Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1298590

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 6 - Issue 4: 373-379 / July 2023

SOME SOYBEAN [*Glycine max*. L. (Merill)] VARIETIES DETERMINATION OF CULTIVATION POSSIBILITIES OF AS MAIN CROP

Mehtap ANDIRMAN[1], Nurettin BARAN[2]*

[1]*Batman University, Sason Vocational School, Department of Plant and Animal Production, Organic Agriculture Program, 72000, Batman, Türkiye*
[2]*Muş Alparslan University, Faculty of Applied Sciences, Department of Plant Production and Technologies, 49000, Muş, Türkiye*

Abstract: This research was carried out at Batman University West Raman experimental area with 3 replications in order to determine the yield and yield components of some soybean varieties as the main crop under Batman conditions in the 2018 production year. In the study, 7 different soybean varieties (Umut-2002, Nova, Bravo, Asya, Ataem, Atakişi, Blaze) were used as plant materials. In the study, plant height, number of branches, first pod height, number of pods per plant, yield per decare and oil content were investigated. As a result of the study, the plant height is 64.90-72.47 cm, the number of branches is 4.83-9.23 pieces/plant, the first pod height is 10.70-15.20 cm, the number of pods per plant is 31.27- 49.23 pieces, the seed yield was determined as 244.05-554.44 kg/da and the oil content was between 17.82-24.83%. In addition, it was determined that the results of the heat map clustering, PCA and DARwin plots and the grouping of the relationships between cultivars, traits and cultivar*traits were confirmed.

Keywords: Soybean, *Glycine max*. L. (Merill), Yield, Oil content

***Corresponding author:** Muş Alparslan University, Faculty of Applied Sciences, Department of Plant Production and Technologies, 49000, Muş, Türkiye
E mail: n.baran@alparslan.edu.tr (N. BARAN)
Mehtap ANDIRMAN https://orcid.org/0000-0001-8566-3388
Nurettin BARAN https://orcid.org/0000-0003-2212-3274

Received: May 17, 2023
Accepted: June 06, 2023
Published: July 01, 2023

Cite as: Andırman M, Baran N. 2023. Some soybean [*Glycine max*. L. (Merill)] varieties determination of cultivation possibilities of as main crop. BSJ Agri, 6(4): 373-379.

1. Introduction

Due to the rapid increase in the human population in Türkiye, the need for basic nutrients is also increasing (Ozturk et al., 2000). For this reason, the importance of vegetable and animal origin oils, which also have an important place in food consumption, is gaining interest among consumers. However, due to the extremely high cost of animal oils and the lack of adequate production, a large proportion of the oils that people need are supplied from vegetable oils (Kolsaraci et al., 2015). The importance of oil plants in human and animal nutrition is increasing in terms of the fat, protein, carbohydrate, vitamin and mineral substances they contain. Although a healthy individual needs 2500-3000 calories to carry out his daily vital activities, it is known that 30-35% of these calories come from fats. In this case, each individual should consume approximately 23 kg of fat per year.

Oilseed plants are grown both as annuals and perennials. Annual plants; are soybean, rapeseed, peanut, sunflower, safflower, flax, oil turnip, camelina, sesame, castor oil and crambe, while perennial plants are trees such as olive, coconut, avocado, cocoa, palm and jojoba (Baydar and Erbas, 2014).

While 58% of the world's oilseed demands come from the production of soybean plants, 53% Türkiye's of oilseed demands come from sunflower production. However, the amount of oil consumption is increasing as a result of the continuous increase in the population, and the oil deficit is increasing day by day because the demand for the amount of vegetable oil produced in Türkiye cannot be met. The oil shortage, which is increasing due to the insufficient cultivation of oil crops, is mitigated through the import of seeds and crude oil. For these reasons, there is a serious foreign exchange loss in Türkiye. By increasing the current agricultural potentials of oilseed plants, which are as strategic as cereals, both the oil needs of Türkiye will be demands and the capacities of oil factories will increase and great contributions will be made to the oil sector (Arioglu et al., 2010). Approximately 3.4 million hectares of land (TUIK, 2019) in Türkiye are used as a fallow land and cannot be utilized for alternative oil crops and oilseed meal, which is needed for the development of livestock sector.

Soybean, which has 130 million hectares of cultivation area, 381 million tons of production and an average yield of 293 kg/da in the world, has a cultivation area of 135 thousand hectares and a production value of 150 thousand tons in Türkiye (USDA, 2022; TUIK, 2022). Although soybean has the potential to be successfully grown as a second product after wheat harvest in the Aegean, Mediterranean and Southeastern Anatolia regions of Türkiye, cultivation area and production are

quite insufficient (Figure 1). An average of 3,000,000-3,200,000 tons of soybean products are needed annually and approximately 97% of this product is imported from abroad (TURKIYEM-BIR, 2022) (Figure 1).

More than 90% of soybean production in Türkiye comes from the provinces in the Mediterranean Region. The country that produces the most soybeans in the world is the USA. This country is followed by Brazil, Argentina and China (TUIK, 2022; USDA, 2022). Although soybean is the primary product among oilseeds in many countries around the world and constitutes approximately 50% of the total oilseed production, this rate is only 4% in Türkiye. The most important feature of soybean is that it provides more and cheaper protein per unit area than other plant and animal feed sources. Soybean protein is the closest protein to animal protein and has a very high biological value. For this reason, soybean skim flour is used as a protein source, especially in the rations of poultry and ovine animals; as well as dairy cattle and beef cattle. Soybean is mostly consumed as animal feed in Türkiye (TEPGE, 2015).

The soybean plant (*Glycine max* L.) belongs to the legume family and is an annual, summer plant. It contains 36-40% protein, 26% carbohydrates, 18-24% oil and 8% mineral substances and vitamins in its seeds. It has different usage areas because it contains important amino acids (Bellaloui et al., 2013; Bohn et al., 2014). Although it is the plant that produces the most protein per unit area, it is considered as an excellent plant for animal feed, especially in the nutrition of poultry, since it contains a remarkable protein in the pulp that remains after the oil is removed from the seeds (Okcu et al., 2007; Yilmaz and Efe, 1998).

Türkiye has suitable climatic features for the cultivation of oil crops with different characteristics. Researching and identifying oilseed plants that can be grown in different climate factors in order to close the existing oil deficit in Türkiye and initiating production incentive programs by increasing agricultural supports will contribute to closing the oil deficit. As in all plants, the most important factor affecting yield and yield characteristics in soybean is the determination of the appropriate variety (Tuncturk et al., 2020). With the provision of irrigation facilities of the Southeastern Anatolia Project and the expansion of soybean cultivation areas, there will be a parallel increase in production. After this situation, it is thought that it will be used as both the main product and the second product and the rate in oilseed production will increase day by day. The aim of this study is to determine the potential of different soybean varieties to be grown under Batman conditions as the main product.

2. Materials and Methods

The research was carried out in the trial area at Batman University West Raman Campus in the 2018 growing season. In the study, 7 different soybean varieties (Umut-2002, Nova, Bravo, Asya, Ataem, Atakişi, Blaze) were used as plant materials. The coordinates of the experiment are: 37°78' 73 20'' North latitude and 41°06' 27 30'' East longitude. The annual total precipitation amount of the long-year average (UYO) in the growing season of the region where the research was conducted is 40.63 mm, the average temperature is 16.38ºC, and the average relative humidity is 41.3%. The total rainfall in the growing season of 2018 was 30.70 mm, the average temperature was 24.50 °C, and the average relative humidity was 42.53% (Anonymous, 2018). The 7 different soybean varieties included in the study were obtained from Çukurova University, Faculty of Agriculture, Department of Field Crops.

This study was carried out in a randomized block design with three replications. Each plot consisted of four rows with a width of 2.8 m and a length of 5.0 m. Sowing was done by hand with 70 cm row spacing and 10 cm intra-row spacing. 20 kg/da of 18-46-0 DAP (Diamonyumfosfat) fertilizer was given to all parcels as a spread and mixed into the soil with a rake. Due to insufficient rainfall in June, July and August, the water needed by the plant was met with irrigation water. Irrigation was applied 6 times using of drip method.

Figure 1. Distribution of soybean production by provinces in Türkiye.

In the harvest, the remaining 2 rows were harvested by removing the one row at the edge of the parcel and the 0.5 m section at the ends as the edge effect. In statistical analysis, the values obtained from the trial results were subjected to analysis of variance using the JMP (13.0) pro package program according to the randomized blocks trial design. The differences in the obtained data were grouped by the LSD test. In addition, principal component analysis (Principal Component Analysis, PCA) (XLSTAT, 2021) was applied to the examined cultivars and their characteristics. Heat map clustering (ClustVis) and the DARwin-6 program were used to visualize and differentiate the examined varieties and traits and to determine the correlation between them.

3. Results and Discussion

3.1. Plant Height (cm)

According to the results of the variance analysis of the plant height values obtained from the 7 different soybean varieties included in the experiment, they were found to be statistically significant. According to the results of the study, it was determined that the plant height values varied between 64.90-72.47 cm. The highest plant height was obtained from the Umut-2002 variety with 72.47 and the lowest value was obtained from the Atakişi variety with 64.90 cm (Table 1). The findings of plant height in this study; are compatible with other findings from other researchers including Ekinci (2019), 37.27-98.67 cm; Cetin and Ozturk (2012), 58.4-66.8 cm; Yildirim (2017), 63-94.85 cm; Gumus and Beyyavas (2020) show that 41.20-104.83 cm. However, for plant height, the obtained results was lower than the findings by Erdogmus et al. (2007), 82.0-107.9 cm; Karaaslan (2011), 108.7-138.8 cm; Bakal et al. (2016), 89.9-131.5 cm; Altinyuzuk (2017), 74.1-113.1 cm.

It was expected that the results to be obtained will differ from each other due to the fact that the studies are carried out in different ecological conditions and using varieties with different characteristics.

3.2. Number of Branches (pieces/plant)

It has been shown that there is a significant variation in the number of branches among the cultivars included in the experiment. According to the results of the study, it was determined that the number of branches varied between 4.83-9.23 pieces/plant. The highest number of branches was obtained from the Umut-2002 variety with 9.23 pieces/plant and the lowest value was obtained from the Asya variety with 4.83 pieces/plant (Table 1).

Other researchers obtained similar results; for the number of branches such as Cetin and Ozturk (2012), 4.8-6.9 pieces/plant; and even lower numbers such as Acar (2015), 1.17-3.80 pieces/plant and Altinyuzuk (2017) who obtained the number of branches varying between 1.9 and 3.9 pieces/plant.

3.3. First Pod Height (cm)

According to the results of the variance analysis of the first pod height values obtained from the 7 different the soybean varieties included in the experiment, they were found to be statistically significant. According to the results of the study, it was determined that the first pod height values varied between 10.70-15.20 cm. The maximum height of the first pod was obtained from the Atakişi variety with 15.20 cm and the lowest value was obtained from the Nova variety with 10.70 cm (Table 1).

Findings of the first pod height obtained from the study was in the range of data obtained by; Karaaslan et al. (1999), 10.0-12.9 cm; Karaaslan (2011), 9.2-15.4 cm; Sabanci (2013), 12.68-18.13 cm in Aydin. However, Tunçtürk (2020) determined that 15.6-21.2 cm is lower than the findings obtained.

3.4. Number of Pods per Plant (pieces)

According to the results of the variance analysis of the pod number values obtained from the 7 different soybean varieties included in the experiment, they were found to be statistically significant. According to the results of the study, it was determined that the number of pods per plant varied between 31.27-49.23 pieces The highest number of pods per plant was obtained from the Asya variety with 49.23 pieces and the lowest value was obtained from the Ataem variety with 31.27 pieces (Table 1).

In the studies conducted with the number of pods per plant, Karaaslan (2011), 51.2-70.6 pieces; Acar (2015), 32.17-72.10 pieces; Altinyuzuk (2017) determined that it varies between 45.7-94.9 pieces.

Table 1. Sources of variance and significance levels for the analyzed features

Variety	Plant height (cm)	Number of branches (pieces/plant)	First pod height (cm)	Number of pods per plant (pieces)	Number of seeds per pod (pieces/plant)	Seed yield (kg/da)	Oil content (%)
Asya (G1)	69.27^{b}	4.83^{c}	11.76^{bc}	49.23^{a}	27.2^{a}	554.44^{a}	20.88^{b}
Blaze (G2)	68.77^{bc}	6.57^{b}	11.8^{bc}	41.20^{b}	25.77^{abc}	534.23	19.40^{bc}
Bravo (G3)	65.86^{cd}	4.87^{c}	14.2^{a}	35.37^{c}	26.4^{ab}	467.79	24.83^{a}
Ataem (G4)	65.37^{d}	4.93^{c}	12.77^{b}	31.26^{d}	24.47^{c}	464.87	23.73^{a}
Atakişi (G5)	64.90^{d}	8.93^{a}	15.2^{a}	36.97^{c}	26.07^{ab}	425.51	21.19^{b}
Nova (G6)	67.23^{bcd}	7.43^{b}	10.70^{c}	36.87^{c}	25.30^{bc}	349.04	17.82^{c}
Umut-2002 (G7)	72.47^{a}	9.23^{a}	14.9^{a}	36.93^{c}	26.06^{ab}	244.05	19.40^{bc}
CV (%)	2.64**	8.1**	5.53**	3.12**	3.11*	5.87**	6.52**

**P<0.01; *P<0.05.

3.5. Number of Seeds per Pod (pieces/plant)

The number of seeds in the pod obtained from the 7 different soybean varieties included in the experiment was found to be statistically significant according to the results of the analysis of variance. According to the results of the research, it was determined that the number of seeds in the pod varied between 24.47-27.2 pieces/plant. The highest number of seeds per pod was obtained from the Asya variety with 27.2 pieces/plant, and the lowest value was obtained from the Ataem variety with 24.47 pieces/plant (Table 1).

3.6. Seed Yield (kg/da)

According to the results of the variance analysis of the seed yield values obtained from the 7 different soybean varieties included in the experiment, they were found to be statistically significant. According to the results of the study, it was determined that the seed yield values varied between 244.053-554.44 kg/da. The highest seed yield was obtained from the Asya variety with 554.44 kg/da and the lowest value was obtained from the Umut-2002 variety with 244.053 kg/da (Table 1).

One of the most important conditions for the sustainable and economical production of oilseed plants is a high seed yield per unit area. Because there are two important goals in the production of oilseed plants. In the first place, the oil yield per unit area must be high as possible, and in the second place a very high pulp yield per unit area must be obtained. In order to achieve these goals, the most important condition is to obtain a very high seed yield per unit area (Gecit et al., 2009).

Other researchers, in their studies on seed yield obtained varying results as follow; Tayyar and Gul (2007), 189.0-330.2 kg/da in Canakkale conditions; Karaaslan (2011), 187.1-287.1 kg/da; Arioglu et al. (2012), 275.2-367.4 kg/da; Cetin and Ozturk (2012), 192-251 kg/da in Konya conditions; Acar (2015), 128-239 kg/da in Bingöl conditions; Bakal et al. (2016), 321-463 kg/da; Altinyuzuk and Ozturk (2017), 395-489.9 kg/da in Çukurova conditions; Ozturk (2019), in the study conducted in Sirnak ecological conditions, 232.57-376.25 kg/da; Tuncturk et al. (2020), 170.51-214.15 kg/da; Sengoz and Arslan (2022) determined that it varies between 206.22-269.41 kg/da in Sanliurfa ecological conditions.

While the seed yield values obtained from this study were in line with the data obtained by some researchers above, they were found to be inconsistent with other findings.

New varieties that are superior in terms of yield and agricultural characteristics are developed through breeding studies (Nyirahabimana et al., 2022). It is known that the new lines or varieties developed give different results in different ecological conditions. Therefore, regional adaptation studies are especially important for new varieties or lines.

3.7. Oil Content (%)

According to the results of the analysis of variance of the oil ratio values obtained from the 7 different soybean varieties included in the experiment, they were found to be statistically significant. According to the results of the study, it was determined that the fat content values varied between 17.82-24.83 %. The highest oil content was obtained from Bravo variety with 24.83 % and the lowest value was obtained from Nova variety with 17.82% (Table 1). While the oil content values obtained from this study were in line with the data obtained by Ozturk (2019), 19.90-21.23% and Ozturk et al. (2021), between 18.29-24.81%, whereas the fat ratio values by Bakal et al. (2021), were found to be inconsistent with the findings of 16.8-17.4%

The reason why the parameter values examined in the study are different from the findings of Bakal et al. (2021), is that different varieties and lines, were grown using different agricultural practices during the cultivation period. As well as the climatic factors were different and laboratory conditions of the analyzed materials varied.

3.8. PCA Graph of Heatmap Clustering and Examined Parameters

In the research, a heat map graph was created to interpret the relationships between parameters, applications and similarity between parameters. It has been determined that the investigated parameters occur in two different main clusters and subgroups occur in each main cluster.

In the first main cluster these parameters were included; SY (Seed yield), PH (Plant height), NP (Number of pods) and NGP (Number of grains per pod). In the second main cluster, parameters such as; OR (Oil content), NB (Number of branches), and FPH (First pod height) were included (Figure 2). According to the heatmap clustering and PCA plot, the subgroups show a high level of correlation (Figure 2 and 3).

Also, the variation between traits explained 36.13% of PC1; and 29.21% of PC2. According to the PCA analysis, Umut-2002 (G7) cultivar is the most ideal variety in terms of features in the first group (NB), and Asya (G1) is the best variety in terms of features in the second group (NP, OR and NGP). In addition, it is understood that Blaze (G2) and Atakişi (G5) cultivars did not stand out in terms of any traits examined in the study, while Nova (G6), Ataem (G4) and Bravo (G3) cultivars gave values close to the trial average in all traits (Figure 3).

The DARwin analysis graph confirmed the results of the heat map clustering and it was determined that there were 2 different main groups (A and B) in terms of varieties. The main group A; contains Asya (G1), Blaze (G2), Bravo (G3), Ataem (G4) and Atakişi (G5), while in the main group B; Nova (G6) and Umut-2002 (G7) varieties were included. In addition, main group A formed 2 subgroups. In the subgroup AI; it consisted of Asya (G1) and Ataem (G4) cultivars, and in subgroup AII, consisted of Blaze (G2), Bravo (G3) and Atakişi (G5) cultivars (Figure 4). The main purpose of the DARwin analysis program was to determine the morphological relationship between the varieties.

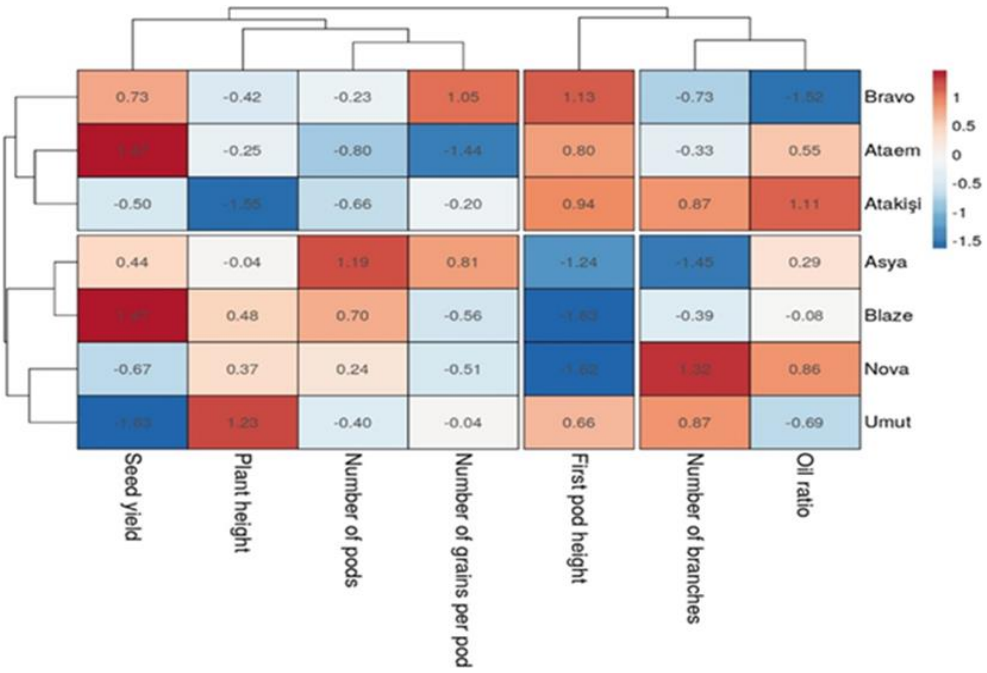

Figure 2. Clustering of soybean cultivars by heat map of investigated traits.

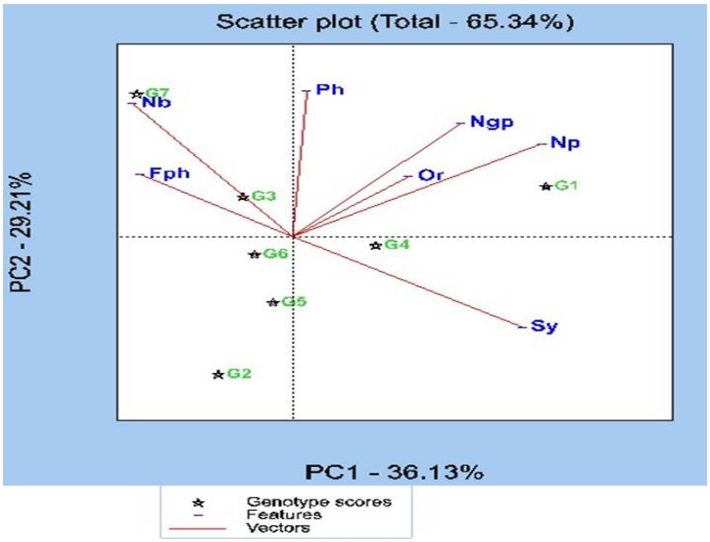

Figure 3. Principal component analysis (PCA) of soybean varieties.

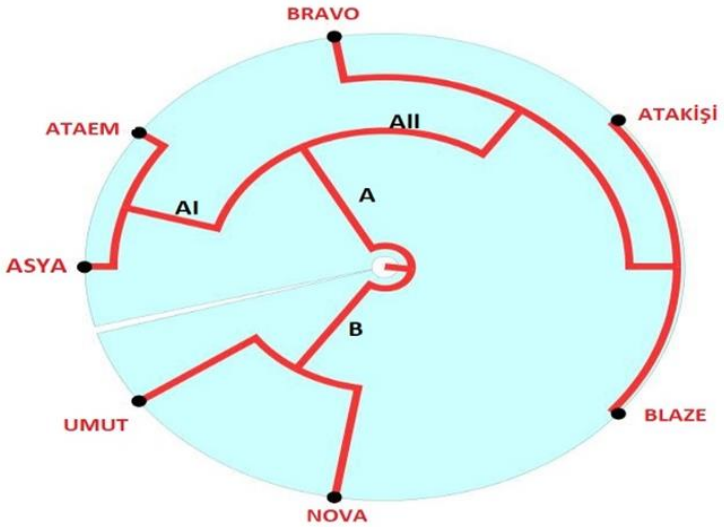

Figure 4. Morphological association of varieties with DARwin program.

4. Conclusion

In order to increase the production and cultivation area of the soybean plant, which is of great importance to meet the vegetable oil requirement in Türkiye, it is necessary to determine the ecologies in which the improved varieties can provide the best adaptation in terms of yield. Each variety in different climatic conditions (humidity, temperature, precipitation, etc.). Ecological conditions affect the adaptation of varieties and seed yield. For this reason, in order to obtain high seed yield, it is necessary to determine the varieties that are least affected by climatic factors during the year and to pay attention to these varieties.

With the researches carried out in the Southeastern Anatolia Region recently, the soybean plant has been tried to be introduced and popularized in this region. In this study, which was carried out in order to determine the suitability of the soybean plant for cultivation as the main product in irrigable agricultural lands in Batman province and to determine the variety; It has been determined that soybean can be successfully grown as the main product in Batman province, ''Asya'' in terms of seed yield and ''Bravo'' varieties in terms of oil content are among the varieties that can be recommended for local conditions with both high seed yield and high oil rate.

Considering that the world soybean yield is 293 kg/da it is an indication that soybean farming can be done in Batman since we have soybean varieties that can reach approximately twice the world average in terms of yield. For this reason, it has been concluded that the soybean varieties used in the research can be successfully grown as the main product in Batman Province conditions in terms of growing time and yield values and the ''Asya'' variety is the most suitable variety. In addition, it was determined that the results of the heatmap clustering, PCA and DARwin plots and the grouping of the relationships between cultivars, traits and cultivars*traits were confirmed.

Soybean plant is from the legumes family and it contributes to the yield of plants such as wheat, cotton and corn that will be planted after it, since it transforms the free nitrogen in the air into useful soil.

It is estimated that this study will shed light on other research to be carried out in Batman and the soybean agriculture that is expected to develop in the region. As a result of the repetition of similar studies in larger areas in the coming years, it will be possible to mobilize the people of the region for soybean production if the use of varieties determined to be productive and of high quality is encouraged.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	M.A.	N.B.
C	50	50
D	50	50
S	50	50
DCP	50	50
DAI	50	50
L	50	50
W	50	50
CR	50	50
SR	50	50
PM	50	50
FA	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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