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Effects of Different Frequencies and Potassium Doses on Yield and Yield Components in Seed Sunflower

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ABSTRACT

Field trials of the present study was realized in 3 isolation areas (3 different regions) as EK1102 variety in Eşrefli location, VE3060 variety in Aşağıpiribeyli location and PS4042 variety in Doğanyurt location - TURKEY according to split plot in randomized complete block design with 3 replications. The main plots consisted from the plant density for the line control (PS4042: 6200 plant da^{-1}, VE3060: 5700 plant da^{-1}, EK1102: 6500 plant da^{-1}, 5000 plant da^{-1}, 6000 plant da^{-1}, 7000 plant da^{-1}) and 4 potassium doses (0, 3, 5, 7 kg/da K_2SO_4) applicated According to results the following ranges were detected; 109.67-307.00 kg da^{-1} for grain yield, 9.33-12.33 for days emergence period, 68.00-77.67 for days flowering period, 76.00-168.00 cm for plant height, 17.00-27.00 cm for diameter of the head, 7.33-8.72 gr for weight of one hundred grains, 4.17-7.15 mm for seed diameter, 11090.88-14519.33 pieces for kernel kg^{-1}. Consequently, results of the present research showed that, the lowest value was 11090 kernels kg^{-1}, PS4042 variety with 7 kg da^{-1} potassium dose application and 7000 plant da^{-1} sowing density while the highest value was 14519 kernel kg^{-1} and VE3060 variety with 5 kg da^{-1} potassium dose application and 5000 plant da^{-1} sowing density. It can be concluded that deep and various factors are needed to focus for more reliable data collection and adaptation to different ecologies.

1. Introduction

Fats are one of the basic foodstuffs that have vital value for our body and have an important place in our diet. Fats are as essential to our life as proteins and carbohydrates. Vegetable oils have a special importance in terms of their benefits for human health and their high nutritional value, especially with their low saturated fat content, containing free fatty acids necessary for cell structure, and dissolving fat-soluble vitamins such as A, D, E, and K in our body (Kolsarıcı et al., 2005; Kahraman, 2017). Humans need food to survive. A balanced diet, regular exercise, a good and quality sleep pattern bring a healthy life (Harmankaya et al., 2016). Cereals and legumes that are plant sources in addition to roots, leaves, shoots, flowers, fruits, bulbs of various plant parts are the basic foods for humans (Ceyhan et al., 2014). Change in the economic, social and cultural fields significantly affects the agriculture and food sector from production to consumption (Kahraman et al., 2015). Global agricultural policies increase the interest in the production of oilseeds and cereals and highlight monoculture in agricultural production. In addition to the change in income level and rapid urbanization add a different dimension to the demand for agricultural products, from nutritional habits to food supply (Ceyhan et al., 2011). All these developments significantly affect the production and consumption of legumes which are the main protein source of more than 2 billion people as well as the protection of soil and water resources that are main concepts of sustainability (Ozkan et al., 2017).

When the production of oilseed plants is considered, soybean takes the first place in the world and the production of oilseed plants in Turkey is listed as çigit, sunflower and soybean, respectively (Anonymous, 2008).

In the 2019/2020 marketing year in the world, sunflower was planted on 26.3 million hectares of land and 2-ton ha^{-1} yield was obtained. Compared to the previous marketing year, there was an increase of 2.2% in the planted area and 6.1% in the yield. In the same marketing year, production increased by 8.8% compared to the previous marketing year and totaled 54.9 million tons in the world (USDA, 2020).

While Turkey's oil sunflower cultivation areas were 560 thousand hectares in 2015, it increased by 21% in 2019 to 670 thousand hectares. On the other hand, sunflower production, which was 1.4 million tons in 2015, increased by 39% in 2019 and reached 1.95 million tons. According to TURKSTAT 2018/2019 marketing year data, the sufficiency rate of sunflower is 66.4%. While the average yield per decare was 264 kg in 2015, the yield per

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decare increased by 10% and reached 289 kg in 2019 (TUIK, 2019).

In 2019, seed production areas of companies producing seeds in Turkey, especially in Konya, Afyonkarahisar and Eskişehir, are approximately 20000 ha and the production was 28602-tons (BUGEM, 2020).

In the study conducted to determine the effects of different levels of nitrogen, phosphorus and potassium applications on yield and yield elements of sunflower under irrigated conditions, they observed that the increase in NPK level led to an increase in yield parameters in general. Accordingly, they reported that 80-50-50 kg/ha NPK fertilizers should be used per hectare to increase yield elements such as 100 grain weight, grain yield and the productivity of sunflower (Sadiq et al., 2000).

8 domestic and foreign hybrid sunflower varieties (AS 508, AS 615, AS 6310, Nantio F1, TR 6149, TR 3080, 64 A 83 and XF 4826) and 3 planting density (25 x 60, 35 x 60, 45 x 60). As a result of the research, the highest table diameter was from the variety AS6310 with 24 cm, the highest thousand-grain weight was from the TR 3080 variety with 76.66 g, the highest oil rate was from the Nantio variety with 39.78%, and the highest grain yield per decare was from the AS615 variety. determined (Şimşek and Sinan, 2001).

The effects of potassium fertilizer on sunflower yield and yield components in Tekirdağ region were investigated and it was determined that with 25 kg/ha K_2O, significant yield increases were achieved compared to the control block, plant height and head diameter were not affected, but the oil content per grain increased (Kacar et al., 2002).

As a result of a study conducted with Fedouk and Euroflor sunflower varieties; The highest seed yield and oil rate from both dense sowing (20 cm) and nitrogen levels of 100-140 kg/ha, the highest oil rate (43.5-44.2%) from Sakha-53 variety at 25 cm plant density and 70 kg. /ha nitrogen level was obtained. As a result, he recommended the use of frequent sowing (20 cm) and a nitrogen dose of 100 kg/ha to obtain the highest seed and oil yield under the environmental situation of the North Sinai Region (El-Sarag, 2007).

In the study on the research of soil tillage methods in second crop sunflower production in Tekirdag province, heavy disc harrow (DT), rotary tiller (ROT), heavy disc harrow+rotary tiller (DT+ROT), plow+heavy disc harrow (PUL+DT) was used as soil tillage methods., plow+heavy disc harrow+combicure (PUL+DT+KOM) and plow+rotatiller (PUL+ROT) methods were used. As a result, the results in terms of field emergence time, plant height, stem diameter and yield were found to be statistically significant. The highest plant height was in the tillage method with rotary tillers (ROT), while the lowest was in the plow+heavy disc harrow (PUL+DT) method. The highest efficiency was in the tillage methods made with plow+rotatiller (PUL+ROT) and rotary tiller (ROT), while the lowest efficiency was in the heavy disc harrow (DT) method (Akdağoğlu, 2015).

In an experiment established in 2016 to determine the oil sunflower varieties for Konya under Konya ecological conditions, it was found that Transol variety in Altınekin region, LG5580 and Bosfora in Obruk region, Transol and C70165 in Çumra region, Transol, Sanbro and C70165 varieties according to the average of three regions can be recommended for regional conditions. It was concluded that (Çetin, 2018).

In a trial conducted in Çukurova under dry conditions, the yield and yield components of sunflower (P64LC108) were examined after different fertilizer dosage applications (20.20.0 compound fertilizer, 0, 10, 15.20 kg/da); It was determined that plant height, head diameter, oil rate, seed yield and oil yield values increased as the fertilizer dose increased (Tunç, 2019).

In the experiment conducted in Adana conditions, in the field of Eastern Mediterranean Agricultural Research Institute in 2019, 3 different sunflowers (Zuhat, P64LC108 and Tunca) and 4 different in-row spacing (15-20-25-30 cm) were applied and 12 characteristics were examined (flowering time, physiological maturation time). As a result of the research, seed and oil yield, table diameter and hectoliter weight of different row spacings (self-fertilization rate, plant height, head diameter, seed kernel ratio, thousand grain weight, hectoliter weight, seed yield, protein ratio, oil ratio and oil yield) effect was detected. As a result of the experiment, the highest yield of 409.5 kg/da was obtained from the Tunca variety at a distance of 25 cm between the rows (Uçdağ, 2020).

In the 2-year study (2017-2018), which was conducted to determine root and root collar diseases in sunflower cultivation areas in Konya, Aksaray and Karaman and to investigate these and biological control possibilities, researches were conducted in the districts where the majority of oil sunflower production is made in these provinces, and plant samples showing disease symptoms were taken. Soil-borne fungi on isolated plants were diagnosed at the genus and species level by using macroscopic and microscopic methods. As a result of the isolations, Sclerotinia sclerotiorum was determined as the most common fungal agent. According to the symptomatological data, the disease rate of Sclerotinia sclerotiorum was 9.38% in Konya (Altınekin) and 4% in Aksaray (Center/Eskil) (Koçak, 2019)

Sarıkaya applied potassium at different doses (0-3-6-9-12 kg da^{-1}) in the sunflower experiment he established in Bursa under dry and irrigated conditions in 2012 and 2013, and 9 different characteristics were examined in the experiment (plant height, tabletop). diameter, grain yield, number of plants, number of grains, weight of bins, oil rate, inner bark rate and fresh weight), grain number, oil rate, inner bark rate, fresh weight and bin weight increased in dry conditions with potassium applications; in wet conditions; Thousand grain weight, wet weight and inner bark ratio statistically increased with potassium applications (Sarıkaya, 2016).

Seed sunflower production is one of the most developed sectors and has increasing export potential. In hybrid seed production, both at the certification stage and during seed production and sales, the processes are quite regular compared to other sectors. Especially in recent years, with the official introduction of special production zones, one of the biggest problems in the sector has been solved (Kaya, 2014).

Seed sunflower production in Turkey, especially in the Central Anatolian region, is increasing narrowly every year. While this production was 25 thousand tons in 2018,

it increased to approximately 29 thousand tons in the next year (BUGEM, 2020). This research aims to contribute to the country's economy by increasing the yield and quality values of the sunflower plant, of which a large number of seed is produced in Turkey, and by increasing the quality values of these seed companies of foreign origin, increasing their satisfaction and profitability; was established to increase the production in Turkey every year.

2. Materials and Methods

Field studies of this research were carried out in Emirdağ-Afyonkarahisar, Paddy-Konya ecology. In 2018, the trial was established in 3 replications according to the split plot in randomized complete block design, and was conducted in 3 isolation zones (Eşrefli, Aşağıpiribeyli/Emirdağ and Doğanyurt/Çeltik villages. The trial: Witness, 5000 plant da^{-1}, 6000 plant da^{-1}, 7000 plant da^{-1} was formed from 3 main blocks 0-3-5-7 kg da^{-1} potassium sulphate (K_2SO_4) was installed with applications. Before planting, 15-15-15 fertilizer was applied and mixed into the soil with a rake. Frequency trials were placed on the main plots and potassium doses were placed on the subplot.

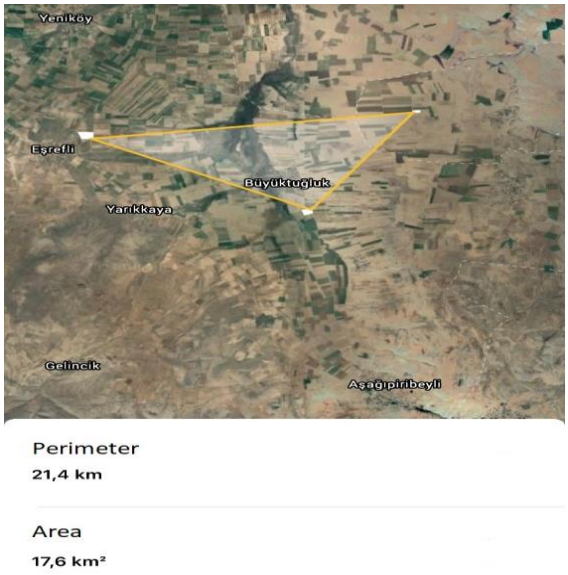

Figure 1
Location of Trial Fields

Considering the factors discussed in the research; A field trial consisting of 3 male sterile sunflower genotypes, each in a single isolation zone x 4 different frequency trials x 4 potassium doses x 3 replications, in total 48 x 3 = 144 plots was established. Seeds were planted in the first week of June, taking into account the regional conditions, while the soil prepared by the technique was in the tempering. Soil analysis results of the trial plots are given in Table 1.

Table 1
Some physical and chemical properties of trial fields

Soil parameters	Ashraf	Doganyurt	Asagipiribeyli
pH (1:2.5 h: w)	7.20	7.95	7.35
EC (mhos/cm)	1.05	0.91	1.1
$CaCo_3$ (%)	15.75	19.74	16.15
Organic matter (%)	2.05	1.16	1.9
P (%)	20.6	5.9	6.7
K (%)	68	65	72
Ca (%)	27.55	21.64	25.75
Mg (%)	1.80	3.37	2.23
Na (%)	60	56	65
Changeable % Na	1.29	1.1	1,2
B (%)	0.75	0.72	0.8
C (%)	0.62	1.18	3.34
Fe (%)	0.84	2.55	2.86
Zn (%)	1.52	1.3	1.72
Mn (%)	23.44	21.18	14.4
Textural class	loam	loam	loam

Each parcel has a total area of 21 m^2, 7 m wide x 3.0 m long. A gap of 2 m was left between the parcels and 2 m between the blocks. At harvest, all 2 rows on the sides of the parcel and 0.5 m long sections from both ends of the other rows will have an edge effect. During the research, no measurements or observations were made on the rows forming the edge effect. According to the results of soil analysis, suitable base fertilizer (15-15-15 50 kg da^{-1}) was given to the seedbed prepared by the technique and mixed with the soil with a rake before planting. In each plot, air seeder was planted in 10 rows at 28.6 cm, 23.8 cm, 20.4 cm and witness (22.5, 25.5, 20.5) cm in-row distances. In this research, as a source of potassium in field trials; Potassium Sulphate containing approximately 50% potassium and 46% sulfur was used as the water-soluble mass. Considering that the recommended fertilizer dose is 3-5 kg da^{-1}, once during the flowering period of the application; 4 different doses of 0, 3, 5, and 7 kg da^{-1} were applied to the plots with water. During the growing period, the cultural treatments (irrigation, fertilization, disease and pest control, hoeing) were carried out equally on all plots throughout the experiment. During the vegetation period, irrigation was done according to the need. The water needs of the plants were met by the drip irrigation system. After all the plants in the plots had matured, the parts except for the edge effect were harvested manually, and the seeds of these plants were used in the measurements and analyzes made afterwards. Considering that the recommended fertilizer dose is 3-5 kg da^{-1}, once during the flowering period of the application; 4 different doses of 0, 3, 5, and 7 kg da^{-1} were applied to the plots with water. During the growing period, the cultural treatments (irrigation, fertilization, disease and pest control, hoeing) were carried out equally on all plots throughout the experiment. During the vegetation period, irrigation was done according to the need. The water needs of the plants were met by the drip irrigation system. After all the plants in the plots had matured, the parts except for the edge effect were harvested manually, and the seeds of these plants were used in the measurements and analyzes made afterwards. Considering that the recommended fertilizer dose is 3-5 kg da^{-1}, once during the

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The climate data of Emirdağ-Çeltik region, where the research was conducted, are given in Table 2.

Table 2
Climate data

Month	Rainfall (mm)		Main Air Temperature (°C)		Relative Air Humidity (%)	
	1970-2017	2018	1970-2017	2018	1970-2017	2018
April	41.4	42.9	15.6	15.46	64.1	64.4
May	47.3	47.9	23.4	22.97	50.1	50.5
June	42.6	42.9	27.1	27.17	46.4	47.7
July	30.1	30.5	27.5	28.09	45.1	45.2
August	20.1	19.4	28.9	29.32	48.1	47.7
September	32.5	34.6	26.4	26.1	53.4	55.4
October	46.3	46.9	22.3	22.51	55.4	55.9
Mean	37.2	37.9	24.6	24.5	51.8	52.4

To summarize the measurements, observations and analyzes discussed within the scope of the research; Emergence time (days), Flowering onset time (days) (Ergen and Sağlam, 2005), Head diameter, Plant height (cm), Grain yield (kg da^{-1}) (Yıldırım, 2018) will be determined.

In this context, the analyzes made in the laboratory can be summarized as follows: Hundred grain weight (g) - Diameter of the seed (mm) (Ergen and Sağlam, 2005), kernel kg^{-1}.

The values obtained in the research were subjected to statistical analyzes (variance analysis, grouping of means) with the computer-based package program named "JUMP" according to the "Divided Plots in Random Blocks Experimental Design" by accepting as factors (Sarıkaya, 2016).

3. Results and Discussion

The data obtained as a result of this research, which was carried out with the aim of determining the effects of different density and potassium applications on some agronomic characters in cytoplasmic male sterile parent sunflower lines used in seed production in Konya-Afyon ecological conditions mean squares values are given in Table 3.

Table 3
Analysis summary of the variance of the topics covered in the research

		Emergence time			Flowering time		
		Mean Square			Mean Square		
Source	DF	PS4042	VE3060	EK1102	PS4042	VE3060	EK1102
Total	47	-	-	-	-	-	-
Replication	2	1.98	1.58	0.58	10.14	0.40	0.19
Sowing Frequency (A)	3	1.28	0.35	0.14	1.30	1.02	4.91
Error-1	6	2.81	2.42	0.47	1.58	0.56	5.41
Fertilizer Dose (B)	3	0.11	0.02	0.75	6.08*	1.74	2.52
AxB	9	0.74	1.04	0.88	2.05	1.15	3.15
Error-2	24	0.63	1.01	0.56	1.31	1.55	2.08

	Hundred kernel weight			Head Diameter		
	Mean Square			Mean Square		
Source	PS4042	VE3060	EK1102	PS4042	VE3060	EK1102
Total	-	-	-	-	-	-
Recurrence	0.27	0.26	0.42	13.65	0.79	0.75
Sowing Frequency (A)	0.05	0.08	0.31	80.22**	21.90**	1.14
Error-1	0.06	0.10	0.14	4.44	3.04	0.97
Fertilizer Dose (B)	1.19**	1.02**	0.57**	15.33**	32.73**	3.14
AxB	0.01	0.02	0.00	1.92	15.19**	3.75
Error 2	0.01	0.02	0.00	0.94	6.83	1.89

	Plant Height			Kernel Kg^{-1}		
	Mean Square			Mean Square		
Source	PS4042	VE3060	EK1102	PS4042	VE3060	EK1102
Total	-	-	-	-	-	-
Recurrence	262.04	23.81	34.52	438601		1050321
Sowing Frequency (A)	4720.25**	2917.42**	1990.85**	626256	422282	724701
Error-1	271.43	48.65	13.85	732381	183156	204595
Fertilizer Dose (B)	953.04*	89.14*	50.08**	6435320**	168792	2728771**
AxB	487.04	38.03	7.58	90330	1.28e+7**	145643
Error 2	249.90	19.74	12.74	61764	82598.8	101961

	Grain Yield			Kernel diameter		
	Mean Square			Mean Square		
Source	PS4042	VE3060	EK1102	PS4042	VE3060	EK1102
Total	-	-	-	-	-	-
Recurrence	11.23	1660.75	35.15	0.14	0.71	0.01
Sowing Frequency (A)	2188.20**	7469.97**	6615.22**	0.69	0.54	0.08
Error-1	142.74	621.36	152.70	0.16	0.21	0.38
Fertilizer Dose (B)	27214.20**	34183.70**	23691.50**	5.28**	3.62**	3.98**
AxB	192.58	926.13*	270.32	0.14**	0.03	0.01
Error 2	140.92	319.76	124.67	0.04	0.03	0.01

In the study, grain yields varied in the range of 109.67-307 kg da^{-1} and these features are given in Table 4. As a result of the research, the values determined regarding the grain yields were determined by the results of the study, which states that the grain yields in sunflower vary between 120-360 kg da^{-1} (Simsek and Sinan, 2001; Ergen and Saglam, 2005; Kılıç, 2010; Evci et al., 2011; Kara and Başalma, 2011; Acar et al., 2012; Ali et al., 2013; Deviren, 2014; Erdemli, 2015; Fırat, 2015; Kıllı and Tekeli, 2016; Yıldırım, 2018; Can, 2019) showed parallelism with the studies, while grain yields in sunflower vary between 65-136 kg da^{-1} (Arslan et al., 2000; Karaaslan et al., 2002; Kaya et al., 2005; Tuncturk et al., 2005; Demirel, 2014) over their work.

The grain yield differences in the study may be caused by the genetic characteristics of the varieties, different soil structures and climatic reasons brought by the year.

Table 4
"Grain yield (kg da^{-1})" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	126.33	150.67	183.33	217.67	169.50c
	5000	138.33	178.67	223.33	258.33	199.67a
	6000	122.00	161.67	210.33	243.00	184.25b
	7000	112.00	159.00	203.33	218.42	173.19bc
	Average	124.67d	162.50c	205.08b	234.35a	181.65
VE3060	5700	140.33gh	166.00fg	218.67cd	216.67d	185.42b
	5000	141.00gh	184.00ef	247.33bc	307.00a	219.83a
	6000	130.00h	155.67fgh	204.67	256.00b	186.58b
	7000	109.67i	133.67hi	169.00fg	223.33cd	158.92c
	Average	130.25d	159.83c	209.92b	250.75a	187.69
EK1102	6500	153.00hi	187.00fg	236.00cd	256.00b	208.00b
	5000	170.33gh	222.33	267.67b	292.33a	238.16a
	6000	157.67hi	180.67fg	216.00e	254.33bc	202.16b
	7000	143.33i	161.33hi	196.00f	224.67	181.33c
	Average	156.08	187.83	228.92	256.83	207.42

In the research, emergence times varied between 9.33-12.33 days and these features are given in Table 5. As a result of the research, the values determined regarding the emergence period are in parallel with the studies (Ergen and Saglam, 2005; Ali, 2011), which stated that the emergence period in sunflower varies between 9-16 days.

Table 5
"Emergence time (days)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	11.33	11:00	11.33	11:00	11.17
	5000	10.67	11.33	10.67	12.00	11.17
	6000	11.67	12.00	12.00	11.33	11.75
	7000	12.00	11:00	12.00	11.87	11.72
	Average	11.42	11.33	11.50	11.55	11.45
VE3060	5700	11.33	10.67	11.33	11:00	11.08
	5000	11:00	11.33	10.67	11.33	11.08
	6000	11:00	12.33	10.67	11.33	11.33
	7000	11.67	10.67	12.00	11.33	11.42
	Average	11.25	11.25	11.17	11.25	11.22
EK1102	6500	9.33	10.67	10.67	10.67	10.33
	5000	11:00	10.00	9.67	10.33	10.25
	6000	10.00	9.67	10.33	10.67	10.17
	7000	10.00	10.00	9.67	10.67	10.08
	Average	10.08	10.08	10.08	10.58	10.2

In the study, flowering periods were 68.00-77.67 days varied in the range and these features are given in Table 6. As a result of the research, the values determined regarding the flowering periods are in parallel with the studies (Ergen and Saglam, 2005; Çil et al., 2011; Demirel, 2014), which stated that the flowering period in sunflower varies between 60-75 days, while the flowering period in sunflowers varies between 59-72 days. (Acar et al., 2012; Erdemli, 2015; Can, 2019).

The differences in flowering periods in the study may be caused by genetic characteristics of varieties, different soil structures and climatic reasons brought by the year.

Table 6
"Flowering time (days)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	74.67	77.00	75.67	75.67	75.75
	5000	75.33	76.00	74.67	77.67	75.92
	6000	74.33	75.67	76.67	76.67	75.83
	7000	75.67	76.67	77.00	76.62	76.49
	Average	75.00b	76.33a	76.00a	76.66a	75.99
VE3060	5700	70.00	70.00	69.67	68.00	69.42
	5000	69.33	69.67	70.33	70.00	69.83
	6000	69.67	69.33	69.00	68.67	69.17
	7000	69.33	69.33	70.67	69.33	69.67
	Average	69.58	69.58	69.92	69.00	69.52
EK1102	6500	72.00	70.67	71.67	71.67	71.5
	5000	71.67	71.67	73.33	72.67	72.33
	6000	72.67	74.00	73.33	72.00	73.00
	7000	70.67	71.00	72.00	74.00	71.92
	Average	71.75	71.83	72.58	72.58	72.18

Plant height in the study 76.00-168.00 changed in cm and these features are given in Table 7. The values determined to plant height as a result of the research indicate that the plant height varies between 70-167 cm in sunflower (Atakişi, 1985; Göksoy, 1999; Karaaslan et al., 2002; Ergen and Saglam, 2005; Kaya et al., 2005; Evci, 2011; Karakaş 2012; Qatar 2012; Demirel, 2014; Deviren, 2014; Fırat, 2015; Kıllı and Tekeli, 2016; Memiş, 2018; Yıldırım, 2018), while the plant height in sunflower varies between 144-222 cm (Dilci, 1993; Ali et al., 2013; Can, 2019) remained under the works.

The differences in plant heights revealed in the study may be caused by the genetic characteristics of the varieties, different soil structures and climatic reasons brought by the year.

Table 7
"Plan Height (cm)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	105.33	113.67	112.67	118.33	112.50c
	5000	76.00	128.00	133.67	126.33	116.00bc
	6000	130.33	128.67	124.67	140.33	131.00b
	7000	152.67	155.00	158.00	161.53	156.80a
	Average	116.08b	131.33a	132.25a	136.63a	129.07
VE3060	5700	125.00	128.00	127.00	133.33	128.33c
	5000	123.00	126.67	123.33	130.33	125.83c
	6000	141.67	144.67	137.67	137.33	140.33b
	7000	155.33	157.33	159.33	168.00	160.00a
	Average	136.25b	139.17ab	136.83b	142.25a	138.62
EK1102	6500	119.67	118.00	122.67	124.67	121.25c
	5000	121.00	122.00	124.33	128.00	123.83c
	6000	139.00	137.33	138.33	138.33	138.25b
	7000	146.67	148.00	148.33	152.00	148.75a
	Average	131.58b	131.33b	133.42ab	135.75a	133.02

In the research, the diameter of the table varied between 17.00-27.00 cm and these features are given in Table 8. The values determined to the diameter of the tray as a result of the research, indicate that the diameter of the tray varies between 15-29 cm in sunflower (Atakişi, 1985; Oral and Kara, 1989; Kara, 1991; Şimşek and Sinan, 2001; Sefaoğlu, 2008; Ali et al., 2013; Deviren, 2014; Fırat, 2015; Yıldırım, 2019), indicating that the diameter of the tray varies between 8-19 cm in sunflower (Taşbölen, 1988; Sağlam and Ulger, 1992; Karaaslan et al., 2002; Ergen and Saglam, 2005; Kaya et al., 2005; Doğan and Sinan, 2010; Qatar, 2012; Erdemli, 2015) is on the works.

The differences in table diameter in the study may be caused by the genetic characteristics of the varieties, different soil structures and climatic reasons brought by the year.

Table 8
"Head Diameter (cm)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	18.33	19.00	20.00	21.67	19.75b
	5000	24.00	24.33	25.00	27.00	25.08a
	6000	18.67	19.67	22.33	21.67	20.58b
	7000	18.67	20.00	20.00	19.63	19.57b
	Average	19.92c	20.75b	21.83a	22.49a	21.25
VE3060	5700	18.00f	19.33cd	19.00	19.00	18.83b
	5000	18.33ef	20.33b	20.33b	22.00a	20.25a
	6000	18.33ef	19.00	18.00f	20.00bc	18.83b
	7000	17.00g	17.67fg	19.33cd	20.00bc	18.50b
	Average	17.92c	19.08b	19.17b	20.25a	19.10
EK1102	6500	21.33	20.67	20.67	22.67	21.33
	5000	22.33	20.33	20.33	22.67	21.42
	6000	22.00	22.67	22.33	20.00	21.75
	7000	22.33	20.33	20.33	21.00	21.00
	Average	22.00	21.00	20.92	21.58	21.37

Hundred kernel weight 7.33-8.72 gvaried in the range and these features are given in Table 9. As a result of the research, the values determined to hundred kernel weights indicate that the hundred kernel weight in sunflower varies between 4.3-13.9 g (Oral and Kara, 1989; Karaaslan et al., 2002; Ergen and Saglam, 2005; Sefaoğlu, 2008; Ali et al., 2013; Fırat, 2015; Yıldırım, 2018; Can, 2019) studies, indicating that the hundred-seed weight of sunflower varies between 3.5-7.6 g (İncekara, 1972; Kara, 1991; Dilci, 1993; Arslan et al., 2000; Çil et al., 2011; Deviren, 2014; Erdemli, 2015; Kıllı and Tekeli, 2016) over the studies.

The hundred-kernel weight differences in the study may be caused by the genetic characteristics of the varieties, different soil structures and climatic reasons brought by the year.

Table 9
"Hundred kernel weight (gr)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	7.87	8.18	8.39	8.49	8.23
	5000	7.78	8.06	8.33	8.40	8.14
	6000	7.71	8.06	8.33	8.45	8.13
	7000	7.80	8.11	8.42	8.72	8.26
	Average	7.79d	8.10c	8.37b	8.52a	8.19
VE3060	5700	7.42	7.93	8.21	8.33	7.97
	5000	7.75	7.97	8.17	8.37	8.06
	6000	7.74	7.95	8.16	8.29	8.03
	7000	7.56	7.81	8.00	8.17	7.88
	Average	7.61d	7.91c	8.13b	8.29a	7.99
EK1102	6500	7.56	7.71	7.88	8.03	7.80
	5000	7.72	7.89	8.09	8.20	7.98
	6000	7.60	7.78	7.91	8.17	7.87
	7000	7.33	7.53	7.65	7.86	7.59
	Average	7.56d	7.73c	7.88b	8.07a	7.81

The kernel diameter 4.17-7.15cm varied in the range and these features are given in Table 10. As a result of the research, the values determined regarding the seed diameter are Ergen and Saglam (2005), who stated that the seed diameter in sunflower varies between 4-6 cm; Mızrak (2006); It is in parallel with the studies of Karakaş (2012).

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Table 10
"Kernel Diameter (cm)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	5.03f	5.28ef	5.52e	6.11cd	5.49
	5000	5.12ef	5.53e	6.09d	6.52b	5.82
	6000	5.00f	5.55e	6.37bcd	6.63b	5.89
	7000	5.24ef	5.45e	6.42bc	7.15a	6.07
	Average	5.10d	5.45c	6.10b	6.61a	5.81
VE3060	5700	4.64	5.17	5.37	5.87	5.26
	5000	4.86	5.16	5.53	6.06	5.40
	6000	4.17	4.74	5.23	5.62	4.94
	7000	4.29	4.90	5.36	5.56	5.03
	Average	4.49d	4.99c	5.37b	5.78a	5.16
EK1102	6500	5.40	5.83	6.30	6.83	6.09
	5000	5.60	6.02	6.29	6.83	6.19
	6000	5.54	5.94	6.30	7.00	6.20
	7000	5.42	5.84	6.07	6.75	6.02
	Average	5.49d	5.91c	6.24b	6.85a	6.12

In the research, kernel kg^{-1} 11090.88-14519.33 pieces varied in the range and these features are given in Table 11.

Table 11
"Kernel kg^{-1} (numeral)" values and Lsd groups obtained according to different density and potassium doses

Lines (Location)	Plant density	Potassium doses (kg da^{-1})				Average
		0	3	5	7	
PS4042	6200	12.479.67	11.960.00	11.748.33	11.238.67	11.856.67
	5000	13.253.00	12.379.33	11.993.67	11.509.00	12.283.75
	6000	13.483.00	12.477.00	12.099.00	11.470.67	12.382.42
	7000	13.185.00	12.393.00	11.936.33	11.090.88	12.151.30
	Average	13.100.17a	12.302.33b	11.944.33c	11.327.30d	12.168.53
VE3060	5700	13.896.00	12.795.67	12.566.33	11.419.67	12.669.42
	5000	14.519.33	13.124.00	12.436.67	11.729.00	12.952.25
	6000	13.907.33	12.838.33	12.360.67	11.769.67	12.719.00
	7000	14.160.33	12.945.33	12.344.67	11.730.67	12.795.25
	Average	14.120.75a	12.925.83b	12.427.08c	11.662.25d	12.783.98
EK1102	6500	12.997.67	12.779.00	12.552.00	12.259.00	12.646.92
	5000	13.243.67	12.791.00	12.814.00	12.428.33	12.819.25
	6000	14.088.00	13.155.67	12.938.33	12.237.00	13.104.75
	7000	13.787.00	13.162.00	13.200.00	12.537.33	13.171.58
	Average	13.529.08a	12.971.92b	12.876.08b	12.365.42c	12.935.63

As a result of the research, when the statistical analyzes given above are examined; The best grain yield is 219.22 kg da^{-1} in 5000 plant da^{-1} plant density and 247.75 kg da^{-1} and 7 kg da^{-1} application in terms of fertilizer dose and 7 kg da^{-1} Potassium application at 5000 plant density in comparison of planting frequency x fertilizer dose 285 We see that it is taken at 89 kg da^{-1} value

Considering the 100-grain weight characteristic, it was found valuable in terms of 7 kg da^{-1} potassium application and 8.28 g fertilizer dose application.

Considering the seed diameter feature, 7 kg da^{-1} potassium application and 6.41 cm fertilizer dose were found to be valuable in terms of application.

When we look at the number of grains per kilogram feature, they were found to be statistically significant with 12748 grains kg^{-1} in 7000 plants da^{-1} planting in terms of sowing frequency, and 13583 grains kg^{-1} with 0 kg da^{-1} potassium application in terms of fertilizer dose.

Considering that there are 150000 seeds in seed sunflower bags, 10,000 kernels kg^{-1} 15kg, 11,000 kernels kg^{-1} 13.6 kg, 12,000 kernels kg^{-1} 12.5 kg, 13,000 kernels kg^{-1} 11.5 kg, 14,000 kernels kg^{-1} 10.7 kg,

15,000 kernels kg^{-1} is 10 kg. Considering both the transportation and the area it covers and the absence of very small seeds, the ideal range for companies is 12,000-14,000.

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