Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 6 Issue 2, February - 2019

The Determination of the Yield and Yield Components of Soybean (*Glycine max*. (L.) Merill) Grown as an Secondcrop Under the Conditions of Şırnak, Turkey

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***Abstract*— The study investigates the seed yield, oil content, protein yield and yield components of certain soybean genotypes. Six soybean genotypes from different maturation groups were used as the study material. The experiment was carried out in a farmland 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. The study examines certain important properties such as seed yield, oil content, crude oil yield and yield components. The results showed that the seed yields of the investigated soybean genotypes varied between 2565.5 kg ha^{-1} and 4377.8 kg ha^{-1} and the highest seed yield values were obtained from the Gapsoy (4377.8 kg ha^{-1}), Planet (3895.1 kg ha^{-1}) and Arısoy (3239.8 kg ha^{-1}) genotypes. The oil and protein contents of the soybean genotypes were in the range of 20.16-23.83% and 32.98-36.25%, respectively. The highest protein content was obtained with the Arısoy (36.25%) variety, while the highest oil content values were obtained with the Arısoy (23.83%) and Blaze (22.86%) genotypes. The results revealed that, considering the growing period and yield values, the genotypes can be successfully grown under secondcrop conditions.**

I. INTRODUCTION

Soybean is of great importance in human and animal nutrition due to its nutrient content. Soybean oil contains fatty acids that regulate the oil and lipid metabolism in humans and thus, is a crucial food product in a healthy diet. Moreover, soybean is an important raw material in the industrial sector [1]. According to the data from 2016, soybean (336.8 million tons) constitutes 60.8% of the 554 million-ton oilseed production and 187.0 million tons of the global vegetable crude oil production consisted of 27.8% soybean, 2.9% cottonseed, 8.9% sunflower, 15.4% rapeseed, 33.2% palm and 11.8% other oilseeds [2].

The vegetable oilseed production in Turkey reached 2,881,700 tons in 2016. The annual soybean requirement in Turkey is above 2 million tons. In 2016, production of soybean as an oilseed was 165 thousand tons. According to the data of Turkish Statistical Institute from 2016, the self-reliance of Turkey for soybean was around 6.9%. The total crude oil production in Turkey is 2,787,000 tons and 27.3% of the total production (760,000 tons) is generated from local seeds, while its 72.7% (2,027,000 tons) is met by imported oilseeds and crude oils. Of a total of 2,027,000 tons of imported vegetable oils, 567,000 tons were obtained with the domestic processing of imported oilseeds and 1,460,000 tons were directly imported as crude oil. This indicates a 93.97% gap in soybean production and the cost of import to close this gap is annually around 3.45 billion dollars (the highest after petrol). Despite its suitable agricultural conditions for oilseed production, according to the data from 2017, the oilseed production area in Şırnak was 5000 da and production was limited to 2.2 thousand tons [3]. Oilseed production in Şırnak is considerably low, despite its wide potential in terms of available area and suitable ecological conditions to produce oil plants. There hasn't been any soybean production activity in Sirnak in recent years. Therefore, the determination and breeding of the genotypes with a high yield potential is of great importance for the region. Furthermore, the oil content and fatty acid content of the genotypes grown in the region are of great importance especially to the industrialists.

The study investigate the yield potential, oil, yield and quality properties of the soybean genotypes that were bred by different institutions and seed companies and investigated as an secondcrop under the conditions of Şırnak.

II. METHOD

Location and climatic conditions

The study was installed and carried out in three repetitions in the agricultural lands in Kurtuluş Village of İdil Town, Sirnak, Turkey, in 2018 under the second crop conditions and in accordance with the randomized block design. Six soybean genotypes from different maturation groups (Blaze, Arısoy, Atakişi, Gapsoy, Nova, Planet) were used as the study material. The genotypes were obtained from Agricultural Research Institutes and seed companies.

The climatic and edaphic 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 by irrigation at 8 times in growing period. The soils on which the trial was carried out were clay-loamy and had a pH of8.12. 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).

Experimental design, plant materials, treatments and experimentation

The experiment 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. The seed bed was prepared for sowing by cultivation after the wheat harvest. Prior to the sowing, 200 kg 18-46 diammonium phosphate (DAP) (3.6 kg ha^{-1} N and 92 kg ha^{-1} P) per decare and, then, before the first irrigation, 200 kg ha^{-1} 26% ammonium nitrate and 52 kg ha^{-1} nitrogen were applied. In the trial, the parcel size was taken as 5.0 m x 2.8 m = 14 m^2 and each parcel contained 4 planting rows. The row spacing in the parcels was adjusted to 70 cm x 5 cm. Sowing was performed manually on June 26. During the growing period, the necessary maintenance work was carried out using the appropriate methodology in a timely manner. Row irrigation was used four-five times depending on the needs of the plants. The harvest of the genotypes was carried out in the second week of October, depending on the maturation status of the genotypes.

Data collection

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

Statistical analysis

The variance analysis of the data was carried out 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 statistically significant effects on the investigated properties were determined using the Tukey (0.05) test.

III. RESULTS

The study included six different soybean genotypes and Table 1 shows the combined variance analysis of the properties. The node number was found insignificant, while Plant height, first pod height, number of pods, seeds per plant, seed yield,100-seed weight, protein content and oil content were determined to be statistically significant at the P<0.05 significance level (Table 1).

TABLE 1. Variance analysis results of analysis of variance for soybean genotypes

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	5	*	*	ns	*	*	*	*	*	*
CV		6.57	6.36	16.07	8.96	10.72	11.13	9.44	3.17	2.95

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

TABLE 2. Mean performance and LSD ranks of the soybean genotypes for measured characters

Genotypes	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 (%)
Blaze	43.03 ab	8.06 c	11.12	37.40 c	80.93 d	2565.5 d	9.85 c	34.16 b	22.86 a
Arısoy	41.19 bc	7.46 c	13.73	47.93 b	99.53 cd	3239.8 bc	12.02 b	36.25 a	23.83 a
Atakişi	37.56 c	10.13 ab	13.53	46.67 b	187.35 a	3000.5 cd	11.79 bc	33.42 b	20.26 b
Gapsoy	47.25 a	8.36 c	10.12	57.80 a	130.40 b	4377.8 a	16.24 a	33.63 b	20.66 b
Nova	40.37bc	10.21 b	11.26	37.53 c	85.40 d	2859.1 cd	10.60 bc	32.98 b	20.16 b
Planet	48.11 a	11.10 a	9.93	52.40 ab	118.43 bc	3895.1 ab	14.45 a	33.81 b	20.23 b
LSD	5.13	1.06	3.88	7.26	22.96	673.0	2.14	1.96	1.14

In each column, means followed by the same letter within columns are not significantly different (P < 0.05) according to Tukey test, ns: not significant

The differences between the genotypes in node number were not statistically significant. Among the soybean genotypes, the Planet (48.11 cm) and Gapsoy (47.25 cm) genotypes had the highest plant height, while the lowest plant height was obtained with the Atakişi (37.56 cm) variety (Table 2). A significant and positive relationship between plant height and seed yield was previously reported by researchers who carried out studies with different genotypes and under different environmental conditions [4,5]. From this viewpoint, plant height is an important criterion for yield in soybean [6]. The differences between the genotypes in plant height is attributable to the differences in the genetic structures of different genotypes and lines and differences in how they are affected by the environmental conditions. Some researchers have reported that the plant height of soybean varied between 90 cm and 120 cm [7,6]. In [8], the researchers stated that plant height can vary from 30 cm to 150 cm depending on the growing techniques and sowing time. In their study in which soybean genotypes were investigated as an secondcrop grown under the conditions of Diyarbakır, Turkey. In [4], the researchers reported that the plant heights of soybean genotypes were between 42.0 cm and 73.6 cm. The study was designed as an second crop study and there were statistically significant differences between the soybean genotypes in terms of first pod height. With 11.10 cm, the Planet variety ranked first in first pod height. To minimize the losses during harvest, the first fruits of the genotypes should be above the soil surface. In their study, [4] reported that the first pod height values varied between 6.2 cm and 10.1 cm. The results obtained in this study agree with the results obtained by [4], but the results were lower than those obtained in [9] and [10]. In the selection of genotypes to achieve the minimization of harvest losses, first pod height is an important factor that should be taken into account.There were no statistically significant differences between the genotypes in terms of the number of nodes and the number of nodes varied between 9.93 nodes plant^{-1} and 13.73 nodes plant^{-1}.

In terms of the pod number per plant of the soybean and genotypes in the study, the Gapsoy variety (57.80 pods) had the highest pod number, while the lowest pod number values were obtained with the Blaze (37.40 pods) and Nova (37.53 pods) genotypes (Table 2). Other researchers have reported that [9] the pod number per plant varied between 39.8 pods and 61.2 pods. In a study in which certain agricultural properties of soybean were investigated, the mean pod number per plant was determined to be 44.3 pods (Bakoğlu and Ayçiçek, 2005). The results obtained in this study is higher than those obtained in [11] but close to those obtained in [9]. There were significant differences between the genotypes in the seed number per plant values and the highest seed number value was obtained with the Atakişi variety (187.35 seeds), while the Blaze (80.93 seeds) and Nova (85.40 seeds) genotypes had the lowest seed number values. Seed number is positively related to yield. The differences in seed number are attributable to the differences in environmental conditions and genetic structure.

Thousand-seed weight is the most important indicator of seed size and there were statistically significant differences between the genotypes in terms of 1000-seed weight (Table 1). The highest 100-seed weight values were obtained with the Gapsoy (16.24 g) and Planet (14.45 g) genotypes, while the Blaze variety had the lowest seed weight with 9.85 g. The variation between the genotypes in 1000-seed weight can be associated with the differences in their genetic structures and how they are affected by the environmental conditions. In their study, [9] reported that 1000-seed weight varied between 176.0 g and 194.0 g. [12] found that the 1000-seed weight values were in the range of 124.0-153.0 g. The results obtained in this study were close to those obtained in [12] but considerably lower than those obtained in [9]. Moreover, compared with previous studies, the results of this study were lower than those obtained in [13], [14] and [15]. There were statistically significant differences between the soybean genotypes in seed yield and different groups were obtained for seed yield (Table 2). The seed yield values of the genotypes varied between 25.655 kg ha^{-1} and 4377.8 kg ha^{-1}. The highest yield was obtained with the Gapsoy (43.778 kg ha^{-1}) variety, while the Blaze (2565.5 kg ha^{-1}) variety had the lowest yield value. Furthermore, with seed yield values above 3200 kg ha^{-1}, certain genotypes were determined to have a good potential for yield. As revealed by the examination of the results obtained by other researchers, [16] obtained seed yield values between 2243 kg ha^{-1} and 2968 kg ha^{-1} for the soybean lines that were developed in the study. In addition, in other studies carried out in Turkey, [15] reported that the seed yield values for the first and second year under the conditions of Diyarbakır were 3220 kg ha^{-1} and 3060 kg ha^{-1}, respectively. [7] reported a seed yield value of 3100 kg ha^{-1} under the second crop conditions in Menemen. [14] found that the mean seed yield values in the Harran Plain were 1920 kg ha^{-1} and 3700 kg ha^{-1} and [10] reported that the seed yield values varied between 1890 kg ha^{-1} and 3300 kg ha^{-1} under the conditions of Çanakkale. The comparison of our results with those obtained by other researchers indicated that the genotypes used in the study had a good yield potential in the study area.

There were differences between the genotypes in terms of protein content. The highest protein content was obtained with the Arısoy (36.25%) variety, while there were no differences between the other genotypes and the protein contents of the genotypes varied between 32.98% and 34.16%. The differences in protein content are attributable to the different genetic structures of the genotypes. The differences between the genotypes in terms of oil content were significant and the oil contents of the soybean

genotypes ranged from 20.16% to 23.83% (Table 2). The differences in oil content are attributable to the "genotype x environment" interaction. With 23.83 – 22.86%, the highest oil content values were obtained with the Arısoy and Blaze genotypes, while the oil contents of other genotypes were in the range of 20.16-20.66%. In their studies, they were determined that oil content of soybean differed depending on the variety [17,18,19,20].

IV. CONCLUSION

The study was carried out under the conditions of Şırnak and showed that soybean can be grown as an alternative to other plants in the irrigable lands of the region. Furthermore, these genotype that can reach yield levels twice as high as that of the global average of 2490 kg ha^{-1} is an indicator of Turkey's suitability for the agriculture of soybean. As revealed by the results of the study, the seed yield values of the soybean genotypes varied between 2565.5 kg ha^{-1} and 4378.7 kg ha^{-1} and the highest seed yield values were obtained with the Gapsoy (4377.8 kg ha^{-1}), Planet (3895.1 kg ha^{-1}) and Arısoy (3239.8 kg ha^{-1}) genotypes, while the Arısoy variety had the highest protein and oil content. The investigated genotypes were successfully grown under the secondcrop conditions in terms of growing period and yield values and therefore, the genotypes were deemed suitable for growing in Sirnak, Turkey

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