.75-35.75 g (Şakar et al 1997), between 38.1-72.4 g (Kaçar & Azkan 1997), 24.2-42.0 g (Türk & Atikyilmaz 1998), 34.86-48.26 g (Karadavut et al 1999), 36.6-45.1 g (Bildirici & Çiftçi 2001), 26.8-40.1 g (Sözen & Karadavut 2017) changes have been indicated. These results are consistent with our result.

The highest plant height among the standard varieties was measured with Pul Mercimek variety with 33.02 cm and the lowest plant height with 27.23 cm in Çağıl variety. The highest plant height of the genotypes used in the experiment was 43.99 cm with the number of genotypes of BRODSKA, and the lowest plant height was obtained from the genotype with 17.68 cm with the number of genotypes of ILL 486. 30 genotypes were identified higher than the standard varieties with the highest plant size.

Hopefully, genotypes have been found to increase plant height. In the studies, the plant height between 10-45 cm (Solh & Erskine 1984),28.7-33.9 cm (Erskine & Witcombe 1984), between 21-41 cm (Swarup & Lal 1987), 20.4-24.9 cm (Günel et al 1993), between 6.2-24.2 cm (Gupta et al 1996), 32-64

cm (Şakar et al 1997), between 19.9-27.9 cm (Kaçar & Azkan 1997), 30.0- 38.7 cm (Türk & Atikyilmaz 1998), 28.9-38.0 cm (Bozdemir & Önder 2009) changes have been determined. According to these results, our results are similar.

Pul Mercimek with the lowest standard of varieties in the number of pods was 59.87, and the highest standard was 167.49. In terms of genotypes, the highest number of pods in the plant was determined as STELA genotype with 440.62/ plant and the lowest genotype of 9.21 with ILL 605 genotype number were identified. 94 genotypes have higher values than standard varieties. In the studies, the number of pods in the plant between 8.92-13.88 (Günel et al 1993), 11-91 (Gupta et al 1996), 8.7-15.1 (Kaçar & Azkan 1997), 20.16 -33.90 (Karadavut et al 1999), 22.8 -44.3 units (Koç 2004) changes were observed and the highest unit of 66.95 (Çölkesen et al 2005) and 26.35 units (Biçer and Şakar 2011) were found. In our study, the number of pods in the plant was higher than the values in the other study. This shows that we can use these genotypes to increase the number of pods in breeding studies. In light of this information, these genotypes can be used in breeding studies to increase the number of pods.

Among the standard varieties, the shortest vegetation length was 96.3 days with Çağıl, and the longest vegetation length was 105.6 days with local red varieties. It was found that the shortest vegetation length of the genotypes was 79.85 days with genotype PAK20 and the longest vegetation length was 120.85 days with genotype PETROVSKAYA ZELENOZERNAYA. The vegetation length of the 61 genotypes used in the experiment was shorter than the standards. These genotypes can be used to develop early varieties in breeding studies. Vegetation length value between 80-89 days (Günel et al 1993), 85-152 days (Whitehead et al 2000) and 102.9-107.8 days (Bozdemir & Önder, 2009) were found.

Among the standard varieties, the shortest 50% flowering days were 62.2 days with Çağıl variety and 72.2 days with Pul Mercimek varieties. The genotypes included the genotypes with the shortest number of 50% flowering days of 46.5 with 18+12 genotypes, and the longest 50% flowering days of 82 with CNPH84-125 and ZELENAYA AHUNSKAYA genotypes were found. In the studies between 55-61 (Solh and Erskine, 1984), 41.8-64.6 (Erskine 1990), 55-61 (Günel et al 1993), 87-143 (Gupta et al 1996), 45-80 (Whitehead et al 2000), and 65.1-72.0 days (Bozdemir & Önder, 2009) changes were observed. Many of these studies are in parallel with our study.

Table 5
Standard types and genotypes according to the characteristics discussed in the minimum-highest values and lsd values.

Characteristics	Seed yield (g plant^{-1})	Thousand seed weight(g)	Plant height (cm)	Number of pods per plant	Vegetation length (days)	%50 flowering days
Min	0.19	12.92	17.68	9.21	79.85	46.50
Max.	35.88	78.31	43.99	440.62	120.85	82.00
Çağıl	188.80 a	31.88 b	27.23 c	167.49 a	96.2 b	62.2 b
Fırat	132.98 b	36.98 ab	30.68 b	135.91 a	100.2 a	69.2 a
Pul Mer.	62.05 c	41.98 a	33.02 a	59.87 b	103.4 a	72.2 a
Yerli Kır.	147.62 b	37.02 ab	29.48 bc	135.72 a	105.6 a	71.4 a
LSD (0.05)	16.26	5.76	1,61	46.87	6.50	3.97

In accordance with these results, genotypes used in the experiment can be utilized in the development studies of varieties suitable for the conditions of our region, in terms of seed yield and important agricultural characteristics.

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Evaluation of Agricultural Machinery Presence and Usage Activities in Konya Districts by Geographical Information Systems.

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ABSTRACT

The negative effects of global climate change continue to be an element of pressure on agricultural production in Turkey as in many other countries. In a changing climate, the necessity of more efficient and sustainable agricul-tural production in the world is paramount to feed an increasing population. Currently agricultural machines, which minimally disturb the soil, produce less waste and consume less energy, are being used. The most important factor in this process is the change and transformation in agricultural machinery used in agricultural production.

In the province of Konya, production is still carried out with traditional agricultural machinery. The size of the land and the density of agricultural production are not taken into consideration in the purchase and use of agricultural machinery.

In this study, the impact area of the agricultural machines/machinery groups in the districts of Konya will be calculated, compared with the size of the cultivated areas and their efficiency will be evaluated. At the same time, by using Geographical Information Systems (GIS), the presence of agricultural machinery and the impact areas of machine groups in the districts of Konya will be mapped.

This study, which is conducted for the first time in Konya province, will provide a guide in determining which agricultural machinery/machinery groups are overbought, used below capacity, or insufficient in Konya dis-tricts.While there is a surplus in almost every machine group, the largest number of machines is in the soil tillage and seed bed preparation machine group (64,733 units), the largest impact area belongs to the plantcare and fertilizer machine group (611,808,657 da year -1), and the most surplus is seen in the soil tillage and seed bed preparation machinery group (62,707 units in excess). In the case of harvesting machines, their number is found to be inadequate (335 units of shortage).

1. Introduction

Agriculture is the starting point of food chain, which we define as the primary production. Sustainable agriculture involves the production of adequate and high quality foodstuffs in a cost efficient manner as well as systems and practices that improve the protection of agricultural land, farmers, the environment and natural agricultural resources.

In our country's agricultural production, the cost of agricultural inputs is continuously increasing. Among costs, the machinery inputs occupy the first place. Approximately 35% of production inputs are mechanization inputs. Despite this high cost share, mechanization is perceived as less important than seed, fertilizer, pesticide and fuel costs. However, when one considers the fact that the fuel is a mechanization input, the importance of mechanization becomes evident. The mechanization input is ignored because saving the day rather than efficiency is prioritized. However, the mechanization tools that have old technology greatly reduce the product efficiency (Özgüven et al., 2010). For this reason, renewal of machines with timely and correct decisions reduces the operating costs and makes the enterprise more efficient. Working with agricultural machinery that are used beyond their mechanical and economical depreciation period, leads to appalling economic losses to our country's agricultural sector. In addition to economic losses, the use of depreciated machinery leads to environmental pollution well above

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the limits and also poses a major risk to life and property safety (İleri, 2018).

The demand for the tractors is quite high due to the number of agricultural enterprises in our country, the habit of using tractors in daily life and socio-economic reasons. The old tractors that have completed their economic life cause 30% more fuel consumption than the new ones. Nearly half of the current tractor pool (43%) is composed of tractors that have completed their mechanical life and these tractors are known to consume 30% more fuel (1,620 L) than the new ones. The monetary equivalent of this (2018 average diesel price is 5.93 TL L-1) is approximately 9,600 TL per year (Anonymous, 2019b). They cause 1,400 TL increase in maintenance and repair costs and 150 hours of worktime loss in 1 year. They pollute the air up to 10 times more and create at least 7 dbA more noise while running. It has been determined that working with depreciated machinery causes deterioration of product quantity and quality. It also leads to deterioration of human health and decreased work efficiency due to increased noise emission and to loss of life and property due to increased accident risk. (Evcim, 2008)

The amount of wheat harvested with combine harvesters is considered to be approximately 80% of total product. In our country, if we assume that half of this machinery-harvested product (8 million tonnes of wheat which corresponds to half of 80 % of 20 million tonnes of total wheat production per year) is harvested using depreciated combines that are at least 10 years old (60 % of total combine harvester pool is depreciated), then the 1% preventable grain loss caused by these machinery is 80 thousand tons of wheat, which corresponds to approximately 108 million TL in 2019 prices. This amount covers only the product loss. Work, quality and increased operating costs should be calculated separately.

Acquisition of machines that are not needed, and using worn-out machines that have completed their economical depreciation period, increase the costs significantly. Most producers are not aware of this cost. Therefore, it is important to have sufficient num-ber of machines, which are also adequate in terms of power. Moreover, agricultural machinery should not be used beyond their mechanical and economical de-preciation period (Anonymous, 2016).

In this study, the number of existing machinery in the districts of Konya and the impact areas of the agricultural machinery at the district level were compared with the cultivated areas and mapped. In this study, the number of tractors, harvesters and other agricultural machinery, which have not completed the economic life were used. The purpose of the study is to determine whether agricultural machinery is over-bought or not sufficient for current production levels by comparing the functional efficiency of each agri-cultural machine with the crop cultivation areas.

2. Materials and Methods

The agricultural machinery presence, the cultivated areas and harvested areas were determined using official statistics published by Turkey Statistical Institute in Konya and its districts (Anonymous, 2017).

There are 75 types of agricultural machinery in Konya. In this study, the machines that are found in the farmers' machine park but have lost their use or are not widely used (wooden plough, threshing sled, churn, etc.) are not taken into account in the calcula-tions. Agricultural machines were examined in 7 groups and combine harvesters were evaluated as a separate group apart from other harvesting machines.

These are;

1. Soil Tillage and Seed Bed Preparation Machines (Arc Opening Plow, Sub-soiler, Disc type stubble Plow, Disc Harrow, Disc Tractor Plow, Toothed Harrow, Harrow-drill combination, Stubble Plow, Tractor Plow, Cultivator, Roller, Rotary tiller, Set Making Machine, Stone Collecting Machine, Rotary Cultivator, Soil Levelling Machine)

2. Sowing Planting Machines (Stubble Sowing Machine, Combine Grain Sowing Machine, Potato Planting Machine, Pneumatic Sowing Machine, Tractor Sowing Machine, Universal Sowing Machine (Including Mechanical Beet Drum Seeder)

3. Plant Husbandry and Fertilization Machines (Manure spreading machine, Animal and Tractor operated Hoeing Machine, Chemical Fertilizer Distributor)

4. Agricultural Pest Control Machines (Atomizer, PTO driven Sprayer, Motorized Sprayer, Pull type Motor Sprayer and Pollinator Combine Atomizer, Pollinator)

5. Harvesting Machines (Baler Machine, Combine Beet Harvesting Machine, Combine Potato Harvesting Machine, Maize Silage Machine, Hay Rake, Sugar Beet Harvester, Potato Harvester, Stalk Shredder, Tractor Drawn Mower)

6. Combine Harvesters

7. Tractors

In the calculation of the impact areas of agricultural machinery, the machines having completed their economic life have been excluded from the evaluation. In agricultural machinery, the economic life is widely accepted as ten years. According to this, it was accepted that 50% of agricultural machinery and 47% of tractors (Özgüven et al., 2010) completed their economic life. Since the contracting system is widely used in combine harvesters; all existing harvesters is included in the calculations (Yılmaz and al., 2006).

In the calculation of working widths of the agricultural machinery, agricultural tools and machinery manufacturers' catalogs in the province of Konya and other provinces of Turkey were used in addition to the average working widths based on (Ozden and Soğancı, 1996).

The annual number of workable days of agricultural machinery is calculated by using meteorological data

of districts (Anonymous, 2019a). In the calculation, daily average temperature, daily total precipitation, 10 cm soil temperature and daily average relative humidity values, which are an important criterion for harvesting and harvesting machines, were obtained for each district from the 8th Regional Directorate of Meteorology for the 2007-2018 period. These criteria are common variables used for soil processing, plantcare and pest control, harvesting and threshing in different studies and are taken from Kuşçu (2008).

Group I: Soil Processing and Sowing Activities

TAVE i	> 5 °C
PRE i	< 2.5 mm
PRE i + PRE i-1	< 3.5 mm
PRE i + PRE i-1 + PRE i-2	< 4.0 mm
TSOI i	> 0.0 °C

II. Group: Plantcare and Pest Control Activities

TAVE i	> 5 °C
PRE i	< 0.5 mm
TSOI i	> 5.0 °C

III. Group: Haversting and Blending Activities

TAVE i	> 15 °C
PRE i	< 0.0 mm
PRE i-1	< 2.0 mm
RH i	< 60

Here;

TAVE i	Average temperature on day i (°C)
PRE i	Total precipitation on day i (mm)
PRE i-1	Total precipitation on the day before day i (mm)
PRE i-2	Total precipitation on day i-2 (mm)
TSOI i	Soil temperature at 10 cm below surface (°C)
RH i	Average relative humidity values on day i (%)

After calculating the number of workable days for the whole year according to the meteorological data, the following periods during which the agricultural activities are carried out were taken into account (Ada and al., 2010; Arıoğlu and al., 2006; Bozdemir, 2017; Sade and al., 2007):

• For soil processing and planting, 15 March - 30 April, 15 September - 31 October

• For plantcare and pest control procedures, 15 February - 14 April, 1 May - 14 July, 15 October -14 November

• For harvesting and threshing, the interval between 01 July and 30 November were used.

The number of workable days calculated according to meteorological data has been reduced considering the above periods.

The annual number of workable days calculated by this method is shown in Table 1.

In the calculation of the district level usage period of the tractors, Agricultural Cost System (TAMSIS) 2017 data of the Ministry of Agriculture and Forestry were used. TAMSIS is a system of production costs calculated separately for each product produced in the district based on interviews with farmers at the district level. For fuel costs, TAMSIS data, which are determined separately for each product, are used.

Fuel cost had been converted to liters (Anonymous, 2019b).

Hourly fuel consumption (l h^{-1}) of the tractors in the district according to the power (BG) average was calculated by using Yavuzcan and Vatandaş, (1986).

The total amount of annual fuel are divided into the calculated values to calculate the annual working hours. Daily working time was assumed to be 8 h day^{-1}.

The annual number of workable days for tractors calculated by this method is shown in Table 1

Table 1
Workable Days per year for Agricultural Machinery (days).

District	Soil Processing and Sowing Machines	Plantcare Fertilization and Pest Control Machines	Harvesting Machines	Combine Harvesters	Tractors
Ahırlı	53	74	81	75	73
Akören	68	72	92	75	98
Akşehir	59	48	71	75	72
Altınekin	71	78	97	83	105
Beyşehir	55	41	80	85	128
Bozkır	59	74	90	83	134
Cihanbeyli	80	56	93	84	148
Çeltik	71	80	93	73	62
Çumra	76	60	92	93	123
Derbent	56	54	69	67	91
Derebucak	45	60	74	65	129
Doğanhisar	58	64	63	64	67
Emirgazi	70	81	98	89	152
Ereğli	65	67	91	90	86
Güneysınır	59	70	87	77	123
Hadim	47	46	61	87	22
Halkapınar	66	83	93	84	75
Hüyük	69	66	84	72	189
Ilgın	72	47	85	73	68

Table 1(Continuation)
Workable Days per year for Agricultural Machinery (days).

Kadınhanı	76	49	81	82	161
Karapınar	72	62	91	87	223
Karatay	74	82	92	83	101
Kulu	72	59	83	83	182
Meram	74	60	79	81	61
Sarayönü	73	40	79	80	315
Selçuklu	71	33	79	78	73
Seydişehir	46	39	69	82	94
Taşkent	56	62	70	77	147
Tuzlukçu	66	69	86	62	105
Yalıhüyük	54	76	89	77	106
Yunak	61	46	78	83	119
Konya	64	61	83	79	107

Source: Author's compilation of data obtained from 8th Regional Directorate of Meteorology for the 2007-2018 peri-od.

The daily working time of the effective work success of agricultural machinery was taken as 8 h day^{-1}.

The forward speed in working with agricultural machinery and their time-utilization coefficients, that are used in the calculation of the effective working capacity of agricultural machinery are taken from (Özmerzi et al., 2004).

Equation (1) is used in the calculation of the effective working capacity of the agricultural machinery.

Effective working capacity (da h^{-1}) = Machine working width (m) x Forward speed (km h^{-1}) x Time-use coefficient (%)……..……(1)

While calculating the agricultural machinery working widths, average values are found by scanning the catalogs of the companies that produce agricultural machines in Konya and in other cities and by using (Özden and Soğancı, 1996).

Forward speed and time utilization coefficients in working with agricultural machinery are based on (Özmerzi et al., 2004).

Based on the number, effective working capacity, daily working time (8 hours) and the number of working days per year of agricultural machines, the annual impact area are calculated for 7 different machine groups in each district of Konya. The these calculations were given in equation (2).

Machine impact area (da year^{-1}) = number of machines (pcs) x effective working capacity (da h^{-1}) x daily working time (h day^{-1}) x number of annual workable days (day year^{-1})..... (2)

For each group of machines, the impact areas (da) calculated according to Equation 2 are converted into circular areas in each district and the radius (m) of this area is calculated. Similarly, the area planted according to the agricultural production in the district was considered as a circle and the radius of these areas was also determined (Yıldız et al., 2007).

For this, the following formula is used.

$$r = \sqrt{A/\pi} \quad \text{……. ……..(3)}$$

Here;

r: Calculated Area Radius (m)

A: Area (m^2)

π: 3,1416

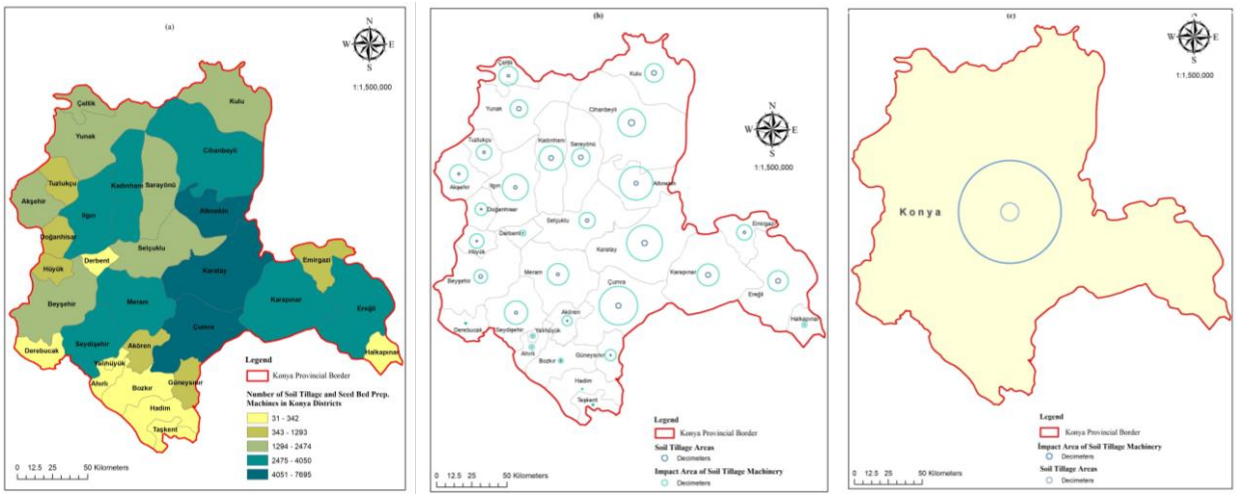
Using equation (2) the impact areas of the machinery groups are calculated. Then, using equation (3) machine impact areas and cultivated areas are transformed into circular form. Using these data, the impact areas of the machines are compared with planted areas. The number of required machinery was calculated based on the size of planted areas. The adequacy or surplus of agricultural machines were determined according to above calculations and comparisons.

For each machine group, two different maps were created at the district level. The first map shows the numbers of the existing machine group, and the second map shows the impact areas of the machine groups and the planted areas as circular areas to allow for comparison.

3. Results and Discussion

Soil Tillage and Seed Bed Preparation Machines:

The number of soil tillage and seed bed preparation machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 1. Table 2 shows the cultivated areas and the impact areas of soil tillage and seed bed preparation machines..



(a) (b) (c)

Figure 1
(a) Number of soil tillage and seed bed preparation machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 2
Impact Areas of Soil Tillage and Seed Bed Preparation Machines and Cultivated Areas.

District	Number of Agricultural Tools and Machines(units)	Impact area of the To-ols/machines (da year $^{-1}$)	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Culti-vated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Çumra	7,695	60,351,661	138,602	1,100,034	18,712	141	-7,554
Karatay	6,428	51,288,394	127,772	1,286,503	20,236	162	-6,266
Altınekin	6,155	45,534,970	120,392	649,907	14,383	88	-6,067
Cihanbeyli	4,050	31,742,016	100,518	1,548,905	22,204	198	-3,852
Seydişehir	3,313	21,837,893	83,374	354,342	10,620	54	-3,259
Ilgın	3,270	27,746,784	93,979	531,473	13,007	63	-3,207
Kadınhanı	3,181	23,840,653	87,113	899,923	16,925	121	-3,060
Karapınar	2,919	19,648,512	79,084	999,737	17,839	149	-2,770
Meram	2,711	18,543,926	76,829	405,361	11,359	60	-2,651
Ereğli	2,761	16,853,876	73,244	893,597	16,865	147	-2,614
Yunak	2,474	12,411,597	62,855	840,146	16,353	168	-2,306
Akşehir	2,313	13,641,791	65,896	262,507	9,141	45	-2,268
Çeltik	2,202	14,778,338	68,586	318,078	10,062	48	-2,154
Kulu	2,083	13,957,459	66,654	935,087	17,252	140	-1,943
Sarayönü	2,082	13,181,289	64,774	888,258	16,815	141	-1,941
Beyşehir	1,781	7,481,364	48,799	570,487	13,476	136	-1,645
Selçuklu	1,626	10,470,796	57,732	484,820	12,423	76	-1,550
Emirgazi	1,293	9,642,696	55,402	287,995	9,575	39	-1,254
Tuzlukçu	1,201	9,492,226	54,968	271,353	9,294	35	-1,166
Hüyük	1,105	8,579,681	52,259	173,009	7,421	23	-1,082
Doğanhisar	1,095	6,088,051	44,021	147,360	6,849	27	-1,068
Güneysınır	968	5,263,508	40,932	112,655	5,988	21	-947
Akören	648	4,285,523	36,934	139,093	6,654	22	-626
Ahırlı	342	1,067,293	18,432	45,805	3,818	15	-327
Derbent	312	1,219,098	19,699	83,142	5,144	22	-290
Bozkır	228	973,642	17,605	95,213	5,505	23	-205
Yalıhüyük	178	910,613	17,025	32,810	3,232	7	-171
Halkapınar	164	1,045,546	18,243	39,881	3,563	7	-157
Derebucak	64	220,320	8,374	24,728	2,806	8	-56
Taşkent	60	220,954	8,386	11,666	1,927	4	-56
Hadim	3k1	103,325	5,735	2,878	957	1	-30
Konya	64,733	452,423,791	379,487	14,159,429	67,135	2,026	-62,707

When we examine Figure 1 and Table 2, we observe that district with the maximum number of machines in the soil tillage and seed bed preparation machines group is Çumra (7,695) and it constitutes 12% of total number in the province. In terms of the number of machines in this group, Karatay (6,428) is the second and Altınekin (6,155) in the third.

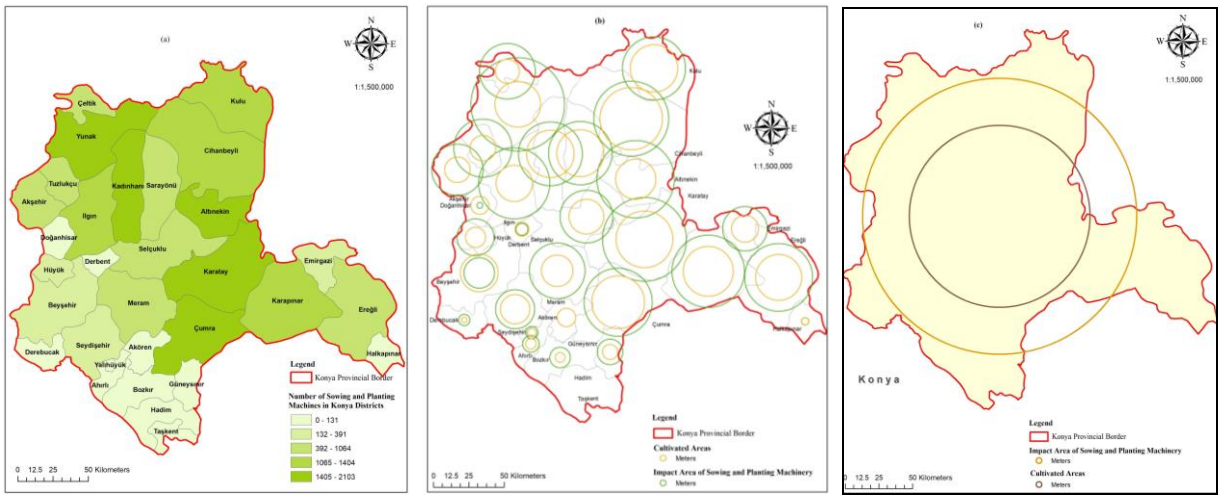
The districts with the least machinery in this group are Hadim (31 units), Taşkent (60 units) and Derebucak (64 units).

Accordingly, Çumra, Karatay and Altınekin districts occupy the top three positions in the ranking of impact areas of the soil tillage and seed bed preparation machinery group. Hadim, Derebucak, Taşkent districts occupy the bottom three positions in this regard.

When we compare the machine group impact areas and cultivated areas, it was determined that 7,554 units of soil tillage and seed bed preparation machines in Çumra, 6,266 units in Karatay and 6,067 units in Altınekin district are overbought. In this group, it is evident that there is a surplus in the number of machines in comparison to the cultivated areas. In Konya, the total number of surplus in the soil tillage and seed bed preparation machines is 62,707 units.

Sowing Planting Machines:

The number of sowing and planting machines in the districts of Konya and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and provincial scale are given in Figure 2. Table 3 shows the cultivated areas and the impact areas of sowing and planting machines



(a) (b) (c)

Figure 2
(a) Number of sowing and planting machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 3
Impact Areas of Sowing and Planting Machines and Cultivated Areas

District	Number of Agricultural Tools and Machines (units)	Impact Area of the Tools/Machines (da year $^{-1}$)	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of Tools/Machines Based on Cultivated Area (units)	Difference in Number of Tools/Machines (Necessary-Existing)
Yunak	2,103	3,469,634	33,233	826,802	16,223	502	-1,601
Altınekin	2,058	2,391,970	27,593	647,321	14,354	557	-1,501
Karatay	1,981	2,783,982	29,769	1,283,413	20,212	914	-1,067
Ilgın	1,343	2,008,659	25,286	520,459	12,871	348	-995
Çeltik	942	1,235,580	19,832	232,586	8,604	178	-764
Kadınhanı	1,666	1,616,155	22,681	894,062	16,870	922	-744
Karapınar	1,380	2,075,781	25,705	991,795	17,768	660	-720
Çumra	1,691	1,839,010	24,194	1,100,034	18,712	1,012	-679
Tuzlukçu	806	1,336,521	20,626	263,263	9,154	159	-647
Akşehir	750	1,054,206	18,318	262,507	9,141	187	-563
Kulu	1,204	1,585,256	22,463	895,834	16,886	681	-523
Meram	767	1,235,759	19,833	398,091	11,257	248	-519
Ereğli	913	1,830,558	24,139	836,393	16,317	418	-495
Sarayönü	1,064	1,602,298	22,584	878,469	16,722	584	-480
Cihanbeyli	1,404	2,231,045	26,649	1,548,905	22,204	975	-429
Selçuklu	705	1,112,816	18,821	481,936	12,386	306	-399

Table 3 (Continuation)
Impact Areas of Sowing and Planting Machines and Cultivated Areas

Emirgazi	391	787,149	15,829	287,995	9,575	144	-247
Hüyük	331	544,782	13,168	162,322	7,188	99	-232
Seydişehir	378	607,926	13,911	347,741	10,521	217	-161
Güneysınır	111	262,719	9,145	92,616	5,430	40	-71
Bozkır	86	170,170	7,360	39,613	3,551	21	-65
Doğanhisar	170	164,388	7,234	131,390	6,467	136	-34
Yalıhüyük	59	60,861	4,401	29,333	3,056	29	-30
Ahırlı	46	109,789	5,912	45,705	3,814	20	-26
Derebucak	21	50,982	4,028	11,850	1,942	5	-16
Halkapınar	23	22,227	2,660	23,042	2,708	24	1
Akören	131	136,590	6,594	138,413	6,638	133	2
Derbent	38	58,231	4,305	79,810	5,040	53	15
Beyşehir	342	369,110	10,839	570,487	13,476	529	187
Konya	22,749	32,604,363	101,874	14,159,429	67,135	9,880	-12,869

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When we examine Figure 2 and Table 3, we observe that district with the maximum number of machines in the sowing and planting machines group is Yunak; with 2,103 units, which constitutes 9% of total number of sowing and planting machines in the province. Altınekin (2,058 units) is the second and Karatekin (1,981) is the third.

The districts with the least number of machines in this group are Derebucak (21 units), Halkapınar (23 units) ve Derbent (38 units).

When the districts with the most and least number of sowing and planting machines are examined; we observe that sowing and planting machines are concentrated mostly in the districts that have large agricultural lands where farmers engage in field crop cultivation, whereas the number of sowing and planting machines are fewer in the districts where the land structure is small and fragmented.

The impact areas of sowing and planting machines were compared at the district scale. According to the calculations; the cultivated area in Yunak district is 826,802 da, while the impact area of sowing and plating machines is 3,469,634 da. The number of machines should have been 502 based on the size of the cultivated areas (826,802 da). Therefore 1,601 units of 2,103 existing machines in the district constitute a surplus. In the evaluation of the machine group impact areas, Altınekin is the second with 1,501 units of surplus machines and Karatay is the third (1,067 units).

Plantcare and Fertilization Machines:

The number of plantcare and fertilization machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 3. Table 4 shows the cultivated areas and the impact areas of plantcare and fertilization machines.

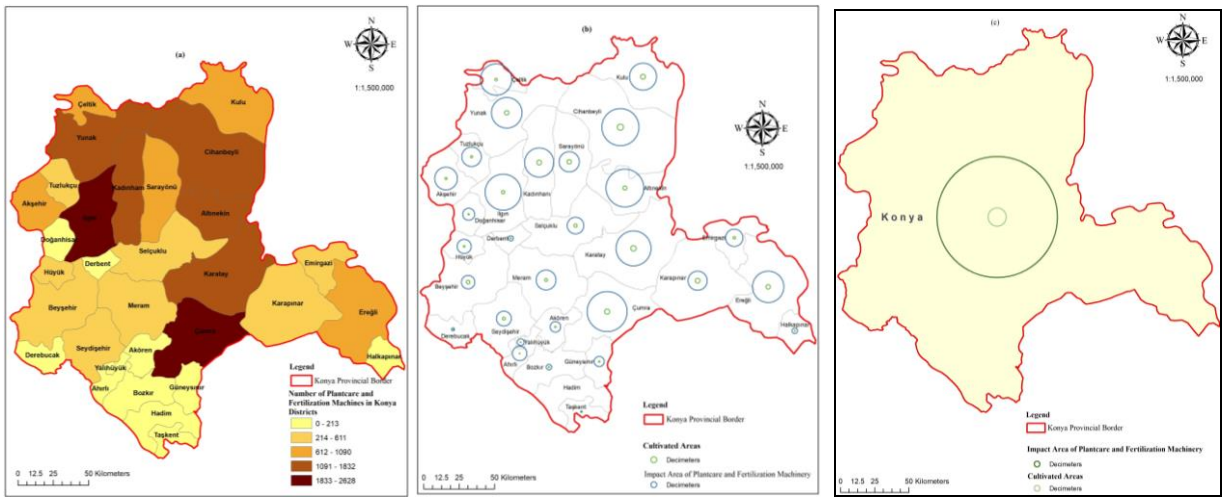


Figure 3
(a) Number of plantcare and fertilization machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 4
Impact Areas of Plantcare and Fertilization Machines and Cultivated areas.

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Çumra	2,628	63,562,656	142,241	1,100,034	18,712	46	-2,582
Ilgın	2,097	51,569,829	128,122	520,459	12,871	22	-2,075
Cihanbeyli	1,832	54,289,805	131,457	1,548,905	22,204	53	-1,779
Yunak	1,590	37,636,832	109,454	826,802	16,223	35	-1,555
Altınekin	1,558	56,210,669	133,762	647,261	14,354	18	-1,540
Karatay	1,408	48,774,387	124,601	1,283,413	20,212	38	-1,370
Kadınhanı	1,363	34,226,382	104,377	894,062	16,870	36	-1,327
Ereğli	1,090	39,152,978	111,637	836,393	16,317	24	-1,066
Çeltik	938	38,988,544	111,402	317,812	10,058	8	-930
Akşehir	938	20,490,547	80,761	262,507	9,141	13	-925
Kulu	904	29,158,083	96,339	895,834	16,886	28	-876
Sarayönü	771	16,449,888	72,361	878,469	16,722	42	-729
Selçuklu	611	10,892,086	58,882	481,936	12,386	28	-583
Meram	550	15,706,224	70,707	398,091	11,257	14	-536
Karapınar	556	14,901,179	68,871	991,795	17,768	38	-518
Seydişehir	447	8,901,984	53,231	347,741	10,521	18	-429
Tuzlukçu	416	14,941,978	68,965	263,263	9,154	8	-408
Beyşehir	322	7,118,617	47,602	570,487	13,476	26	-296
Emirgazi	292	11,814,401	61,324	287,995	9,575	8	-284
Hüyük	260	7,944,130	50,286	162,322	7,188	6	-254
Ahırlı	213	8,231,523	51,188	45,805	3,818	2	-211
Doğanhisar	167	5,809,869	43,004	131,390	6,467	4	-163
Akören	125	4,560,134	38,099	139,093	6,654	4	-121
Güneysınır	111	4,230,744	36,697	92,616	5,430	3	-108
Yalıhüyük	48	2,002,022	25,244	29,333	3,056	1	-47
Bozkır	48	1,337,446	20,633	55,886	4,218	3	-45
Derbent	38	1,126,138	18,933	79,810	5,040	3	-35
Halkapınar	29	1,320,962	20,505	31,401	3,162	1	-28
Derebucak	14	356,544	10,653	23,970	2,762	1	-13
Taşkent	3	102,077	5,700	11,666	1,927	1	-2
Konya	21,367	611,808,657	441,298	14,159,429	67,135	495	-20,872

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 3 and Table 4 are examined, we observe that the district with the most machinery presence in the group of plantcare and fertilization machines is Çumra. Plantcare and fertilization machines in Çumra district constitute 12% of the total number in the province. The least number of plantcare and fertilization machines are in Taşkent and Derebucak districts. Within the group which includes manure spreading machine, animal and tractor-pulled hoeing machine and chemical fertilizer distributor, the number of chemical fertilizer distributor is the highest with 18,550 units in total, animal and tractor-pulled hoeing machine is the second with 2,662 units in total, and manure spreading machine is in the third place with 155 units.

The number of plantcare and fertilization machines is higher in districts that have large agricultural areas and engage in field crop cultivation such as Çumra, Ilgın and Cihanbeyli. The numbers are fewer in the districts such as Taşkent, Derebucak and Halkapınar, which have less agricultural land and where fruit and vegetable growing is common.

Within the plantcare and fertilization machines group, the number of chemical fertilizer distributor is the highest, followed by animal and tractor-pulled hoeing machine and manure spreading machine respectively.

When we examine the required number of plantcare and fertilization machines, calculated by comparing the impact radii and cultivated area radius, we can determine that for Çumra district, which has the highest number of plantcare and fertilization machines, 46 units of plantcare and fertilization machines would be sufficient. Therefore, we can conclude that out of the total number of 2,678 units in the district, 2,632 units are in excess.

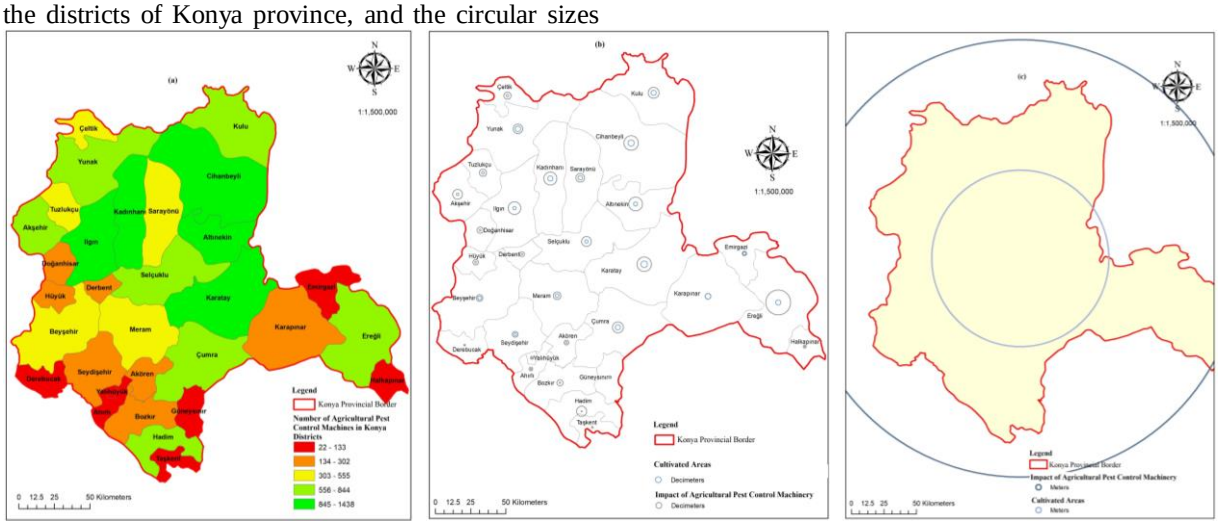
In the group of plantcare and fertilization machines, Ilgın is the second district with the most machinery presence compared to the cultivated areas, and 22 plantcare and fertilization machines are sufficient for the cultivated areas, however, it is observed that 2,097 units have been acquired and 2,075 units are redundant.

According to the effect of machine group domain, it is determined that there are 2 and 13 surpluses in

Taşkent and Derebucak districts which have the least machine group respectively.

Agricultural Pest Control Machines:

The number of agricultural pest control machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 4. Table 5 shows the cultivated areas and the impact areas of agricultural pest control machines.



(a) (b) (c)

Figure 4
(a) Number of agricultural pest control machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 5
Impact Areas of Agricultural Pest Control Machines and Cultivated areas

District	Number of Agricultural Tools and Machines (units)	Impact area of the To-ols/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cul-tivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Cihanbeyli	1,438	8,566,168	52,218	1,588,982	22,490	267	-1,171
Altınekin	1,262	7,525,856	48,944	649,907	14,383	109	-1,153
Karatay	1,437	8,321,529	51,467	1,799,108	23,931	311	-1,126
Ilgın	1,121	6,479,502	45,415	531,473	13,007	92	-1,029
Kadınhanı	1,200	7,012,096	47,244	1,072,475	18,476	184	-1,016
Hadim	755	4,095,780	36,107	79,482	5,030	15	-740
Çumra	843	4,748,214	38,877	1,108,580	18,785	197	-646
Akşehir	687	4,026,183	35,799	292,714	9,653	50	-637
Kulu	810	4,803,625	39,103	1,152,087	19,150	195	-615
Ereğli	644	24,945,199	89,108	1,154,597	19,171	30	-614
Selçuklu	663	3,834,428	34,936	484,820	12,423	84	-579
Yunak	844	3,754,400	34,570	1,191,449	19,474	268	-576
Sarayönü	555	3,204,958	31,940	888,258	16,815	154	-401
Meram	462	2,410,928	27,702	578,415	13,569	111	-351
Çeltik	367	2,097,087	25,836	318,078	10,062	56	-311
Tuzlukçu	350	2,082,933	25,749	271,353	9,294	46	-304
Bozkır	294	1,622,816	22,728	95,213	5,505	18	-276
Doğanhisar	302	1,685,549	23,163	153,172	6,983	28	-274
Beyşehir	350	1,872,728	24,415	580,481	13,593	109	-241
Seydişehir	258	1,486,451	21,752	354,342	10,620	62	-196
Hüyük	220	1,244,526	19,903	173,009	7,421	31	-189
Derbent	172	971,131	17,582	83,142	5,144	15	-157
Akören	169	955,646	17,441	140,614	6,690	25	-144
Ahırlı	92	550,160	13,233	53,991	4,146	10	-82
Yalıhüyük	75	412,516	11,459	32,810	3,232	6	-69
Halkapınar	72	415,730	11,504	39,881	3,563	7	-65

Table 5 (Continuation)
Impact Areas of Agricultural Pest Control Machines and Cultivated areas

Emirgazi	133	795,340	15,911	408,652	11,405	69	-64
Karapınar	274	1,480,367	21,707	1,245,782	19,913	231	-43
Taşkent	30	114,587	6,039	21,203	2,598	6	-24
Güneysınır	53	315,006	10,013	192,521	7,828	33	-20
Derebucak	22	94,505	5,485	24,728	2,806	6	-16
Konya	512	89,725,750	168,999	14,619,579	68,217	2,600	-13,354

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 4 and Table 5 are examined, it is seen that the districts of Cihanbeyli (1,438 units), Karatay (1,437 units) and Altınekin (1,262 units) are in the top three positions in terms of the presence of agricultural pest control machinery group whereas Derebucak (22 units), Taşkent (30 units) and Güneysınır (53 units) districts occupy the last three ranks.

Within the in the agricultural pest control machinery group, the number of PTO driven sprayers is the highest with 1,430 units in the Cihanbeyli district, and 1,250 units in each of the Altınekin and Karatay districts, whereas the number of Pull type Motor Sprayer and Pollinator Combine Atomizer is the least with 1 units in each of the Yunak, Yalıhüyük and Doğanhisar districts.

At the Konya provincial level, in terms of the presence of agricultural pest control machines, the number of PTO driven sprayers is the highest with 13,019 units, followed by motorized sprayer with 2,053 units, and atomizers with 606 units. At the fourth rank is Pull type Motor Sprayer and Pollinator Combine Atomizer with 216 units, followed by 60 pollinators.

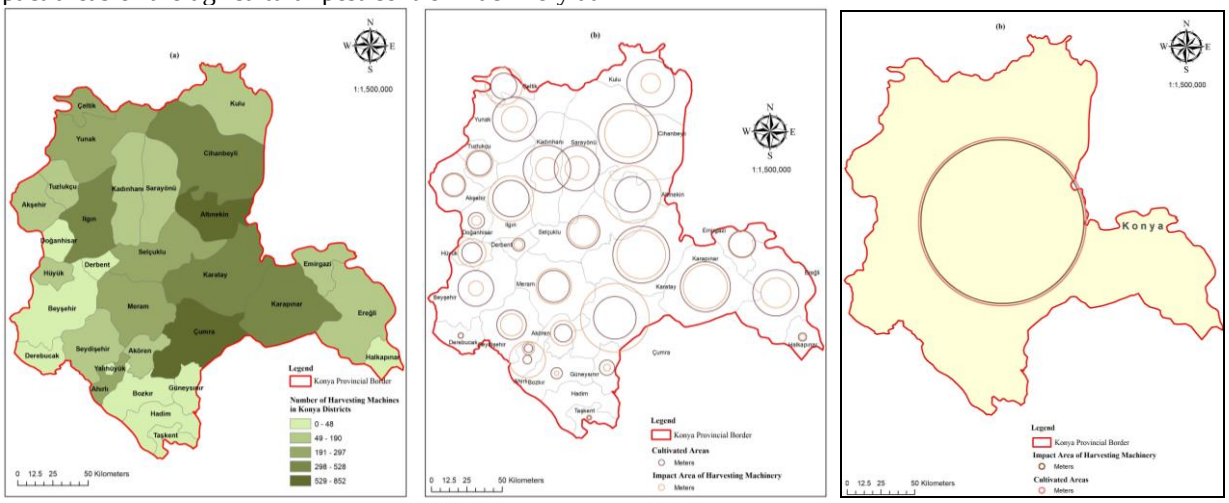
When we compare the cultivated areas and the impact areas of the agricultural pest control machinery at the district level, the disttict with the highest machine group impact area is Ereğli (24,945,199 da) and according to the calculated impact area, 30 units of agricultural pest control machinery would be sufficient for the cultivated areas in Ereğli district, therefore the remaining 614 units of agricultural machinery are redundant.

In comparing the cultivated areas with the impact area of the machinery group, 1,171 units in Cihanbeyli district, 1,153 units in Altınekin district and 1,126 units of agricultural pest control machinery in Karatay district are found to be redundant.

Derebucak (16 units), Güneysınır (20 units) and Taşkent (24 units) districts occupy the lowest ranks in terms of the surplus in the agricultural pest control machinery group.

Harvesting Machines:

The number of harvesting machines in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 5. Table 6 shows the cultivated areas and the impact areas of harvesting machines.



(a) (b) (c)

Figure 5
(a) Number of harvesting machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 6
Impact Areas of Harvesting Machines and Cultivated Areas.

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Altınekin	852	1,294,666	20,300	506,303	12,695	334	-518
Çumra	800	1,855,448	24,302	720,699	15,146	311	-489
Ahırlı	297	521,541	12,885	31,074	3,145	18	-279
Ilgın	528	811,453	16,071	520,459	12,871	339	-189
Çeltik	256	548,019	13,208	269,067	9,255	126	-130
Akören	128	252,190	8,960	123,193	6,262	63	-65
Meram	287	495,972	12,565	398,091	11,257	231	-56
Hüyük	87	314,275	10,002	162,322	7,188	45	-42
Tuzlukçu	150	299,335	9,761	237,339	8,692	119	-31
Yalıhüyük	31	60,746	4,397	29,333	3,056	15	-16
Emirgazi	180	298,875	9,754	277,076	9,391	167	-13
Taşkent	9	12,970	2,032	5,498	1,323	4	-5
Derebucak	8	9,511	1,740	12,060	1,959	11	3
Halkapınar	9	13,487	2,072	29,371	3,058	20	11
Derbent	24	34,425	3,310	63,732	4,504	45	21
Akşehir	126	183,136	7,635	222,399	8,414	154	28
Bozkır	6	8,054	1,601	50,980	4,028	38	32
Güneysınır	15	20,781	2,572	92,616	5,430	67	52
Doğanhisar	34	40,118	3,574	106,726	5,829	91	57
Selçuklu	221	336,868	10,355	437,471	11,800	287	66
Karapınar	452	759,172	15,545	991,795	17,768	591	139
Seydişehir	190	191,787	7,813	347,741	10,521	345	155
Karatay	495	935,144	17,253	1,283,413	20,212	680	185
Ereğli	150	355,921	10,644	836,393	16,317	353	203
Beyşehir	48	86,364	5,243	506,992	12,704	282	234
Cihanbeyli	382	865,827	16,601	1,413,119	21,209	624	242
Sarayönü	150	224,655	8,456	810,000	16,057	541	391
Yunak	229	265,393	9,191	770,116	15,657	665	436
Kulu	94	150,563	6,923	895,834	16,886	560	466
Kadınhanı	174	205,079	8,080	894,062	16,870	759	585
Konya	6,412	11,451,777	60,376	12,048,374	61,928	6,747	335

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

In Figure 5 and Table 6, in the group of harvesting machines, Altınekin has the highest number of machinery with 852 machines, which constitutes 13.2% of all harvesting machines in the province. In the second place is Çumra (800 units), followed by Ilgın (528 units) district.

In the harvesters group, Bozkır (6 units), Derebucak (8 units) and Taşkent (9 units) districts are listed as the districts with the least machine presence.

Within the group of harvesting machines at the district scale, Altınekin ranks first with 550 sugar beet harvesters, Cihanbeyli district is the second with the presence of 300 combine sugar beet harvesters, and Ilgın is the third with tractor drawn mower machines.

In the 6,412 units harvesting group machines throughout Konya, there are 1.654 sugar beet harvesters, 1,274 grass rakes and 1,164 tractor drawn mowers.

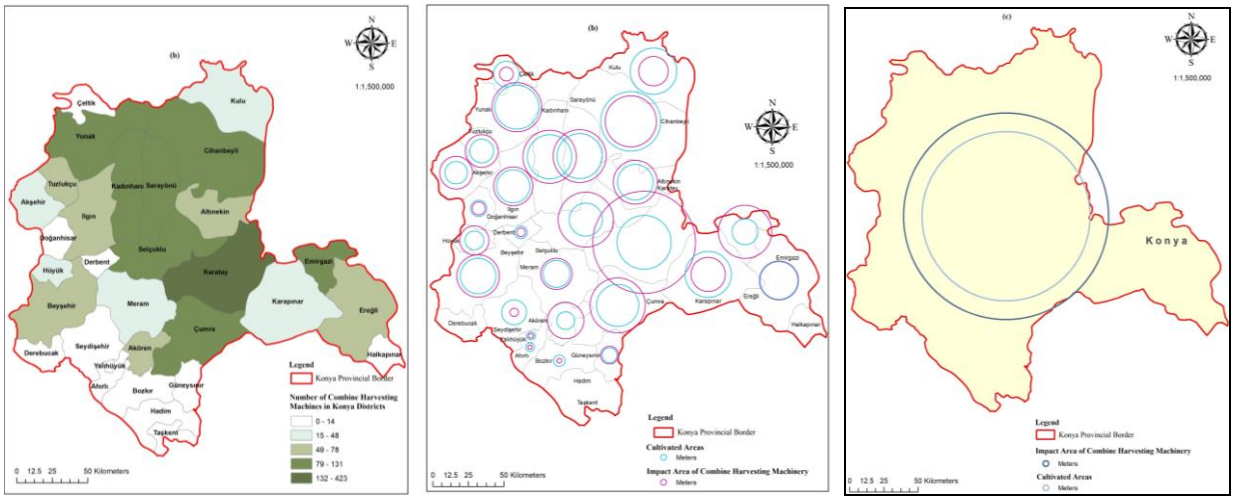
In this group, the combine potato harvesting machine (70 units), stalk chopper (153 units) and potato harvester (229 pieces) are the machines with least presence.

In the harvesting machines group, if we compare the cultivated areas and the impact areas of the agricultural machinery at the district level, 334 harvesting machines are found to be sufficient for the cultivated areas in Altinekin district, while 518 machines were obtained in excess. Although the 311 machines would be sufficient for the cultivated areas in Çumra district, it was found that 489 machines were acquired in surplus, while 18 machines were sufficient in the Ahırlı district and 279 more machines had been acquired.

In this group of machinery, according to the machine machine impact areas, 174 harvesting machines in Kadınhanı district can only be sufficient for 23% of the cultivated areas and 585 more machines are needed. 466 more harvesting machines in Kulu and 436 more in Yunak are needed as well.

Combine Harvesters:

The number of combine harvesters in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 6. Table 7 shows the cultivated areas and the impact areas of combine harvesters.



(a) (b) (c)

Figure 6
(a) Number of combine harvesters in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 7
Impact Areas of Combine Harvesters and Cultivated Areas

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Karatay	423	4,128,818	36,252	1,146,707	19,105	118	-305
Selçuklu	131	1,201,637	19,557	437,471	11,800	48	-83
Emirgazi	107	1,119,905	18,881	268,126	9,238	26	-81
Akören	59	520,380	12,870	123,196	6,262	14	-45
Çumra	110	1,203,048	19,569	708,799	15,021	65	-45
Kadınhanı	116	1,118,611	18,870	776,734	15,724	81	-35
Sarayönü	118	1,110,144	18,798	805,200	16,009	86	-32
Tuzlukçu	59	430,181	11,702	227,324	8,506	32	-27
Altınekin	78	761,342	15,567	505,203	12,681	52	-26
Akşehir	48	423,360	11,609	197,360	7,926	23	-25
Hüyük	40	338,688	10,383	139,479	6,663	17	-23
Beyşehir	72	719,712	15,136	506,992	12,704	51	-21
Yunak	98	956,558	17,449	770,116	15,657	79	-19
Ilgın	70	600,936	13,831	440,312	11,839	52	-18
Meram	41	390,550	11,150	288,239	9,579	31	-10
Güneysınır	14	126,773	6,352	86,758	5,255	10	-4
Ereğli	57	603,288	13,858	569,285	13,461	54	-3
Ahırlı	1	8,820	1,676	31,074	3,145	4	3
Yalıhüyük	1	9,055	1,698	27,367	2,951	4	3
Bozkır	1	9,761	1,763	50,980	4,028	6	5
Derbent	4	31,517	3,167	63,732	4,504	9	5
Doğanhisar	9	67,738	4,643	106,726	5,829	15	6
Çeltik	9	77,263	4,959	260,107	9,099	31	22
Seydişehir	3	28,930	3,035	243,604	8,806	26	23
Karapınar	45	460,404	12,106	845,618	16,406	83	38
Cihanbeyli	105	1,037,232	18,170	1,413,119	21,209	144	39
Kulu	36	351,389	10,576	853,559	16,483	88	52
Konya	1,855	17,836,039	75,348	11,944,889	61,662	1,243	-612

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 6 and Table 7 are examined, the highest number of combine harvesters among the districts of Konya is found in Karatay with 423 units, which constitutes 22.8% of the combine harvesters in the province of Konya. However, in terms of areas harvested by combine harvester, Karatay district is the

second and has a share of 9.6%. Although Selçuklu district comes in the second place with 131 harvesters in terms of the presence of combine harvesters, the areas harvested by combine harvesters constitute 36% of the impact area of combine harvesters.

In Ahırlı, which has the least harvesting capacity, there is 1 combine harvester and can cover only 28% of the areas harvested by combine harverters.

There are no combine harvesters in Derebucak, Hadim, Halkapınar and Taşkent. In these districts, agricultural production is predominantly based on fruit and vegetable cultivation. Field crops produced in small and fragmented land are harvested either by combine harvesters from other districts or by other methods.

In the districts of Konya, when the impact areas of combine harvesters are compared with the cultivated areas, it is seen that in the Karatay district where the maximum number of harvesters is present, the existing harvesters can cover for 3.6 times the cultivated area and 118 harvesters would be sufficient for this district according to the calculated impact area. It is noteworthy that 305 of the 423 harvesters were overbought.

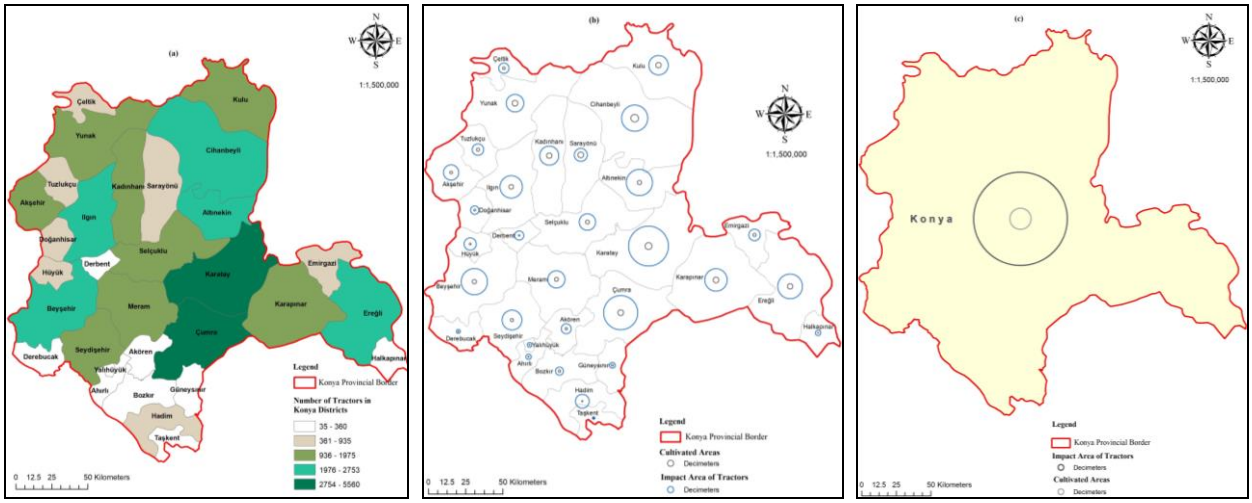
Kulu district, where farmers mostly produce grains, is found to be the most lacking district in terms of the presence of combine harvesters. The existing machinery pool in the Kulu district, with respect to their impact area, can only be sufficient for 36% of the areas harvested by combine harvester. According to the size of areas harvested by combine harvester, there should be 88 harvesters in this district, while only 36 units are available and 52 more combine harvesters are required.

Cihanbeyli is the second in the ranking of districts where the need for combine harvesters is highest. Although this district is the first province in Konya in terms of cultivated areas; the existing number of combine harvesters can only be sufficient for 73% of the cultivated areas and 39 more combine harvesters are needed in this district.

According to the impact areas of combine harvesters, the districts where most combine harvesters are acquired are Karatay (305 units), Selçuklu (83 units) and Emirgazi (81 units).

Tractors:

The number of tractors in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 7. Table 8 shows the cultivated areas and the impact areas of tractors.



(a) (b) (b)

Figure 7
(a) Number of tractors in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 8
Impact Areas of Tractors and Cultivated Areas

District	Number of Agricultural Tools and Machines(units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Karatay	5,560	71,879,680	151,261	1,286,503	20,236	100	-5,460
Çumra	3,975	62,582,400	141,140	1,108,580	18,785	70	-3,905
Ereğli	2,753	30,305,024	98,216	893,597	16,865	81	-2,672
Ilgın	2,547	22,169,088	84,004	531,473	13,007	61	-2,486
Altınekin	2,531	34,016,640	104,057	649,907	14,383	48	-2,483
Beyşehir	2,328	38,141,952	110,186	580,481	13,593	35	-2,293
Cihanbeyli	2,367	44,840,448	119,470	1,588,982	22,490	84	-2,283
Seydişehir	1,975	23,763,200	86,972	354,342	10,620	29	-1,946
Karapınar	1,834	52,349,696	129,087	999,737	17,839	35	-1,799
Meram	1,714	13,382,912	65,268	405,361	11,359	52	-1,662
Akşehir	1,495	13,777,920	66,224	292,714	9,653	32	-1,463
Selçuklu	1,485	13,875,840	66,459	484,820	12,423	52	-1,433
Kulu	1,465	34,128,640	104,228	1,152,087	19,150	40	-1,425
Kadınhanı	1,454	29,964,032	97,662	899,923	16,925	44	-1,410
Yunak	1,269	19,329,408	78,439	840,146	16,353	55	-1,214
Hadim	935	2,632,960	28,950	76,979	4,950	27	-908
Çeltik	878	6,967,808	47,095	318,078	10,062	40	-838
Sarayönü	656	26,449,920	91,756	888,258	16,815	22	-634
Hüyük	551	13,329,792	65,138	173,009	7,421	7	-544
Doğanhisar	516	4,425,216	37,531	147,360	6,849	17	-499
Tuzlukçu	482	6,478,080	45,410	271,353	9,294	20	-462
Emirgazi	425	8,268,800	51,303	288,652	9,585	15	-410
Akören	360	4,515,840	37,913	140,614	6,690	11	-349
Derbent	307	3,575,936	33,738	83,142	5,144	7	-300
Bozkır	256	4,390,912	37,385	95,213	5,505	6	-250
Ahırlı	195	1,822,080	24,083	53,991	4,146	6	-189
Güneysınır	185	2,912,640	30,449	112,655	5,988	7	-178
Halkapınar	151	1,449,600	21,481	39,881	3,563	4	-147
Yalıhüyük	86	1,166,848	19,272	32,810	3,232	2	-84
Derebucak	52	858,624	16,532	24,728	2,806	1	-51
Taşkent	35	658,560	14,478	21,203	2,598	1	-34
Konya	40,821	310,651,547	314,457	14,619,579	68,217	1,921	-38,900

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

According to Figure 7 and Table 8, the first three districts with the highest number of tractors are Karatay district with the presence of 5,560 units, Çumra district with 3,975 units and Ereğli district with 2,753 units.

The last ranks are occupied by Taşkent district with 35 units, Derebucak district is one rank above with 52 units and Yalıhüyük with 86 tractors.

When we analyze the presence of tractors in Konya districts in terms of power distribution, we observe that those districts which have large agricultural lands and mainly engage in field crop cultivation like Karatay, Çumra, Cihanbeyli, etc. have high-power tractors, whereas in districts that mostly commonly grow vegetables and fruits like Hadim, Ereğli, Beyşehir etc. farmers prefer less powerful and usually single-axle tractors.

The impact area of 5,560 tractors in the Karatay district was calculated as 71,879,680 da. According to this impact area, while 100 tractors were sufficient for the cultivated areas of Karatay district (1,286,503 da), 5,460 more tractors were acquired. It can be said that there are 3,905 excess units in Çumra, which is in the second place, and 1,799 excess tractors in Karapınar district, which is in third place.

In comparing the impact area of the tractor with with the cultivated area, Taşkent district is in the last place with 34 excess units, Derebucak has 51 excess units and Yalıhüyük district has 84 tractors in excess.

Among the 7 machine groups identified throughout Konya, the largest number of machines is in the soil tillage and seed bed preparation machine group, the largest impact area belongs to the plantcare and fertilizer machine group, and the most surplus is seen in the soil tillage and seed bed preparation machinery group. In the case of harvesting machines, their number is found to be inadequate.

In this study, the usability of geographical information systems in the field of agricultural machinery is demonstrated and the research is designed at the district level for richer detail. Both of these factors required comprehensive work. With this study, in 31

districts of Konya province, cultivated areas and the impact areas of agricultural machinery categorized in 7 groups were converted into maps by using ArcGis 10.4 program.

At the district level, it was found that the most surplus was in the group of soil tillage and seed bed preparation machines, with 7,554 excess units in Çumra, 6,266 units in Karatay and 6,067 units in Altınekin district. Again at the district level, the most deficiency was observed in the group of harvesting machines in the districts of Kadınhanı, Kulu, Yunak, Sarayönü, Cihanbeyli, Beyşehir and Ereğli.

When individual machines forming the groups are examined at the district level; the 5,460 tractors in Karatay, 3,905 tractors in Çumra, and 3,546 moldboard type tractor ploughs in Çumra are in excess, whereas 2,149 more balers in Cihanbeyli district, and 1,706 more balers in Karatay district are needed along with 1,674 more atomizers in Cihanbeyli district and 1,346 more atomizers in Karatay district.

In Konya province overall surplus in agricultural machinery groups are 62,707 units in the soil tillage and seed bed preparation machines, 38,900 units in tractors, 20,872 units in the plantcare and fertilization machinery group, 13,354 units in the agricultural pest control machinery group, 12,869 units in the sowing and planting machines and 612 units in combine harvesters. In the group of harvesting machines, there is a need for 335 more machines.

At the provincial level, among the individual machines forming the groups, the surplus is 20,463 moldboard type tractor ploughs, 18,106 chemical fertilizer distributors and 10,574 PTO driven sprayers; whereas the shortage is 17,711 balers, 14,842 atomizers and 8,403 pneumatic seeders.

As a result of this study conducted in Konya at both provincal and district level, we can conclude that although there is an unused mechanization capacity in all machine and machine groups in general; there is also a significant gap in Konya districts with respect to machines such as stubble sowing machine, subsoiler, stone collecting machine, manure spreading machine, stalk shredder machine, and baler machine which support novel environment-friendly approaches and have recently been introduced to the machine pool.

The main finding of the study is that there is a generalized inert mechanization capacity in terms of both the agricultural machinery groups and individual machines forming the groups in Konya districts. This inert mechanization capacity, which is quite substantial in Konya districts, leads to higher investment costs in machinery capital in enterprises. Therefore, encouraging the joint use of machinery or contracting can be proposed as a solution.

It is important to develop policies to encourage the acquisition of machines such as baler, atomizer, pneumatic seed drill, stubble sowing machine, subsoiler, stone collecting machine, manure spreading machine and shredder machine, which are found to be lacking in numbers in Konya province. Moreover, it is vital to plan for the elimination of the deficiencies in mechanization tools used in irrigated agricultural areas, which are expected to increase in the near future after all stages of operation of the Konya Plain Project (KOP) are completed.

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Research Article

Using Geographical Information Systems in Determination of Production Areas of Ornamental Plants Konya, Turkey

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ABSTRACT

The increase of dependency of people in nature, due to the gradual increase of population at cities and the effect of life conditions, causes an increase in demand for green areas and ornamental plants. This increase of demand had provided an economic sector dimension to cultivation of ornamental plants. This study had been realized in order to determine suitable areas for cultivation of ornamental plants in the province of Konya which is a significant agriculture potential of Turkey and which has an ecology suitable for cultivation of many agricultural products. In the determination of these suitable areas, Geographical Information Systems having many functions such as location determination, data storage, data analysis and spatial analysis had been used. Climate, topography and soil features required for cultivation of ornamental plants had been obtained in map environment for the research area, and the analyses required for determination of suitable areas had been made in ArcGIS module. As the result of the analyses, it had been determined that the south-east and south-west areas of the province of Konya were suitable or conditionally suitable areas for cultivation of ornamental plants. These areas will be assessed considering their proximity to market and the socio-economic features of the current producer potential, and establishment of ornamental plants cultivation facilities at the most suitable area will provide significant contributions for the province of Konya in economic, social and environmental aspects.

1. Introduction

Against the fact of urbanization developing along with the increase of world population, the green areas and city parks are being addressed as the most basic factors in preserving the natural and humanistic dimensions of world life (Esmaeeli and Latifi, 2009). In this context, improving the green areas is one of the significant factors of urban planning (Teymouri et al., 2010). Especially in large cities, the accessibility of population to nature is at limited level, and the need of people for such areas is increasing as the result of decrease of green areas in cities due to urban structuring (Sarvar et al., 2011). Green areas in cities are important in respect of enabling the accessibility of people to nature and visual attraction (Herzele and Wiedemann 2003). Moreover, the green areas have a significant share in decreased the environmental problems of the cities (Sarvar et al., 2011). The rate of green areas in the cities shall be increased in order to contribute to life quality in cities, health and happiness of people encountering the problems of metropolis (Hartig et al., 2003; Maller et al, 2009) and raising the children in a peaceful environment (Balram and Dragicevic, 2005). Along with the increase of demand for ornamental plants used to generate green areas in cities in the recent years, cultivation of ornamental plants had gained the dimension of an economic sector and had started to provide significant contribution to the country's economy.

Decorative plants produced with aesthetic, functional and economic purposes are being called ornamental plants (Ay, 2009). Ornamental plants are a general concept and are being examined in four sub groups as being cut flowers, indoor (vase-saloon) ornamental plants, outdoor ornamental plants, natural flower bulbs (geophytes) (Groot, 1998; Sayın and Sayın, 2004; Polat, 2011).

Turkey has various ecological areas and suitable for production of ornamental plants in respect of soil requirement. Cultivation of ornamental plants in commercial respect had started in 1940s in Turkey, and the production continues in about 20 provinces. Considering its contribution to economy, the development of ornamental plants sector in other provinces -which are

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suitable in ecological aspect- will provide significant contributions in respect of marketing and employment.

Table 1
Ornamental plants production areas in Turkey (decare)

	1999	2005	2006	2007	2008	2009
Cut Flowers	7957	13310	12 970,4	13 282,3	13 319,3	12126
Indoor Ornamental Plants	541,2	785,4	883	1 249,5	1 325,9	1135
Outdoor Ornamental Plants	5 642,9	11 809,7	15743	15 339,1	16 737,7	19680
Natural Flower Bulbs	270,04	471,5	570	651,8	750,7	649
TOTAL	14 411,5	26 376,6	30 166,6	30 522,7	32 133,6	33 590

Source: Karaguzel et. al, 2010.

Significant increase is being observed as per years in ornamental plants cultivation in Turkey (Table 1). The reason of this increase is its significant place in world markets in parallel to intense demand for ornamental plants. %59 of ornamental plants production area of Turkey had been allocated to outdoor ornamental plants, 36% of it had been allocated to cut flower cultivation, 3% to indoor ornamental plants and 2% to natural flower bulb cultivation (Table 2). It is being observed that the most area had been allocated to cultivation of outdoor ornamental plants providing most of the increase in years.

Table 2
Turkey export of ornamental plants (1000 $)

	2007	2008	2009	2010	2010 (%)
Cut Flowers	32 659	30 116	29 921	32 154	59,6
Indoor Ornamental Plants	7 385	9116	13 009	18 479	34,3
Outdoor Ornamental Plants	1 773	1 715	1775	1 488	2,7
Natural Flower Bulbs	2 918	3 012	2 541	1 810	3,4
TOTAL	44 735	43 959	47 246	53 931	100,0

Source: TSI, 2011.

Along with the increase of ornamental plants cultivation in commercial aspect in Turkey, an increase in export had also been ensured. The export of ornamental plants had been about 54 million $ by 2010, and most of the export had been obtained from cut flowers with a rate of 59%, and outdoor ornamental plants follow it with a rate of 34%. Considering the ecological and geographical position of Turkey, studies shall be made on the issue of providing more contribution to country's economy by increasing the amount of export through the increase of production areas of ornamental plants.

Table 3
The foreign trade balance of ornamental plants in Turkey (1000 $)

	2007	2008	2009	2010
Export	44 735	43 959	47 246	53 931
Import	44 788	49 426	30 348	39 728
Odd (+,-)	-53	-5 467	16 898	14 203

Source: TSI, 2011.

Significant increase is being obtained as per years in the foreign trade balance of Turkey in respect of ornamental plants (Table 3). The foreign trade balance shall be turned in favor of country's economy by enabling the increase facility export amount through extending the production at areas suitable to ornamental plants cultivation.

The first 3 provinces, where the ornamental plants are being cultivated the most in Turkey, are Izmir, Sakarya and Antalya respectively, and the production area in these provinces constitutes 60% of the total production area of ornamental plants (Table 4). Studies shall be performed for extending the production in other provinces which are suitable for ornamental plants cultivation. Thus, both the income level of producers –at micro level- and the country's economy –at macro level- will be positively affected from ornamental plants cultivation.

Table 4
Ornamental plants production by province (2009)

Provinces	Production Areas (da)	Rate (%)
İzmir	8.016	24
Sakarya	7.034	21
Antalya	5.058	15
Yalova	4.541	14
Bursa	3.220	10
Isparta	1.522	5
Kocaeli	946	3
Balıkesir	468	1
Samsun	425	1
Adana	422	1
Others	1.938	6
Total	33.590	100

Source: Republic of Turkey Ministry of Food, Agriculture and Livestock, 2012.

Agriculture is one of the most important activities of natural system use. This use must be done only in suitable areas for this economic activity. Additionally, suitable areas for agricultural use are determined by an evaluation of the climate, soil and relief environment components (Ceballos-Silva and Lopez-Blanco, 2003).

In cultivation of ornamental plants, the cultivation environment shall be carefully determined in order to obtain qualified product and in order to provide production at optimum level. Thus, the suitable areas where ornamental plants will be cultivated shall be determined considering various factors and performing required analyses. The best method which may be used in the determination of suitable areas is Geographical Information Systems. Location determination and data analysis features of GIS technology are being used for determination of current and potential production areas. GIS technology plays an important role in the analysis of information based on place and location. The most significant benefit of GIS is facilitation of collection and classification of information and opening it to sharing. GIS technology is extensively being used in the selection of locations having the highest potential of cultivating agricultural products (Basayigit and Senol, 2008; Unal et al. 2010), in determination of suitable lands for agricultural use (Akinci et al., 2013), in determination of existence of plants at urban areas (Kuter and Erdogan, 2010), and in current status analysis and location selection of green areas and parks within urban planning (Comber et al., 2008; Mohammedi and Parhizgar, 2009; Poggio and Vrscaj, 2009; Lotfi et al., 2011; Sarvar et al., 2011; Fazelniya et al., 2012; Brown et al., 2014).

In the study, the areas suitable for ornamental plants cultivation in order to open a new economic activity by developing the ornamental plants sector at Konya -being one of the significant centers of Turkey- had been determined by the Geographical Information Systems technique. The potential of lands for ornamental plants cultivation can be assessed in respect of climate, soil and topographical factors.

2. Materials and Methods

In the selection of areas suitable for ornamental plants cultivation in the province of Konya, 3 main layers as being climate, soil and topography, and the factors being provided in figure 1 being under these layers had been assessed. The maps required to analyze these factors in GIS environment had been obtained from relevant institutions, and the analyses had been performed by using the ArcGIS 9.2 module.

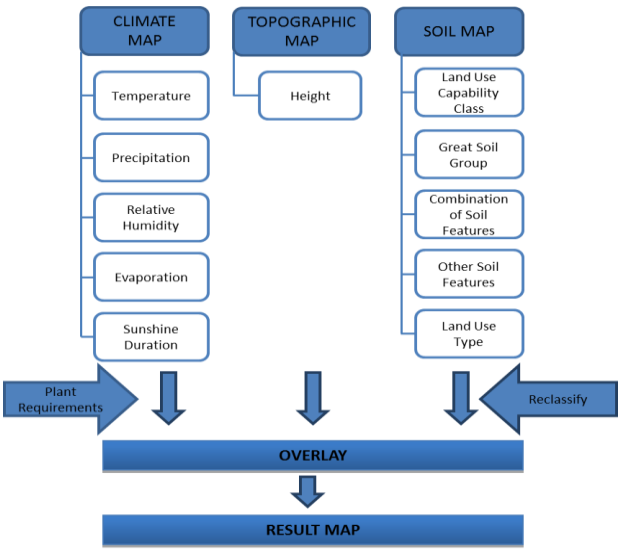


Figure 1
flow diagram in the determination of ornamental plants production

First the plant requirements had been determined in order to assess these factors. In the direction of ornamental plants requirements which may be cultivated at the province of Konya, bases had been composed for location selection by GIS technology and required analyses had been made. In the performance of these analyses at GIS, ArcInfo software and Spatial Analyst module had been used. All factors subjected to analysis had been converted to the format suitable for Grid Analysis and spatial analysis. The factors converted to Grid had been re-classified as being suitable areas, conditionally suitable areas and unsuitable areas as per the requirements of plants. Conditionally suitable areas are of a quality which can be converted to suitable areas through required improvement studies. And after this process, the most suitable areas for ornamental plants in the province of Konya had been determined in respect of the factors addressed through overlaying the data layers.

Scoring had been made as providing the highest score for criteria being suitable in re-classification of factors as per the requirements of plants. Moreover, the layers considered in the selection of areas had been weighted as per level of significance. The most significant factor in cultivation of ornamental plants is the climate layer, and the scores of the factors being at this layer had been multiplied by 1, the factors at the topographic layer –having second level of significance- had been multiplied by 0.8 and the factors at soil layer had been multiplied by 0.6 (Table 5).

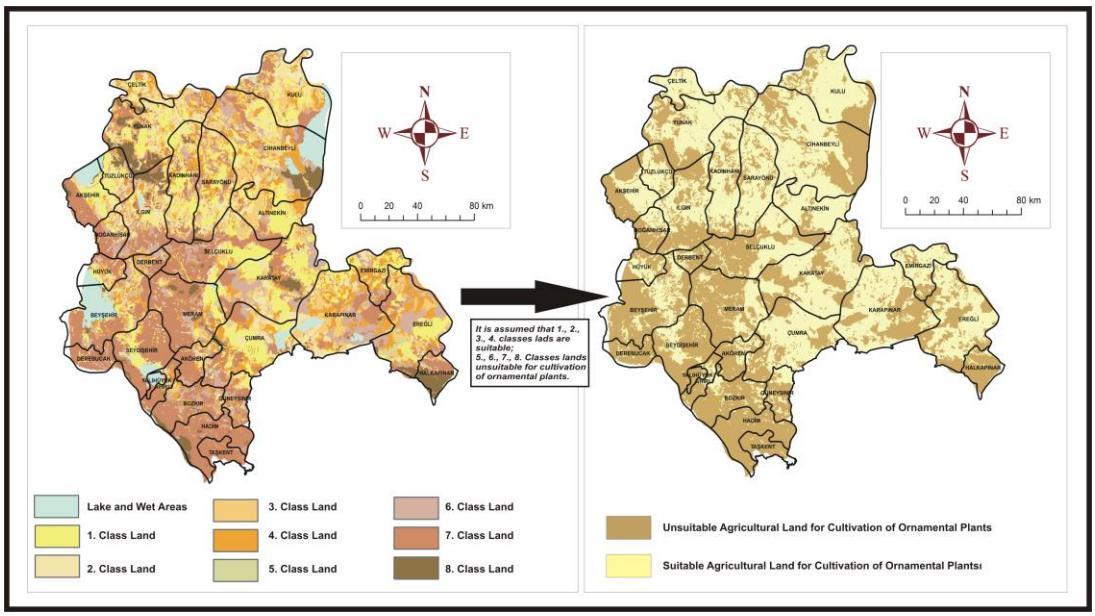
Table 5
Criteria for ornamental plants cultivation

	FACTORS	SUITABILITY	CRITERIAS	SCORE	WEIGHT
CLIMATE LAYER	Temperature	Suitable	13^0-15^0	10	1
		Conditionally Suitable	10^0-13^0	5	
		Unsuitable		1	
	Precipitation	Suitable	Min. 400 mm	10	1
		Conditionally Suitable		5	
		Unsuitable		1	
TOPOGRAPHIC LAYER	Height	Suitable	Below 1250 m	10	0.8
		Conditionally Suitable	1250-1500 m	5	
		Unsuitable	Above 1500 m	1	
SOIL LAYER	Land Use Capability Class	Suitable	I.,II.,III., IV.	10	0.6
		Conditionally Suitable		5	
		Unsuitable	V.,VI.,VII., VIII.	1	
	Great Soil Group	Suitable	Alluvial, Hydromorphic, Brown Forest, Non-calcerous Brown Forest, Reddish Mediterranean, Organic Soils	10	0.6
		Conditionally Suitable	Reddish brown, Brown	5	
		Unsuitable	Other Groups	1	
	Combination of Soil Features	Suitable	%0-6 Slope 50-+cm Depth	10	0.6
		Conditionally Suitable	%6-12 Slope 50-+cm Depth	5	
		Unsuitable	%12+ Slope 0-50 cm Depth	1	
	Other Soil Features	Suitable	Slightly salty	10	0.6
		Conditionally Suitable	Stony, Poor drainage	5	
		Unsuitable	Salty- Alkali	1	
	Current Land Use Type	Suitable	Irrigated Land, Dry Land, Orchard, Garden	10	0.6
		Conditionally Suitable	Abandoned land	5	
		Unsuitable	Others	1	

The values of relative humidity, evaporation and sunshine duration factors being within the climate layer and being valid for the province of Konya had been taken as fixed factors due to being suitable in the cultivation of ornamental plants. While having the annual average temperature in between 13^0-20^0 is suitable, the temperatures outside this range are not being deemed suitable. For suitable areas, the annual average precipitation is required to be at least 400mm and the height is required to be below 1.250m. In respect of land use capability class, revealing the suitability of soil for agricultural production and revealing the opportunities of utilization beyond agriculture, the lands of I., II., III. and IV. class had been determined as lands suitable for cultivation of ornamental plants. Alluvial, hydromorphic, brown forest, non-calcareous forest, reddish Mediterranean, organic soils are soils suitable for cultivation of ornamental plants. The cultivation environment of ornamental plants shall have a slope of at most 6% and shall be deep and mid deep (deeper than 50 cm). Moreover, the soil shall not be salty, alkali and shall not have bad drainage.

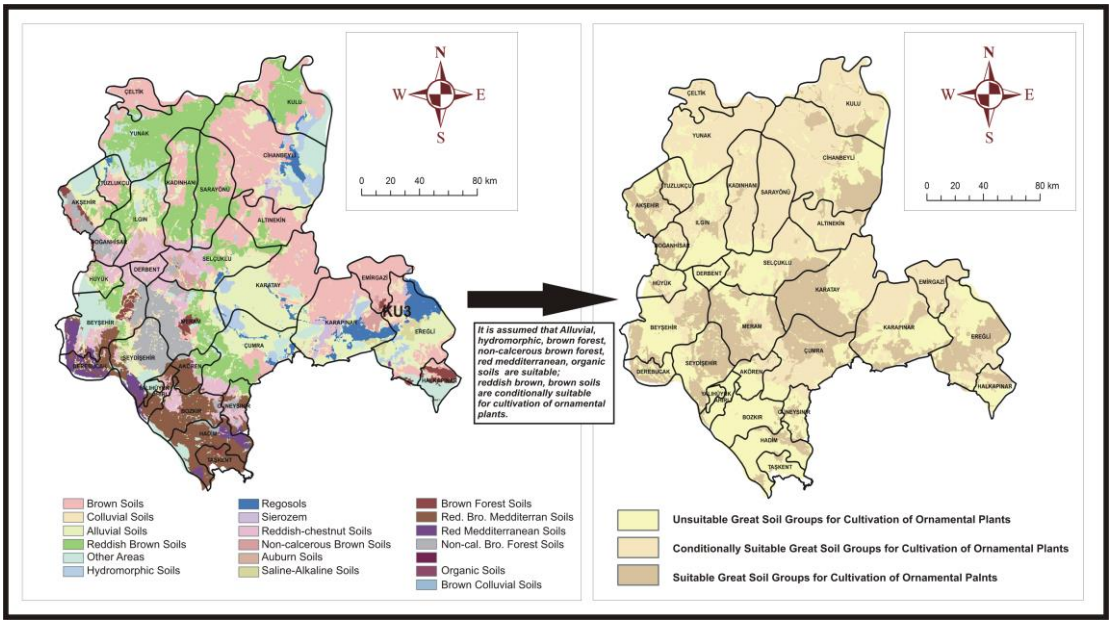
3. Results and Discussion

Province of Konya has the potential of realizing ornamental plants cultivation in economical aspect due to its ecologic and geographic position. In order for it to have a place in national and international markets and to provide significant contribution to country's economy, the most suitable cultivation areas for ornamental plants within the borders of Konya in economical and ecological aspect had been analyzed through the assistance of GIS. Maps had been provided for each of the factors included in analysis as per both factor features and re-classification features.



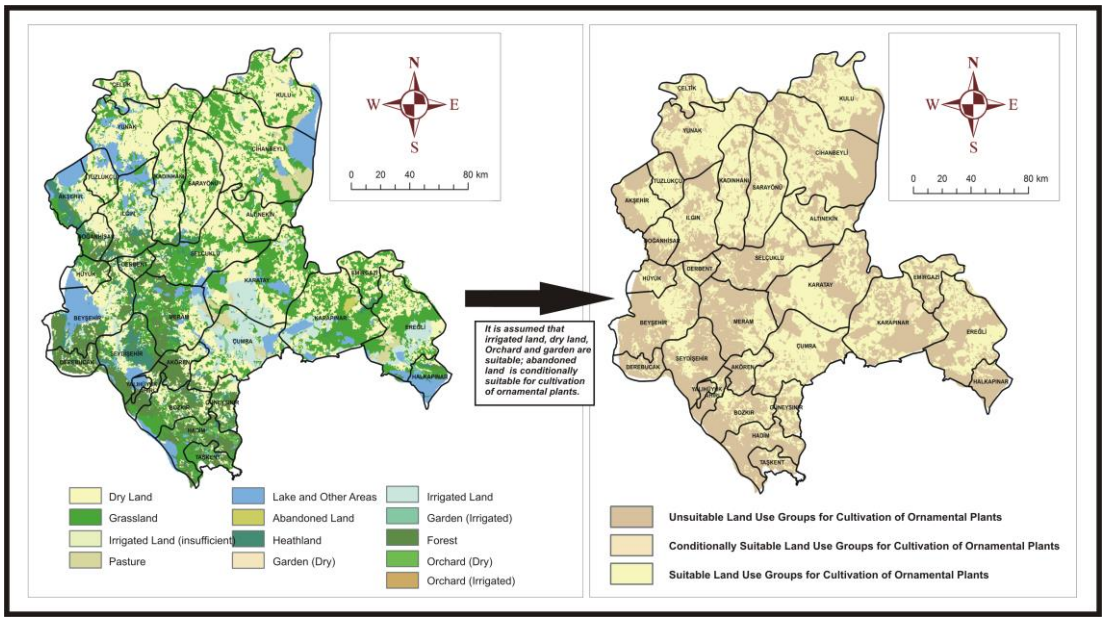
Map 1
Agricultural land map for cultivation of ornamental plants

I., II., III. and IV. classes of agricultural soils - which are allocated to eight classes as per soil ability- had been deemed as suitable for production of ornamental plants due to their features such as ease of cultivation, less slope, well drainage ability. The soil ability classes map, as per suitability for cultivation of ornamental plants, had been re-classified and made ready for analysis (Map 1).



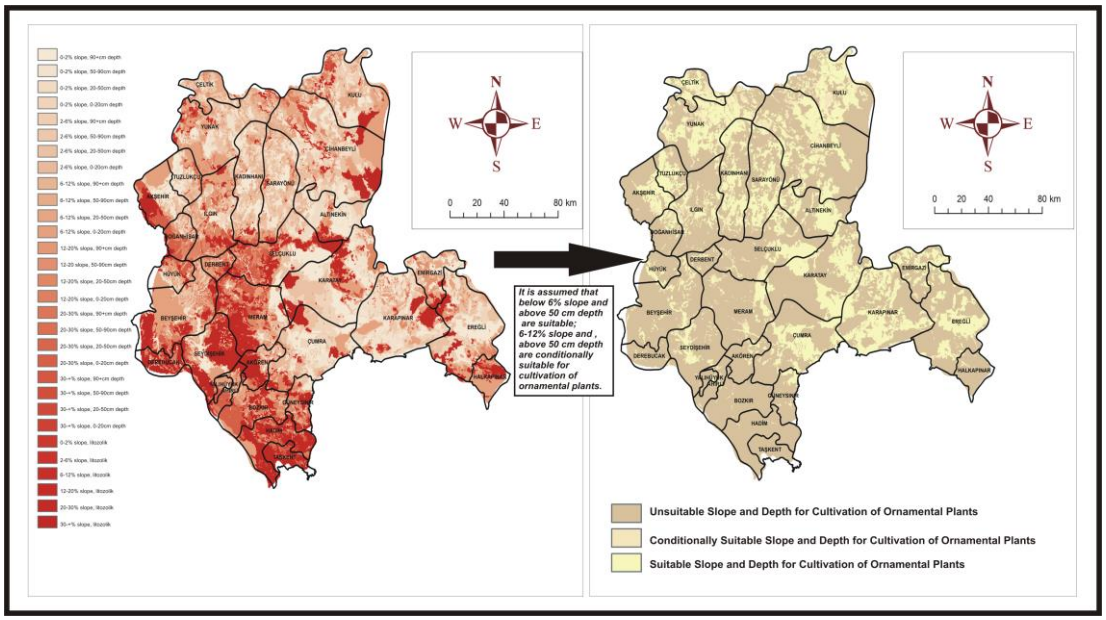
Map 2
Great soil group map for cultivation of ornamental plants

The great soil groups map had been re-classified as per suitability for cultivation of ornamental plants and had been made ready for analysis (Map 2). It had been determined that great soil groups being suitable for ornamental plants were available at Cumra-Karatay, Seydisehir-Beysehir lines and Eregli county of the province of Konya.



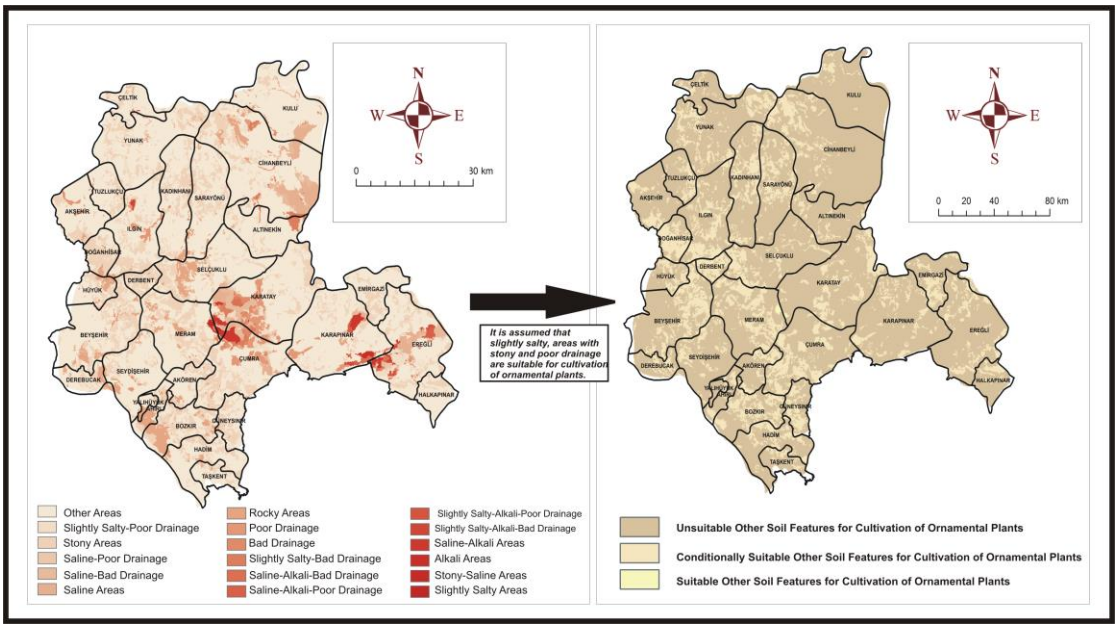
Map 3
Land use groups map for cultivation of ornamental plants

Irrigated agricultural lands, dry agricultural lands, orchard and garden areas had been deemed as suitable areas for cultivation of ornamental plants as per land utilization status. The land utilization status map had been re-classified as per suitable areas for cultivation of ornamental plants and had been made ready for analysis (Map 3).



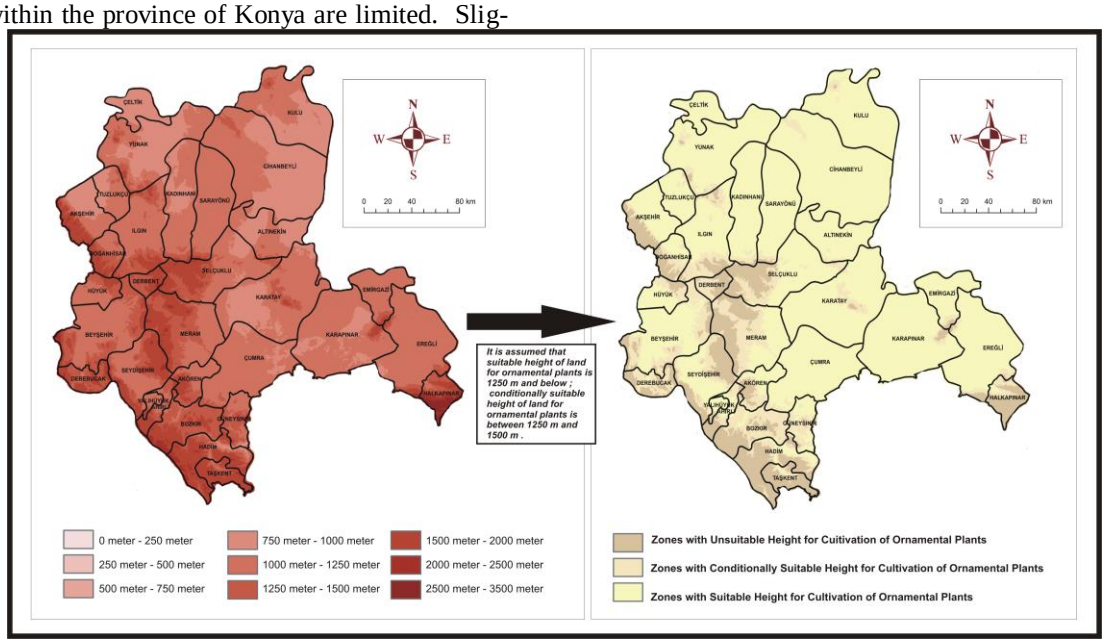
Map 4
Slope and depth map for cultivation of ornamental plants

The areas with a slope of at less than 6% and with a depth of more than 50cm (deep, mid deep) had been deemed as suitable for cultivation of ornamental plants. The slope-depth combination map of the Konya province had been re-classified considering the areas suitable for cultivation of ornamental plants and had been made ready for analysis (Map 4).



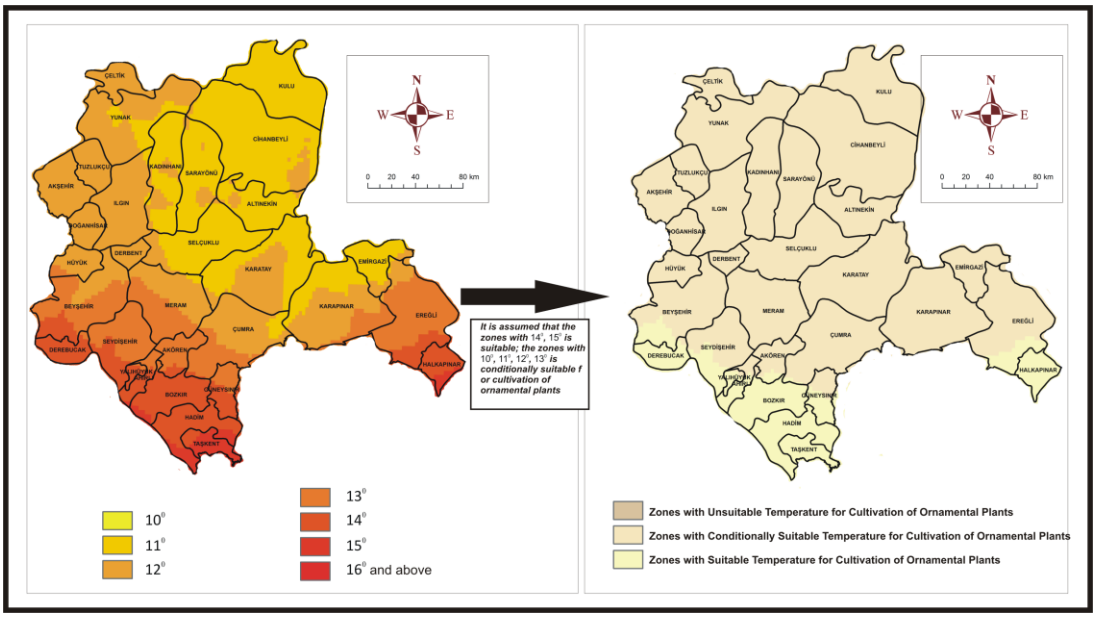
Map 5
Other soil features map for cultivation of ornamental plants

The soil at the province of Konya generally has high pH (pH: 7.5-8.5), high lime (> 15%) and insufficient drainage. When it is assessed only in respect of criteria of saltiness and drainage, it is being observed in map 5 that areas suitable for cultivation of ornamental plants within the province of Konya are limited. Slightly salty, stony and well drained areas had been deemed as areas suitable for cultivation of ornamental plants, and other soil features map had been re-classified as per suitability and had been made ready for analysis (Map 5).



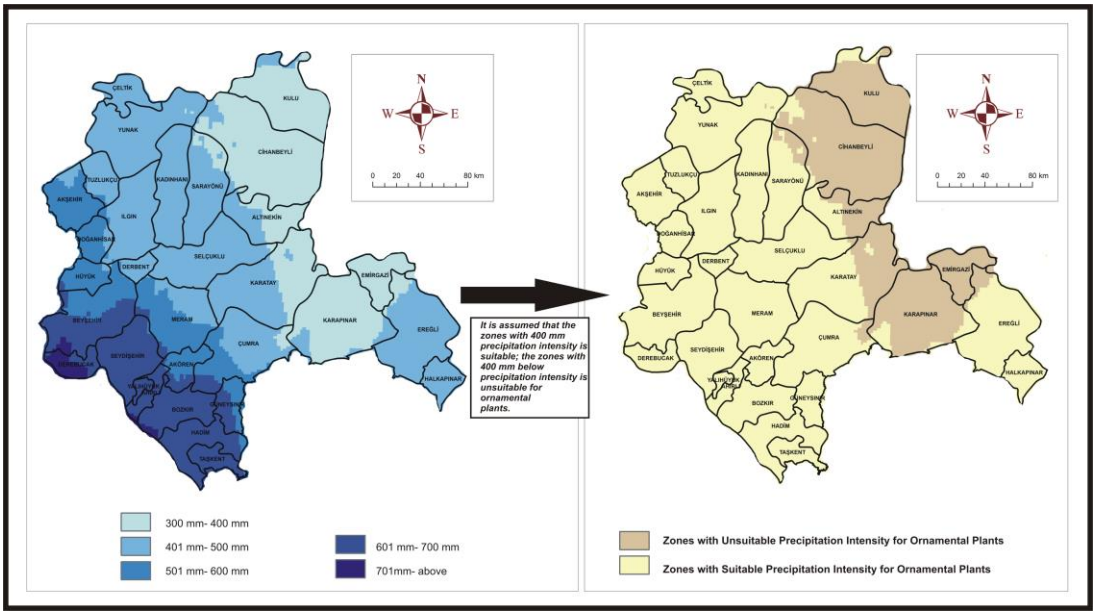
Map 6
Height map for cultivation of ornamental plants

The height of land shall be below 1.250 m for cultivation of ornamental plants. The land height within the province of Konya is in between 0-3500 m, and the height map had been re-classified as per suitability for cultivation of ornamental plants and had been made ready for analysis (Map 6).



Map 7
Temperature map for cultivation of ornamental plants

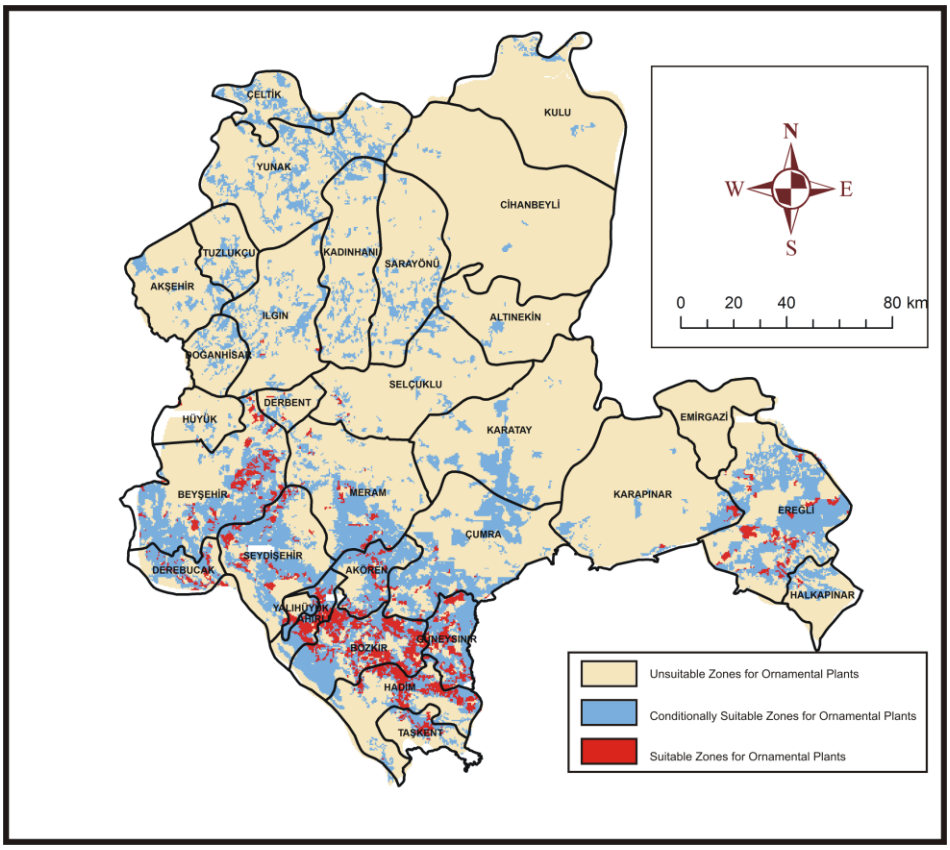
The most significant factors for cultivation of ornamental plants are climate features. The annual average temperature is in the range of 10^0-16^0 within the province of Konya. The annual average temperature requirement of ornamental plants is 14^0-15^0, and the temperature map had been re-classified as per suitability of temperature and had been made ready for analysis (Map 7).



Map 8
Precipitation map for cultivation of ornamental plants

Annual average precipitation amount of the province of Konya is in between 300-800 mm. Precipitation of over 400 mm is being required for cultivation of ornamental plants, areas other than the east of Konya province are suitable areas for cultivation of ornamental plants as per precipitation criterion (Map 8).

The result map indicating the areas suitable for cultivation of ornamental plants within the province of Konya had been constituted by using the layers constituted after conversion of all factors as per cultivation conditions of ornamental plants and by using the ArcInfo software, Spatial Analyst module and Overlay analysis.



Map 9
Suitable zones map for cultivation of ornamental plants

As per the obtained results, the area in between Ahırlı-Bozkır-Hadim-Taşkent-Güneysınır (S1), east of Beysehir Lake (S2), North-East and South-West Axis of Eregli (S3) had been determined as areas suitable for cultivation of ornamental plants within the province of Konya. And the conditionally suitable areas had been determined as the area in between south-west of Derbent and province border of Antalya (CS1), area in between the borders of Çumra-Karatay (CS2), Eregli and its surrounding (CS3), east-west axis of Sarayönü-Kadınhanı-Ilgın-Akşehir (CS4), Yunak and its surrounding, and Cihanbeyli İnsuyu area (Map 9). The general features of suitable and conditionally suitable areas have been provided in Table 6 and Table 7.

For the determination of the most suitable area within the suitable areas, the criteria such as marketing opportunities, transportation opportunities, determination of area of suitable size for the establishment of required facilities as well as cultivation areas, adoption level of a new production area by the producers and determination of areas requiring alternative product cultivation shall be considered.

Table 6
Suitable areas features for cultivation of ornamental plants

	Suitable Area 1 (S1)	Suitable Area 2 (S2)	Suitable Area 3 (S3)
The Region's Location	The area in between Ahırlı-Bozkır-Hadim-Taşkent-Güneysınır	East of Lake Beyşehir	Ereğli North-East and South-West Axis
Temperature	15^0	14^0	14^0
Precipitation	601mm-700mm	601mm-700mm	401mm-500mm
Height	1250m-1500m	750m-1000m	750m-1000m
Land Capability Class	7. class	1. and 7. class	1., 2., 3. class
Great Land Group	Reddish Brown Mediterranean Soils, Reddish Mediterranean Soils, Non-calcerous Brown Forest	Reddish Brown Soils, Reddish Brown Mediterranean Soils, Colluvial Soils	Alluvial Soils, Brown Soils
Combination of Soil Features	Slope %2-6 Depth 50-20 cm, Slope %12-20 Depth 50-20 cm, Slope %20- Depth 20-0 cm, Slope %20-30 Depth litozolik	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm	Slope %0-2 Depth 90-+ cm, Slope 0-2 Depth 20-0 cm, Slope 2-6 Depth 50-20 cm
Other Soil Features	Stony, Slightly salty, Poor drainage	Stony	Saline, Saline-alkali, Poor drainage, Bad drainage
Current Land Use Type	Forest, Dry Orchard, Dry Land	Dry Land, Forest	Irrigated Land, Grassland

Table 7
Conditionally Suitable Areas Features for Cultivation of Ornamental Plants

	Conditionally Suitable Area 1 (CS1)	Conditionally Suitable Area 2 (CS2)	Conditionally Suitable Area 3 (CS)	Conditionally Suitable Area 4 (CS4)	Conditionally Suitable Area 5 (CS5)
The Region's Location	The area in Meram-Çumra-Derbent South-West and the border of Antalya Province	Çumra and its surrounding	Ereğli and its surrounding	Sarayönü-Kadınhanı-Ilgın-Akşehir East-West Axis	Yunak and its surrounding, Cihanbeyli İnsuyu Area
Temperature	14^0 ve 15^0	11^0 ve 12^0	14^0 ve 15^0	11^0 ve 12^0	11^0 ve 12^0
Precipitation	501mm-600mm	401mm-500mm	401mm-500mm	401mm	500mm
Height	750m-1000m ve 2000m-2500m	750m-1000m	750m-1000m ve 1500m-2000m	1000m-1250m	1000m-1250m
Land Capability Class	6. and 7. class	1., 2., 3., and 4. class	3., 4. and 6. class	1., 2., 3., and 4. class	1., 2., 3., and 4. class
Great Land Group	Reddish-Chestnut Soils, Non-calcerous Brown Forest, Brown Forest Soils, Red Mediterranean Soils	Alluvial Soils, Reddish Brown Mediterranean Soils	Regosols, Brown Soils, Saline-Alkali and Saline-Alkali Mixed Soils, Brown Forest Soils	Brown Soils, Reddish Brown Soils	Brown Soils, Reddish Brown Soils
Combination of Soil Features	Slope %12-20 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm, Slope %20-30 Depth 20-0 cm, Slope %20-30 Depth litozolik	Slope %0-2 Depth 90-+ cm, Slope %2-6 Depth 50-20 cm	Slope %0-2 Depth 90-+ cm, Slope %0-2 Depth 90-50 cm, Slope %6-12 Depth 50-20 cm	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth k 90-50 cm, %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth 90-50 cm, %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm
Other Soil Features	Rocky, Slightly salty, Poor drainage	Saline bad drainage, Slightly salty -bad drainage, Saline-alkali	Slightly salty- Poor drainage, Stony	Slightly salty- Poor drainage, Stony, saline-Poor drainage	Slightly salty- Poor drainage, Stony, saline- Poor drainage
Current Land Use Type	Grassland, Forest, Heathland, Dry Land	Irrigated Land	Dry Land	Grassland, Dry Land, Irrigated Land	Grassland, Dry Land, Irrigated Land

4. Conclusions

In the globalizing world, the urbanization and environment comprehension and social requirements which change each passing day increase the demand for ornamental plants. Moreover, the approach of local authorities to take notice of environmental planning, the requirement of people to live in nature as moving away from the city life, rural areas close to the cities, increase of lodgings with gardens within the borders of villages and in metropolis had significantly increased the demand for outdoor ornamental plants being the basic argument of environmental green area planning at cities and at new living areas. The ornamental plants being a significant market product also indicates that they can be assessed in economical aspect. Thus cultivation of ornamental plants provides significant contribution in different aspects as per regions.

As specific ecological conditions are required for cultivation of ornamental plants, GIS technology had been used in the study in the determination of locations suitable to such conditions. As benefiting from the location determination and data analysis features of GIS technology, climate, topographic and soil features –being effective in cultivation of ornamental plants- had been included in the analysis, and suitable and conditionally suitable areas within the province of Konya had been determined. It had been determined as the result of analyses that the south-east and south-west areas of the province of Konya were suitable areas for the cultivation of ornamental plants. Moreover, the junction position of the province of Konya among metropolis at west and east regions provides a significant status in respect of proximity to market.

By performing analysis with GIS technique, it is being contributed to both enabling saving in respect of cost and time in feasibility studies and performance of more qualified and profitable production. Putting into practice the results obtained from this study will provide many contributions to the province of Konya –being the area of research- in economical, environmental and social aspect.

5. Acknowledgement

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Research Article

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Agronomic Characteristics of Domestic and Abroad Originated Bean (*Phaseolus vulgaris* L.) Genotypes

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ABSRACT

Present research was realized during 2017 vegetation period according to Augmented Trial Design under Konya - Tukey ecological conditions. Yield and some agricultural characteristics of totally 100 promising bean genotypes were determined for the purposes of using on selection and hybridization breeding programs. Results of the research were ranged as following; 3.23-57.28 g for seed yield, 8.28-61.94 g for 100 seed weight 5.28-218.61 cm for plant height, 1.16-4.16 for number of main branches per plant, 2.28-60.94 for number of pods per plant, 0.82-6.16 for number of seeds per pod and 95.94-137.27 days for vegetation length. A total of 20 bean genotypes which were used as material in the study were determined as promising for the seed yield and some agricultural characteristics which may be used as genetic source for the future breeding works.

1. Introduction

Genetic diversity of the plants is quite important for many purposes in agricultural production and achievement of nutritional quality that are serving on genetic studies and biotechnology, quality focused studies etc. agronomical and breeding works (Önder and Kahraman, 2008; Ceyhan and Kahraman, 2013; Joshi, 2015; Kahraman and Onder, 2018). There are many genotypes of the dry beans (*Phaseolus vulgaris* L.) over the world that is including the local ecotypes as well which are presenting quite different statues by view of shape, morphology, chemical composition, nutritional statues, genetic structure and diversity, adaptation statues especially for sowing time, phonological characteristics, morphological statues, cultivation necessaries (Ceyhan et al, 2012; 2014; Onder et al., 2013; Yadav et al., 2015; Harmankaya et al., 2016; Kahraman, 2017). It is well known that, dry bean – as a legume crop, is essential for human due to be an important protein source, vitamin, fiber, diet food, cheap price, easy cultivation and adaptation besides take a wide part in the markets over the world in addition to act on sustainability of healthy food production, improvement of soil characteristics and a well alternative for crop rotation programs etc. main concept of sustainable agriculture (Kahraman et al., 2015; Kosev and Naydenova, 2015; Kahraman, 2016; Öktem, 2016).

In Turkey, in the field of cultivation and production, after the chickpea and lentil in the edible legumes, the third place is beans. Dry beans is a legume plant known in our country for many years, cultivated and used in human nutrition, animal nutrition and soil improvement. In our country, dry bean cultivation areas have increased in general until 2002. Bean planting areas, which reached the highest level with 180,000 ha in 2002, have decreased gradually in the following years. The Dry bean production in our country was 84.763 ha area and have an average production capacity of 266/kg/da and 239.000 tons in 2017. (Anonymous, 2017). In Konya, where the most dry bean production was made, the cultivation area was 19.143 ha, the production was 70.242 tons and the average yield was 366.91 kg / da. In our country, until 1987, dry beans were not imported. Although 87.940 tons of dry

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beans were exported in 1997, Turkey has become an importer in recent years (Anonymous, 2012).

Nearly half of the total edible legumes cultivation area in the world belongs to dried beans (Anonymous, 2012). In general, 5 of the 50 Phaseolus species (*Phaseolus vulgaris, Phaseolus lunatus, Phaseolus coccineus, Phaseolus acutifolius and Phaseolus polianthus*) are cultivated for human consumption. In this species, *Phaseolus vulgaris* species is reported to cover 75% of the world's cultivated beans and is the most cultivated species (Singh, 1999; Broughton et al., 2003).

Dry bean cultivation is widespread in the temperate regions of the world and is carried out in Asia and South America continents, mostly in developing countries with a high rate of 94%. In the world in 2012, the total cultivation area of dried beans was 28.780.376 ha and the total production was 23.140.276 tons and the average yield was 80.40 kg / ha. Looking at the production of beans by country, Myanmar (5.190.000 tons), India (3.898.000 tons) and Brazil (2.616.000 tons); in terms of cultivation area, India (9.100.000 ha), Myanmar (2.845.662 ha) and Brazil (2.726.932 ha) respectively (Anonymous, 2016). When the data of FAO until 2012 are examined; in the last 5 years, there has been no significant decrease in dry bean cultivation areas around the world. (Dried bean plantation area in the world in 2011 was 30.411.203 ha, this value decreased to 28.780.376 ha in 2012 only) And the world's most cultivated field and production of edible grain legume plant has been again dry beans.

Present research is realized to determine some agronomic characteristics of the dry bean genotypes which are originated from domestic and abroad sources under Konya – Turkey ecology that is an important producer over the country for the aim of scanning the significant characteristics for future breeding programs.

2. Materials and Methods

This research was carried out in a farmer field in Konya Province, Çumra District and İçeri Çumra Province in 2017. In the research, 100 bean genotypes (*Phaseolus vulgaris L.*) and 3 standard varieties (*Alberto, Kantar, Elkoca*) obtained from Selcuk University Faculty of Agriculture Department of Field Crops were used as materials. (Table 1)

Table 1
Local names and numbers of bean genotypes used in research

No	Local Name	No	Local Name	No	Local Name	No	Local Name
1	Bonvert	26	O-683	51	Bayo	76	Canario
2	Cuarenteno	27	Negro	52	Brown	77	Pinto Mestizo
3	G47	28	Chase	53	Coulee	78	Ac Argonaut
4	Rice	29	California LRK	54	Colorado de Comitan	79	Fiero
5	Idaho Brown	30	White Seeded Tendergreen	55	Callacatlan Frijol	80	Red-white
6	Ayufracho	31	Green Isle	56	Burros Argentinos	81	Ac Black Diamond
7	Golden Shower	32	Mammoth Stringless	57	Early Rose	82	G62
8	Alubia Cerrillos	33	Lapin	58	Golden Early	83	Bonanza
9	G18706	34	Great Northern 1140	59	Berrenclo	84	Q-719
10	Roger Stringless green refugee	35	Jalo EEP558	60	Talete	85	Radical San Gil
11	Norida	36	Blue Victor	61	Pole bean	86	Cameleon
12	Cuarenteno	37	Yamal	62	Redswan	87	Amadeus 77
13	Frijol Tinequito	38	Dresden	63	Richgreen	88	Mecosta
14	Louisiana	39	Montequilla	64	Dwarf	89	Ac Scarlet
15	Bayo	40	G1924	65	Hungarian	90	Salem
16	Pinto Bayacora	41	Dwarf Green Round Pod	66	Swedish Brown	91	Round Pod Kidney Wax
17	Montequilla	42	San Juan	67	Drought Resistant	92	Arikara Yellow
18	Toramane	43	G31	68	Mortino	93	Black Turtle Soup
19	Blue Danube	44	Bush Bean	69	Acotlanero Negro	94	G V 50
20	Chile	45	Polaris	70	G2453	95	Lakette
21	Holberg	46	Monument	71	Blush	96	Brown Dwarf
22	Emerson	47	İmperial Pea Bean	72	Golden	97	Frijol Aluvia
23	Genetic Marker 17	48	Frijol Tinequito	73	Oregon Brown Greasy	98	No.1072
24	Norwegian Brown	49	Colombia	74	Claret	99	Delgado
25	Horticultural	50	Talete	75	Bigbend	100	Niagara 773

Some physical and chemical properties were determined as a result of the analysis of the experimental area soil. The soil of the trial area has a slightly alkaline structure and pH is 7.86 and the ratio of organic

matter is 0.91%. Available Phosphorus content is 13.66 kg / ha, Available Potassium ratio is 190.55 kg / da and the micro element ratios are sufficient (Table 2).

Table 2
Important Soil Properties of the Trial Field

Analysis Name	Unit	Results
Structure	%	55
Salinty	%	0,02
pH		7.86
E.C.		489
Organic Matter	%	0.91
Lime	%	9.47
Availabe Phosphorus ($P_2O_{5)}$	Kg/da	13.66
Availabe Potassium(K_2O)	Kg/da	190.55
Calcium	Ppm	5629
Magnesium	Ppm	741
Iron	Ppm	2.55
Copper	ppm	0.60

The average temperature demand of beans during the developments and flovering period is 20-25 ^{0}C (Şehirali 1979). In 2017, the average temperature was suitable for bean cultivation.(Table 3).

Table 3
Climate Data In Çumra District Of Konya Province Of Vegetation Period

Montths	Monthly Average Temperature (^{0}C)		Monthly Total Rainfall (mm)	
	Long Term (30 Years)	2017	Long Term (30 Years)	2017
April	11,3	11,4	36,6	60,4
May	15,7	15,8	35,5	58,6
June	19,8	20,3	19,8	14,0
July	22,9	24,5	6,9	0,0
August	22,6	23,4	4,5	2,2
September	18,4	21,2	11,2	0,0
Total			110,4	135,2
Average	16,11	19,43		

Due to the fact that all of the bean genotypes used as materials in the research were obtained from the gene banks and the amount of seed was low and a large number of genotypes were used in the experiment. This research was established according to the Augmented Trial Pattern. In accordance with the characteristics of the Augmented Trial Pattern, in this experiment, which was planned as 6 replicates, the standard varieties were repeated in each block while the genotypes were randomly distributed to the blocks. Each of the genotypes was planted in 1 row of 1 m. Standard varieties were planted in 4 rows of 1 m. Hand plantings were made between 45 cm in row, 10 cm over row and 60 cm between the blocks On the 1st of May 2017. In the 30 kg DAP formulation (18.46.0), the base fertilizer was applied before the planting. In the trial, totally 6 sprinkler irrigation were applied in the season. In the trial weed control was carried out twice by grubbing.

Hand harvesting and blending were performed on different days in the period when the beans of a large part of each genotype and standard type were yellowed and grains were matured. All the observations were realized according to the UPOV statues. These cultivars and varieties cultivated in the Central Anatolia climate yield, 100 grain weight, plant height, number of branches, number of vetches, number of vetches per plant, vegetation time, such as observations and measurements were made. The statistical analyzes were performed according to "Augmented Design" on these results to determine the performance of some genotypes and some agricultural properties by "JUMP" computer based statistical analysis program.

3. Results and Discussion

When the genotypes were evaluated for grain yield, the highest grain yield was obtained from the genotype 2 with 57.28 g / plant. This was followed by the genotypes 56 (51.9 g / plant) and 75 (50.34 g / plant) in descending order. According to the adaptation to the ecological conditions of Konya, there were genotypes that did not yield, and there were also genotypes giving about 60 g / plant yield. As a matter of fact, Önder et al. (2013) stated that 41 bean genotype yields varied between 114 and 355 kg / da. Ülker and Ceyhan (2008) stated that 19 bean genotype yields varied between 162.92-476.85 kg/da. Önder and Özkaynak (1994) stated that 10 bean genotype yields varied between 264.23-358.47 kg/da. When these results are considered, lines 2, 56 and 75 can be used as genetic source in studies to be made for bean improvement. Variance analysis results of the standard varieties used were given (Table 4).

It was determined that there were positive-significant relationships between seed yield and seed weight in shortie beans. It was determined that the facial weight values showed a wide variation. And this value has ranged from 13.42 to 80.6 g in various studies. (Çiftçi and Şehirali, 1984; Bozoglu and Sozen, 2007; Kahraman & Önder, 2009; Gunes, 2011; Basciftci, 2012; Isik, 2012). Amont the Genotypes number18 genotype (61.94 g / plant), genotype 8 (47.94 g / plant) and number 72 genotype (72.61 g / plant) are the most prominent genotypes.

Table 4
Analysis of variance of the properties examined in the research

Source of variation	DF	Seed yield	One hundred seed weight	Plant height	First pod height	Vegetation length
Standard	3	**	**	**	*	*

*: p<0.05; **: p < 0.01

Among the genotypes used in the study, the plant height was found between 5.28 and 218.61 cm. Similarly to our study results, it has been found that this value changes in a wide range of 1770-310 cm in various studies in which the plant height is determined in beans. (Şehirali, 1965; Akçin, 1971; Çiftçi and Şehirali, 1984; Önder and Özkaynak, 1994; Anlarsal et al., 2000; Kaçar et al., 2004; Karadavut et al., 2005; Pekşen, 2005; Bozoğlu and Sözen, 2007; Ülker and Ceyhan, 2008; Kahraman & Önder, 2009; Güneş, 2011).

Table 5
Standard types and genotypes according to the characteristics discussed in the minimum-highest values and lsd values.

Characteristics	Seed Yield (g plant^{-1})	One Hundred Seed Weight (g)	Plant Height (cm)	Vegetation of Length (days)	First Pod Height
Min.	1.9	8.28	5.28	95.94	6.78
Max.	57.28	61.94	218.61	138.27	24.45
Alberto	45.02 a	33.83 b	101.66 a	109.66 b	16.17 a
Elkoca	23.665 b	39.83 a	69.16 b	115.66 a	12.34 b
Kantar	49.83a	40.16 a	75 b	109.5 b	12.83 b
LSD (0.05)	9.043	1.887	18.247	4.527	2.985

The number of branches in the plants used in the study was found to be 1.16-4.16 / plant range. Singh et al. (1976) stated that the number of major branch in the plant was an important factor affecting grain yield in dry beans.

The number of vetch in the plant has a significant effect on yield. In genotype analysis, genotype 97 was the genotype with the highest vetch number with 60.94 units / plant. In descending order, genotype 21 followed 53.94 pieces / plant and 80 genotypes with 43.28 pieces / plant. In previous studies, it was determined that beans had a wide variation in terms of vetch number and this value could be in the range of 1-163 pieces / plant. (Önder and Sade, 1996, Düzdemir, 1998; Bozoğlu and Gülümser, 2000; Kaçar et al. 2004; Bozoğlu and Sözen, 2007; Kahraman & Önder, 2009; Önder et al., 2013)

In the study, the number of grain in the bean was determined as 0.82-6.16 pieces/vetch. The number of vetch grains in the dry bean plant is an important yield component (Adams, 1967). In the studies on the subject, the number of vetch beans in beans was found to be 1.6-6.3. (Çiftçi & Şehirali, 1984), 1-9 (Anlarsal et al., 2000), 3-7 (Kahraman & Önder, 2009) and 3.0-5.8 pieces /vetch (Önder et al., 2013). The results of our thesis are similar with previous studies.

The highest initial vetch height was obtained from Alberto variety with 16.17 cm height as the average of blocks. This was followed by Elkoca and 12.34 cm Kantar with 12.83 cm in descending order. Of the genotypes used in the trial, the lowest genotype was number 58 (6.78 cm) measured and the highest genotype was number 97 (25.45 cm).

There was no significant difference in flowering time between genotypes used in the study. The number 89 genotype (37.94 days), the shortest flowering period of genotypes, and the longest flowering time number 26 genotype (60.94 days) were measured.

The time to flowering in dry beans has been found to have a significant effect on yield (Singh and Malhotra, 1970). And according to the results of the research (Anlarsal et al., 2000; Karadavut et al., 2005; Pekşen, 2005; Ülker and Ceyhan, 2008; Kahraman & Önder, 2009a; Güneş, 2011), the time to flowering in dry beans varies according to the ecological factors and genotypes and has been found to vary between 36-72 days. Mendes et al. (2008) stated that crossbreeding in dry beans can reduce flowering time from 33.2 to 25.0 days.

The vegetation period was determined as 95.94-138.27 days. Gillard et al (2012) in their report on the study of dry beans for 4 years Although the harvest time is commonly referred to as 90% of the pods in the period of maturation, they stated that this situation is difficult in field conditions, and that if harvest time is not determined correctly, significant decreases in yield and quality may occur.

4. Conclusion and Suggestions

This study was carried out in 2017 together with Kantar, Alberto and Elkoca varieties of 100 different dry and fresh bean lines provided by Prof Dr. Mustafa Önder with the introduction method from different countries and regions under the conditions of farmers in the İçeriçumra neighborhood of Çumra district of Konya Province. Results of the study is summarized in the following lines.

Test results showed highest yield in terms of grain yield per plant of 49.83 g / plant was obtained from the

Kantar variety. The yields of the genotypes 2, 25, 34, 39, 55, 56, 69, 75, 89 and 94 used were close to or high. Similarly, 8 genotypes (8, 18, 29, 51, 71, 77, 79, 86) were found in the coarse grains, which weighed 40.16 g in one hundred grains.

In light of these results genotypes used in this experiment can be used, in the field of cultivation development, which is better in terms of grain yield and important agricultural characteristics used in the experiment.

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