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Second Crop Potential of Soybean Lines for Diyarbakır Location on the Yield and Quality

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Abstract

The importance of vegetable oils and oilseeds, which have an important role in human nutrition and many branches of industry, is increasing day by day. Soybean is one of the most important industrial plants in the world. Despite having the most suitable agricultural land to cultivate soybean, Turkey meets through imports almost all of its soybean needs. The aim of this study is to determine the suitability of soybean genotypes as second crop production for Diyarbakır conditions. In this study, KA-04.03.07, KA-04.06.01, KKMA-118, KSA-26, S-02.14.11, S-03.03.7, Sa-01.08.15 advance lines and Arısoy, Blaze, SA-88 Bravo, Ataem-7, Umut-2002 and GAPSOY-16 varieties were used as materials. According to the results of the research, average grain yield of genotypes was 2,37 t/ha and highest grain yield was obtained from GAPSOY-16 (4,00 t/ha) variety, followed by S-03.03.7 line (3.66 t/ha). The lowest grain yield value was obtained from Umut-2002 (1,33 t/ha) variety. As a result of the correlation analysis, a positive and significant relationship was found between grain yield and thousand grain weight. It is concluded that GAPSOY-16 variety and S-03.03.7 line can be successfully grown as second crop in Diyarbakır province.

Keywords: Soybean, Yield, Diyarbakır, Genotype, Quality, Second Crop

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Introduction

Soybean (*Glycine max* (L.) Merrill) is one of the most important legume plants in the world due to its high protein content. The gene center of soybeans is northeastern China (Popovic, 2010). In Turkey, the cultivation of soybeans started in the Black Sea Region in the 1930s and today the production of soybeans as the main crop is in the Thrace, Marmara, Black Sea and Mediterranean Regions, and the second crop is in irrigated agricultural areas of the Aegean, Southeastern Anatolia and Mediterranean regions. Depending on the variety and growing conditions, soybean contains approximately 35-45% protein content and 19-22% oil content. Soybean is the main nutrient for millions of people worldwide due to its high protein and oil content (Popovic et al., 2011, 2013). Also, legumes are superior previous crops, compared to non-leguminous crops, because they fix atmospheric N (Vyn et al., 2000; Gül et al, 2008).

Soybean diversity is of great importance for growers to achieve high and stable yields. Main objective of modern agriculture is to achieve sustainability through high-yield varieties and hybrids that are resistant to diseases, pests and other adverse environmental conditions. These varieties were obtained using plant breeding methods based on selection, hybridization, and gene recombination in the appropriate genotypes. The main target in soybean breeding is yield increase and stability. Novel varieties must adapt to different growing conditions.

Soybean needs 550-600 mm water during the growing period. For this reason, it should be remembered that soybean farming could be done only by irrigation at the low rainfall areas. Low air humidity, especially in extremely hot areas, also adversely affects the filling of the bean grains, reducing yield. The necessary moisture must be provided with irrigation in dry weather conditions. Flowering and pod formation are most water needed period among developmental stages of soybeans.

In soybean breeding, special attention is paid to the development of varieties containing high amounts of protein and oil content besides high and stable yield (Hollung et al., 2005; Vidic et al., 2010).

When the usage areas of soybeans are examined, it will be possible to see the wide range of soybeans. Some of them are dough products, baby foods, confectionery products, non-allergenic milk and milk products, special dietary products. Soybeans are also industrial plants in terms of both human health and industrial products. Due to the high (18-26%) oil content of soybean seeds, it is classified in oilseed plants. (Kolsarıcı et al., 2005). After the oil of soybean is separated from the seeds, the residuum obtained is one of the important raw protein sources for feeding animals (Yılmaz and Efe, 1998).

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In 2016, 314 million tons of soybean production was produced in the world. Soybean imports in the world are 133.3 million tons; soybean exports were 132.5 million tons. According to TUIK (2017) data, Turkey's 2015/16 soybean production and marketing season were realized 2.3 million tons of soybean imports and 117 thousand tons exports.

280 tons of soybeans were produced in 84.1 ha areas at Diyarbakır in 2018 (TUİK, 2019). With the development of irrigation opportunities in the Southeast Region of Turkey, cotton, corn and fruit entered the region and the soybean plant, which is an important oil and protein store, has important production potential and advantage in the region. Soybean will eventually become an alternative to cotton and corn with government subsidies and the farmer's recognition. Some soybean genotypes (Ataem-7, Batem-201, Batem-219, Batem-220, Batem-223, Ata-135, Ata-137 and 581) have used previously conducted researchs in target region. Soybean genotypes gave high yields in Diyarbakır second crop conditions (Karaaslan, 2011). In the study carried out by Erbil and Gür (2017) in order to determine the performance of some advanced soybean lines in Şanlıurfa second crop conditions by using physiological and morphological parameters, suitable genotypes were determined.

In this study, the adaptation ability and production suitability of some soybean genotypes on Diyarbakır conditions as the second crop were investigated.

Materials and Methods

This study was conducted at Diyarbakır in 2017 and designed of completely randomized block experimental design with three replicates. Each experimental plot consisted of four rows with 5.0-m length 0.70 m/internal. In the research; KA-04.03.07, KA-04.06.01, KKMA-118, KSA-26, S-02.14.11, S-03.03.7, Sa-01.08.15 advanced lines and Arısoy, Blaze, SA-88, Bravo, Ataem-7, Umut 2002 and GAPSOY-16 soybean varieties were used. The lines are included in the middle-early group of soybean breeding activities carried out by the Black Sea Agricultural Research Institute and the GAP Agricultural Research Institute.

The results of some physical and chemical analysis of the soil of the experiment area at Faculty of Agriculture of Dicle University Experiment Station where the experiment was conducted are given in Table 1. The clay content of the soils is high and heavy. In addition, there are no significant problems with pH, salinity and groundwater. The soil of the trial area is low in organic matter, alkaline (pH 7.9) and clayey.

The genotypes were sown on 25 June 2017 with pneumatic sowing machine. Prior to sowing, pure 5 kg N per da and 5 kg P2O5 per da were given. As top fertilizer Ammonium nitrate in the form of pure 5 kg N per da was applied. Irrigation was carried out during the trial as necessary by drip irrigation. During the growing period, 8 irrigation (738 mm in total) was performed according to the needs of the plant and drip irrigation method was applied. The harvesting process was carried out on 18 October 2017. The plants harvested manually from the middle two rows of each plot were passed through the threshing machine. After the seeds were dried and cleaned, seed yield per hectare was calculated.

The province of Diyarbakır has a continental climate and has very hot and dry summers and cold and rainy winters. Climate data for the trial year are given in Figure 1. In 2017, the maximum rainfall in Diyarbakır occurred in November, December and January; The minimum rainfall occurred in June, July and August. In addition, in 2017, the maximum temperature in Diyarbakır was realized in June, July and August; The minimum temperature was in December and January.

In this research, plant height, first pod height, 1000 grain weight, grain yield, oil content, protein content and irrigation based water use efficiency (WUEIr) were investigated.

Irrigation Based Water Use Efficiency (WUE_{Ir}) (kg / ton): Irrigation based water usage efficiency (WUE_{Ir}), expressed as the ratio of total grain yield to the amount of irrigation water supplied, was calculated by the following formula.

$(WUE_{Ir}) = TGY / TAIW + TAR$

(WUE_{Ir}): Irrigation based water use efficiency (kg / ton)

TGY: Total grain yield (kg / m2)

TAIW: Total amount of irrigation water (ton / m2)

TAR: Total amount of rain (ton / m2)

Analysis of variance, correlation and regression analysis) was performed in the JUMP 13.0 package program.

Results and Discussion

In the second crop soybean cultivation, variance analysis values of some characteristics of different soybean genotypes are given in Table 2 and the resulting groups are given in Table 3. It can be observed that there was significant difference among genotypes for the characteristics of grain yield, plant height, firs pod height and WUE_{Ir}. Thus, these results show that there is wide variability between the cultivars (Table 2).

Plant Height (cm): Highest plant length (110.40 cm) was obtained from Sa-88 soybean line and the lowest plant length (76.02 cm) was obtained from Blaze variety. Our results were lower than the findings of Karaaslan (2011) and Yetgin and Arıoğlu (2009) reported 105- 138.8 cm and 91.67-122.2 cm plant height, respectively. The differences in plant height value of the varieties may be due to the differences in their genetic structure. Arslan and Isler (2002) in their study sowing frequency, sowing time, soil moisture and plant nutrients have stated that this character is effective. Findings obtained in the study, soybean plant height value of 50.5-75.0 cm Tayyar and Gül (2007) and 66.2-83.2 cm Karasu et al. (2002) and reported that it was 71.3-107.9 cm Tanriverdi et al. (2000) is similar to the findings. As a matter of fact, Arıoğlu (2007) stated that plant height may be between 30-150 cm depending on the differences in plant growing techniques and sowing time.Genotypes with plant height above 65 cm and first pod height above 10 cm should be selected for machine harvest (Yetgin and Arıoğlu, 2009).

Table 1. Soil analysis results of the experiment area

Depth of soil	pH	P_2O_5 (%)	Organic matter (%)	Lime (%)	EC (dS/m)	Soil structure				Field Capacity (g/10 g)	Fading point (g/100 g)	Volume weight (g/cm³)	Inf. Speed (mm/h)
						Sand (%)	Silt (%)	Clay (%)	Class Structure				
0-30	7.7	0.42	1.67	7.8	0.48	10	24	66	C	35.5	25.5	1.19	8
30-60	7.9	--	1.67	7.8	0.37	12	22	66	C	35.2	25.3	1.25	
60-90	7.8	--	--	8.7	0.42	12	21	67	C	36.4	27.0	1.27	

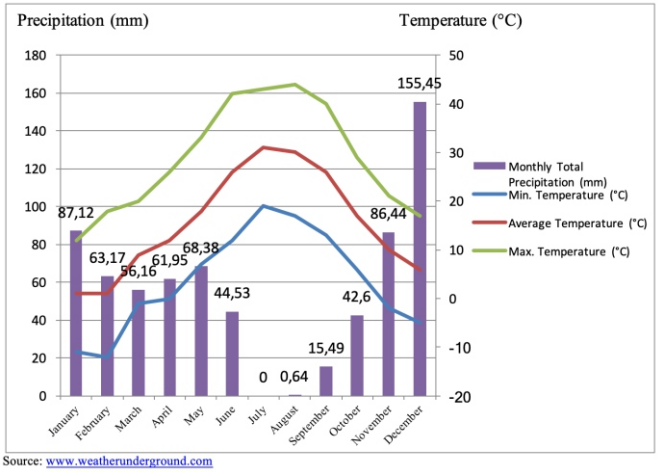

Figure 1. Some climatic data of Diyarbakır for 2017

growing techniques and sowing time. Genotypes with plant height above 65 cm and first pod height above 10 cm should be selected for machine harvest (Yetgin and Arıoğlu, 2009).

First Pod Height (cm): Umut-2002 variety had highest first pod height with 12.09 cm among different soybean varieties used in the research, while the lowest first pod height was obtained with KA-04.03.07 with 4.29 cm. In soybean agriculture, the first pod height is required to be high in order to minimize harvest losses (Yetgin and Arıoğlu, 2009). It was noted that there were significant differences between varieties in terms of first pod height in different studies conducted in different regions of Turkey. In the similar adaptation studies, the first pod height was changed between 9.2-15.4 cm (Karaaslan, 2011), 13.1-20.6 cm (Tayyar and Gül, 2007), 8.2-13.8 cm (Tanrıverdi et al., 2000) and 6.4-12.3 cm (Caliskan and Arioglu 2004). The findings of the researchers are a little bit higher than the values obtained in our study. In order to minimize harvest losses, first pod height is an important feature that should be considered.

Thousand Grain Weight (g): The highest value was obtained from KA-04.06.01 line with 164.68 g and the lowest value was followed by Bravo variety with 98.33 g. thousand grain weight is an important feature that affects the yield and the genetic structure of varieties and is formed by the effect of environmental conditions. Our findings were similar to the dates of Karaaslan, (2011); Yetgin and Arıoglu, (2009); Yaver and Pasha (2009); Aktaş et al., (2015); Söğüt et al. (2001); Söğüt et al. (2005) in terms of a thousand grain weight.

Grain Yield (t/ha): Statistically significant difference was found among different soybean genotypes for seed yield per hectare (Table 3). The highest yield was obtained from GAPSOY-16 (4,00 t/ha) variety, it is followed by S-03.03.7 line (3,66 t/ha). The lowest yield value (1,33 t/ha) was obtained from Umut-2002 variety. Our results were higher than the finding of Karaaslan (2011) who was working in second crop conditions of Diyarbakir condition. The average seed yield of varieties at same study was changed from 1,87 t/ha (cv. Batem-204) to 2,87 t/ha (cv. Ataem-7). Aktaş (2015) who worked with different soybean genotypes at same location had the highest grain yield from Blaze genotypes with 3,31 t/ha while lowest values belonged to Erensoy variety with 2,57 t/ha Average soybean seed yield was reported as 3,07 t/ha under the conditions of Sanliurfa (Erbil and Gür, 2017). Acar (2014), in order to determine the performances of some soybean varieties as the main and second crop in Kahramanmaraş ecological conditions, used 15 varieties. Seed yield in terms of the main product ERENSOY (3,96 t / ha), BLAZE (3,89 t / ha), CINSOY (3,72 t / ha); In the second product SA88 (3,19 t / ha), ATAEM-7 (2,64 t / ha), MAY 5312 (2,55 t / ha) determined that the high value varieties. Karakus et al. (2011), Harran ecological conditions as the main product and second crop as some soybean lines and varieties have made a study to determine the yield and yield components. At the end of the study, it was determined that seed yield was between 2.71-3.62 t / ha in the main crop trial and seed yield was between 2.38 - 3.95 t / ha in the second crop trial.

Oil Content (%): The highest oil content was obtained from Sa-88 with 25.00% and the lowest oil content was obtained from Blaze variety with 22.63% (Table 3). Karaaslan (2011), reported that the average oil content of the varieties ranged between 17.4% (Ata-140) and 20.0% (Batem-223) and oil content was influenced from genotpe x environment interactions. Aktaş et al. (2015) obtained the lowest value in Erensoy variety (17.4%) , while the highest oil content was obtained from Ataem-7 variety (20.5%). Yetgin and Arıoğlu (2009) reported that the highest oil content was obtained from S – 4240 with 22.40% and the lowest oil content was obtained from HA 16–21 line with 18.10%. Kan et al. (2011), in their study to determine the yield and quality characteristics of some soybean genotypes in Central Anatolia Region ecological conditions, in terms of oil content BDS-4 and ATAKİŞİ (19%) varieties have determined that they have high value.

Protein Content (%): The highest protein content among soybean genotypes was obtained from S-02.14.11 line with 42.82%, followed by KKMA-118 soybean line with 39.81% (Table 3). The lowest protein content was obtained from Sa-88 variety with 34.81%. The difference between the varieties for protein content must be affected by genotypic differences. Our findings are consistent with protein content

Table 2. Analysis of variance in the traits evaluated in field

SV	DF	Plant Height (cm)	Pod Height (cm)	Thousand Grain Weight (cm)	Grain Yield (t/ha)	Oil Content (%)	Protein Content (%)	Irrigation Based Water Use Efficiency (WUE_{Ir}) (kg / ton)
Genotype	13	373,84**	12,47**	843,34**	17725,90**	1,40**	10,52**	0.025 **
Replicate	2	308,95	1,73	1609,06	1151,30	0,11	0,86	0.002
Error	26	67,49	2,29	159,83	2722,30	0,24	2,17	0.004
C. Total	41	176,40	5,49	447,25	7402,90	0,60	4,76	0.01
CV (%)	-	9,23	21,75	9,89	21,96	2,07	3,83	21,43

**Significant at 1% of probability, *significant at 5% of probability by the F-test. SV: source of variation. d.f.: degrees of freedom

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Table 3. Mean values of some characteristics of different soybean genotypes

Genotypes	Plant Height (cm)	First Pod Height (cm)	Thousand Grain Weight (g)	Grain Yield (t/ha)	Oil Content (%)	Protein Content (%)	Irrigation Based Water Use Efficiency (WUE_{Ir}) (kg / ton):
Arısoy	88,8 cd	5,63 d-g	125,45 cd	1,96 d-f	23,59 b-f	39,30 bc	0.23 d-f
Ataem-7	88,57 cd	7,38 b-f	112,55 c-e	1,74 ef	23,64 b-e	38,28 b-d	0.21 ef
Blaze	76,02 d	6,48 c-g	130,18 c	1,97 d-f	22,63 g	39,00 b-d	0.23 d-f
Bravo	78,73 d	5,59 d-g	98,33 e	1,61 ef	22,91 e-g	39,48 bc	0.19 ef
GAPSOY-16	94,00 bc	6,47 c-g	152,78 ab	4,01 a	22,92 e-g	38,6 b-d	0.48 a
KA-04.03.07	77,04 d	4,29 g	131,26 c	2,25 c-e	23,82 b-d	37,97 b-d	0.27 c-e
KA-04.06.01	89,60 cd	7,53 b-e	164,68 a	2,85 bc	22,79 fg	37,27 c-e	0.34 bc
KKMA-118	93,63 cd	8,02 b-d	122,48 cd	2,72 cd	23,26 c-g	39,81 b	0.32 cd
KSA-26	103,99 ab	8,38 bc	129,50 c	2,29 c-e	24,02 b-d	37,06 c-e	0.27 c-e
S-02.14.11	76,89 d	5,30 e-g	131,62 c	2,46 c-e	24,40 ab	42,82 a	0.29 c-e
S-03.03.7	80,62 cd	4,87 fg	129,12 cd	3,66 ab	23,23 d-g	38,35 b-d	0.44 ab
Sa-01.08.15	82,83 cd	9,16 b	133,23 bc	1,67 ef	24,08 bc	36,75 de	0.20 ef
Sa-88	110,40 a	6,03 c-g	107,95 de	2,68 cd	25,00 a	34,85 e	0.32 cd
Umut-2002	103,78 ab	12,09 a	119,11 c-e	1,33 f	24,07 bc	36,59 de	0.16 f
Means	88,92	6,94	127,73	2,37	23,59	38,29	0,28
LSD	13,73	2,52	21,15	0,87	0,82	2,46	0,10

findings of Karaaslan (2011), Aktaş et al., (2015), Yetgin and Arıoğlu (2009). Kan et al. (2011), in their study to determine the yield and quality characteristics of some soybean genotypes in Central Anatolia Region ecological conditions, in terms of crude protein ratio ARISOY, NOVA and ÜSTÜN (39%) varieties have determined that they have high value.

Irrigation Based Water Use Efficiency (WUE_{Ir}) (kg / ton): On the basis of genotypes, the highest WUEIr values were GAPSOY-16 (0.48 kg / ton), S-03.03.7 (0.44 kg / ton), while the lowest WUEIr values were Umut-2002 (0.16 kg / ton) (Table 3). In field conditions, differences in water use activities of plants are due to different environmental factors such as weather conditions, sowing dates, genetic characteristics, surface flow, drainage and different amounts of irrigation (Greenwood vd., 2005).

Correlation coefficients were calculated between the measured characters of soybean genotypes and the results were given in Table 4.

Table 4. Correlation analysis among investigated traits

	Plant Height (cm)	First Pod Height (cm)	Thousand Grain Weight (g)	Grain Yield (t/ha)	Oil Content (%)
First Pod Height (cm)	0.47**				
Thousand Grain Weight (g)	0.13	0.05			
Grain Yield (t/ha)	0.21	-0.26	0.44**		
Oil Content (%)	0.26	0.08	-0.27	-0.19	
Protein Content (%)	-0.42**	-0.37*	0.06	0.04	-0.36*

When the correlation relationships among soybean genotypes were examined, positive and significant relation were found between first pod height and plant height (r = 0.47 **), grain yield and thousand seed weight (0.44 **). Protein content was negatively correlated with plant height, oil content and first pod height. Söğüt et al. (2001) were found significant and positive relationships between yield and harvest index, plant height and height of first pods, as a result of the correlation analysis between the characteristics examined in their study in the Çukurova region. Isler and Caliskan (1998) found a significant and positive relationship between grain yield per decare and seed yield per plant at a level of 5% in a study conducted in the GAP region. In addition, they observed significant relationships between plant height and first pod height, first pod height and number of branches, plant yield and 100-seed weight; while correlations were negative between harvest index and first pods height and number of branches.

The results of the regression analysis of the grain weight - seed yield and plant height - protein content are given in Figure 2. and Figure 3. respectively.

Grain yield is a linear increase depending on the weight of a thousand grain weight (R = 0.28 y = -74.75475 + 2.4426672x) (Figure 2.); protein content is in a linear decrease depending on plant height (R = 0.40 y = 47.776376 - 0.1066142x) (Figure 3.) Therefore, genotypes with high grain weight and medium plant height should be considered in the selection of varieties.

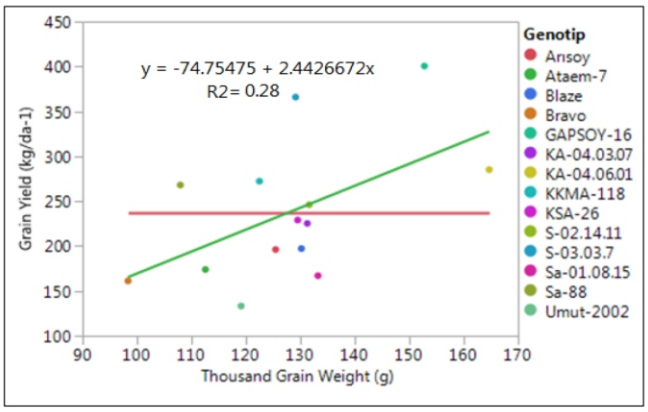

Figure 2. Grain yield (t/ha) - thousand grain weight (g) regression relationships

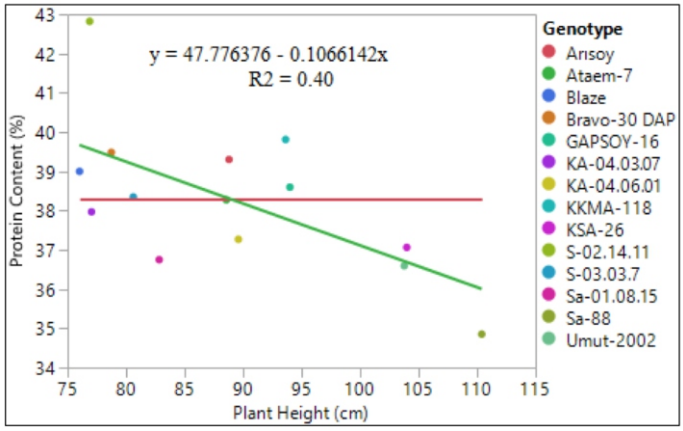

Figure 3. Protein Content (%) - plant height (cm) regression relationships

Conclusion

As a result; GAPSOY-16 variety and S-03.03.7 line will be suitable at the basis of yield in second crop soybean cultivation at Diyarbakır location. These genotypes also have satisfactory oil and protein content. It is foreseen that the Sa-88 genotype having the highest oil content can be used to increase the oil content in breeding studies with its grain yield capacity being above average. According to results, satisfactory income for farmers can be obtained under the second crop conditions of Diyarbakır by using appropriate variety. Considering that the seed yields will be increased by bacterial inoculation and nitrogen will be stored in the soil, the grain yields obtained from this study show that soybean cultivation could be applied profitably.

In order to fully demonstrate the advantages of second crop soybean production, it would be useful to carry out studies comparing economic analysis with other field crops.

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