JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.2.1 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(2):54-57 (2019)

The evaluation of the yield and yield components of seven soybean (*Glycine Max.* L. *Merill.*) genotypes grown as a second crop under Sirnak condition

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Abstract

In this study investigated the seed yield, oil rate, protein rate, yield and yield components of seven different soybean varieties that were from different maturation groups and grown under conditions. The trial was carried out in a farm land in Kurtuluş Village of İdil Town, Şırnak, Turkey in 2018 crop season. The study was designed in accordance with the randomized block design and carried out in three replications. In the study, important properties such as seed yield, oil content, crude oil content and yield components were investigated. The results showed that the seed yield values of the investigated soybean genotypes ranged from 2617.0 kg ha^{-1} to 3762.5 kg ha^{-1} and the highest seed yield values were obtained with the Asya (3762.5 kg ha^{-1}), Adasoy (3330.2 kg ha^{-1}) and Türksoy (3317.4 kg ha^{-1}) varieties. The oil contents of the soybean genotypes varied between 19.90% and 21.23% and protein contents varied between 32.59% and 35.44%. The Adasoy (35.44%) variety had the highest protein content. The results revealed that the genotypes can be successfully grown under second crop conditions in terms of growing time and yield.

Keywords: Soybean, Yield, Protein rate, Oil rate

Received: 08 January 2019 Accepted: 24 February 2019 Revised: 04 March 2019 Published: 15 March 2019

Introduction

Soybean seeds contain 18 – 26% oil and 40% protein. The glycine in the seed is highly important in animal nutrition. Moreover, its richness in oleic and linoleic oil ty acids and low linolenic oil content add to the quality of soybean oil. As a plant containing various vitamins and valuable amino acids and supplying nitrogen to soils in the form of organic substances, soybean is grown in Turkey both as a main crop and a second crop. In Turkey, soybean is predominantly used in the feed sector. Soybean cake contains high amounts of protein and thus, large amounts of soybean are used as a good source of animal feed especially in the feed rations for poultry. The top four materials preferred in the compound feed industry include full oil soybean, soybean cake, sunflower cake and cottonseed cake, while soybean ranks the first (Oner, 2006).

Among the oil plants worldwide, soybean ranks first in terms of cultivation area and production. According to the data of Food and Agriculture Organization (FAO), the global cultivation area, production and yield of soybean in 2017 were 123.5 million hectares, 352.6 million tons and 285.4 kg da^{-1},respectively. In Turkey, it ranks fourth in the cultivation area of oil plants and second in production. In 2017, the soybean cultivation area, production and yield in Turkey were 31.6 thousand hectares, 140 thousand tons and 4420 kg ha^{-1}, respectively (FAO 2017). Of the total soy cultivation in Turkey, approximately 91% took place in the Mediterranean Region including cities such as Adana, Osmaniye, Hatay, Mersin and Kahramanmaraş, 8% took place in the Black Sea Region, around Ordu and Samsun, 1% took place in the Aegean Region (Anonymous, 2017). Today, soy is produced as a main crop in Thrace, Marmara, Black Sea and Mediterranean and as the second crop in Southeastern Anatolia and the irrigable farm lands of the Mediterranean Region.

Soybean has a high yield potential and the selection of the appropriate genotypes and quality of the seeds are the leading factors affecting the yield and yield components. The appropriate genotypes should be selected by considering the sowing times and seeds with a high germination power should be preferred. Otherwise, maximum yield cannot be achieved regardless of the application methods.

High-quality and high-yield genotypes that are suitable for the ecological conditions of Turkey are needed. Wheat is sown as the main crop and soybean is sown as the second crop. The determination of the high-quality and high-yield soybean genotypes that are suitable for the second crop agriculture in Şırnak will be beneficial both to the farmers and to Turkey.

Cite this article as:
Ozturk, F. (2019). The Evaluation of the yield and yield components of seven soybean (*Glycine Max.* (L). *Merill.*) genotypes grown as a second crop under Sirnak condition. Int. J. Agric. Environ. Food Sci., 3(2), 54-57. DOI: https://dx.doi.org/10.31015/jaefs.2019.2.1
Year: 2019 **Volume:** 3 **Issue:** 2 (June) **Pages:** 54-57
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

DOI: https://dx.doi.org/10.31015/jaefs.2019.2.1

Material and Methods

The trial was carried out a farm land in Kurtuluş Village of İdil Town, Şırnak, Turkey in 2018 crop season. The experiment was designed in accordance with the randomized block design and carried out in three repetitions. Seven soybean genotypes from different maturation groups (Lider, Bravo, Asya, ANP 2018, Nazlıcan, Türksoy, Adasoy) were used as the study material. The genotypes used in the trial were obtained from Eastern Mediterranean Agricultural Research Institutes and seed companies.

The climatic conditions of the study area: The location is under the subtropical climatic conditions and affected by the "Arabian-Peninsula Climate". The region is hot and dry in summer and receives little rain in winter. Precipitation decreases in winter and autumn. The mean monthly temperature during the trial ranged from 28.3°C to 32.5°C. In the experimental year, the maximum temperature in Şırnak reached 39.0°C in August. According to the data on precipitation, rainfall during the trial varied between 0.4 mm and 28. mm. Due to the insufficient precipitation, the water requirement was met by irrigation. The soils on which the trial was carried out were clay-loamy and had a pH of 8.12. The salt content of the soils was 0.03% and salinity problem was not observed in the soils. The lime content was 10.8% and, hence, the soils were mildly calcareous. Organic substance content was 0.71% and the soils contained low levels of phosphorus (2.75kg da^{-1}). The soils were highly rich in potassium (K).

The experiment was established in accordance with the randomized block design and carried out in three replications. The seed bed was prepared for sowing by the processing of the trial areas with a cultivator after the wheat harvest. Before sowing, 20 kg 18-46 (DAP) (36 kg ha^{-1}) N and 92 kg ha^{-1} P) per decare was applied to the area and, then, before the first irrigation, 20 kg da^{-1} 26% ammonium nitrate (52 kg ha^{-1} nitrogen) was applied as the fertilizer. In the trial, parcel size was 5.0 m x 2.8 m = 14 m^2 and each parcel contained 4 rows. Row spacing was adjusted to 70 cm x 5 cm. Sowing was carried out manually on June 26. The necessary maintenance work was carried out during the growing period using the appropriate methodology in a timely manner. Row irrigation was carried out for four-five times, depending on the water requirement of the plant. The harvest of the investigated genotypes took place in the second week of October, depending on the maturation status of the genotypes.

The plant height (cm), first pod height (cm), node number (nodes $plant^{-1}$), pod number (pods $plant^{-1}$), number of seeds (seeds $plant^{-1}$), 100-seed weight (g), oil content (%), protein content (%) and seed yield (kg ha^{-1}) of the genotypes were investigated.

The variance analysis of the data was performed using JMP 5 (SAS Institute Inc.) statistical software in accordance with the randomized block experimental design. The differences between the mean values of the factors that had a significant effect on the investigated properties were determined using the Tukey (0.05) test.

Results and Discussion

Table 1 shows the combined variance analysis results for the properties of different soy genotypes. The effects of plant height, first pod height, number of pods, number of seeds per plant, seed yield, 100-seed weight, protein content and oil content were statistically significant at the $P<0.05$, while there were insignificant differences between the genotypes in terms of node number.

Table 1. The results of analysis of variance for soybean.

Source of variance	DF	Plant height	The first pod height	Node number per $plant^{-1}$	Pod numbers per $plant^{-1}$	Seed numbers per $plant^{-1}$	Seed yield	100 Seed-weight	Protein rate	Oil rate
Genotype	6	*	*	ns	*	*	*	*	*	*
CV		9.09	7.91	12.22	12.98	9.97	10.98	10.96	2.84	3.67

ns: not significant, *significant at $P < 0.05$

Table 2. Mean performance and LSD ranks of the soybean and examined features.

Genoteypes	Plant height (cm)	The first pod height (cm)	Node number per $plant^{-1}$	Pod numbers per $plant^{-1}$	Seed numbers per $plant^{-1}$	Seed yield (kg ha^{-1})	100 Seed-weight	Protein rate (%)	Oil rate (%)
Lider	36.82 b	9.40 b	11.60	33.93 bc	80.40 de	2617.0 c	9.71 cd	33.16 bc	21.23
Bravo	45.01 a	11.00 a	9.53	32.60 c	68.54 e	2325.7 d	8.63 d	34.73 ab	21.21
Asya	44.15 a	10.60 ab	9.73	44.13 b	120.73 b	3762.5 a	13.96 a	33.57 bc	20.98
ANP 2018	42.65 ab	7.40 c	7.66	38.43 bc	101.66 c	2955.9 bc	10.96 bc	34.02 abc	20.13
Nazlıcan	44.16 a	9.66 ab	10.40	44.46 b	96.40 cd	3001.1 bc	11.13 bc	32.59 c	20.07
Türksoy	49.09 a	9.33 b	10.60	66.66 a	142.80 a	3317.4 ab	11.97 ab	33.15 bc	20.02
Adasoy	36.90 b	10.33 ab	10.46	70.72 a	141.33 a	3030.2 bc	11.24 bc	35.44 a	19.90
LSD	6.09	1.36	3.96	10.92	19.06	586.5	2.16	1.71	1.34

In each column, means followed by the same letter within columns are not significantly different ($P < 0.01$) according to Tukey test

Among the soybean genotypes, the lowest plant height was obtained with the Lider genotype (36.82 cm), while the other genotypes were in the same group and had plant heights varying between 42.65 cm and 49.09 cm (Table 2). According to their variance analysis of the plant height values of different soybean genotypes, Gaffarogluyetgin (2008) determined that the differences among the genotypes were significant. It has been reported that plant height of soybean can range from 30 cm to 150 cm, depending on the variety, sowing time, row spacing and growing conditions (Arioglu, 2007).

Arıoglu et al., (2015) found that first plant height was between 103.3 cm and 137.9 cm and Senyigit et al., (2015) determined that it varied between 82.2 cm and 108.9 cm. The differences between the plant heights of soybean genotypes are attributable to the genetic structures of the genotypes and the different effects of environmental conditions on the genotypes. In addition, soybean crop is a short-day plant and thus, due to the shortening of days after June, the short-day conditions are effective in the sowings during the last week of June; therefore, the vegetative growth of soybean decreases and, consequently, plant height remains short. In their study under main crop and second crop conditions, Cinsoy et al., (2005) reported that plant height shortened as sowing time was delayed.

The highest first pod height was obtained with the Bravo variety with 11.0 cm, while the Türksoy (9.33 cm) and Lider (9.40 cm) genotypes had the lowest first pod height values. Soybean agriculture is negatively affected if the pods are close to the soil surface. This is because the pods that are close to the soil surface cannot be harvested, which leads to substantial harvest losses (Arslanoglu et al., 2005; Yilmaz et al., 2005; Beyyavas et al., 2007; Ilker, 2017). In their study in which the effects of growing time on certain agronomic properties and quality of soybean were investigated, Bakal et al., (2017) found that the mean first pod height under main crop conditions was 19.3 cm, while it was 17.9 cm under second crop conditions. In the growing of soybean as the main crop, long-day conditions affect the vegetative growth, while in its agriculture as an second crop, short-day conditions are effective (Bakal et al., 2017). In the sowings after June 21, due to the high mean temperatures and the effects of short-day conditions, the plants start to flower shortly after emergence and, therefore, the first pods are closer to the soil (Arioglu, 1999). Thus, first pods are desired to be higher above the soil surface. There were insignificant differences between the genotypes in terms of node number (Table1). The node number values varied between 7.66 and 11.60 nodes. Node number differs depending on whether the genotypes are early-maturing or late-maturing (Gunes, 2006). There were statistically significant differences in the pod number values of the genotypes. The highest pod number values were obtained with the Adasoy (70.72 pods) and Turksoy (66.66 pods) genotypes, while the Bravo (32.60 pods) variety had the lowest pod number. In soy, pod number is closely related to yield and, thus, it is desired to be as high as possible. Pod number changes depending on the sowing time and genetic structure of the genotypes (Yaver and Pasa, 2009). Various cultivation applications (plant density, irrigation, fertilization, etc.) are thought to affect the pod number of soy. The results obtained in the study are attributable to climatic and genotypic factors. There were statistically significant differences in the seed numbers of the plants. The highest seed number per pod values were obtained with the Adasoy (141.33 seeds) and Turksoy (142.80 seeds) (2.78 seeds pod^{-1}) genotypes, while the Bravo (68.54 seeds) variety had the lowest seed number per pod. In another study, the researchers reported that the seed number per pod values of the genotypes were different from each other and the Nova and Umut genotypes (2.83 $seeds.pod^{-1}$) had the highest seed number per pod values (Boydak et al., 2018). There were statistically significant differences between the genotypes in terms of seed yield and the highest seed yield was obtained with the Asya (3762.5 kg ha^{-1}) variety, while the Bravo (2325.7 kg ha^{-1}) variety had the lowest seed yield. The results obtained in this study agree with the results obtained in other studies that were carried out under the second crop conditions in Turkey (Yilmaz et al., 2005; Beyyavas et al., 2007; Arioglu et al., 2012; Caliskan et al., 2007; Sarimehmetoglu and Arioglu, 2008; Ilker, 2017). The Asya (13.96 g) variety had the highest 100-seed weight, while the lowest 100-seed weight value was obtained with the Bravo (8.63 g) variety. The differences between the 100-seed values are attributable to different climatic conditions, maintenance techniques and genetic traits. The results agree with the results obtained in other studies carried out under the second crop conditions in Turkey (Yilmaz et al., 2005; Beyyavas et al., 2007; Karaaslan, 2011; Ilker, 2017).

According to the variance analysis of the crude protein contents of the soybean and genotypes, the differences between the crude protein contents of the lines and genotypes were statistically significant (Table 1). The Adasoy (35.44%) variety had the highest protein content, while the lowest protein content was obtained with the Nazlican (32.59%) variety. The differences in protein contents were attributed to the different genetic structures of the genotypes. The differences among the genotypes in oil rate were not statistically significant and the oil content of the soybean genotypes varied between 19.90% and 21.23% (Table 2). The differences among the genotypes were due to the "genotype x environment" interaction. The highest oil content was obtained with the Arisoy and Blaze genotypes with 23.83% and 22.86%, while the oil contents of other genotypes were in the range of 20.16-20.66%. Hu (2013) found that the sowing time did not affect the oil content. Other researchers reported that the delaying of sowing caused decreases in the oil content (Kumar et al., 2006; Tremblay et al., 2006), which is in contrast to the results found in this study, while Daneshmand et al., (2013) reported that the highest oil content was obtained when sowing was delayed. In their study, Gulluoglu et al., (2010) determined that the oil content of soy differed depending on the variety and the results of their study is different from those reported in studies that were carried out under second crop conditions in Turkey (Bakal, 2017; Sogut et al., 2005; Yilmaz et al., 2005; Beyyavas et al., 2007; Karaaslan, 2011; Arioglu et al., 2012; Ilker, 2017).

Conclusion

The study showed that soybean can be grown as an alternative to other products in the irrigable farm lands of Şırnak. Furthermore, considering the global average soybean yield of 2490 kg ha^{-1} the presence of soybean and genotypes with a yield twice as high as that of the global average is an indicator of its suitability for agriculture in Turkey. As revealed by the results of the study, the yield values of the researched soybean genotypes ranged from 2325.7 kg ha^{-1} to 3762.5 kg ha^{-1} and the highest seed yield were found with the Asya (3762.5 kg ha^{-1}) and Türksoy (3317.4 kg ha^{-1}) genotypes. The Adasoy variety had the highest protein contents. It was concluded that the investigated genotypes can be successfully grown under the second crop conditions in Şırnak.

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