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Full Length Article

Yield and Stability Analysis of some Sesame (*Sesamum indicum*) Genotypes in Turkey

Mehmet Oz*
Uludag University, Mustafakemalpasa Vocational School, 16500 Mustafakemalpasa, Bursa, Turkey
*For correspondence: momer@uludag.edu.tr

Abstract

This study was carried out during 2015 and 2016, using 16 sesame (*Sesamum indicum* L.) genotypes (Golmarmara, Boydak, Sarisu, Tanas, Muganli-57, Cumhuriyet 99,Osmanli 99, Tan 99, Kepsut 99, Hatipoglu, Aslanbey, Baydar 2001, Batem Aksu, Ozberk-82, Orhangazi 99 and local line Pakistan), evaluated for stability characteristics of the genotypes examined through seed yield. Seed yield averages, regression coefficients (bi), deviations from regression (S^2d), regression line intercept values (a) and determination coefficient values (r^2) of genotypes were examined as stability parameters. Minimum and maximum values of examined criteria included seed yields between 1035 and 1989 kg ha^{-1}, regression coefficients between 0.79 and 2.53, deviations from regression between 9.71 and 773.36 intercept values between -211.227 and 271.802, and coefficients of genotypes between 0.002 and 0.945. The cv. Boydak was the most suitable values in terms of stability criteria. © 2018 Friends Science Publishers

Keywords: Sesame; Stability analysis; Yield; Turkey

Introduction

Sesame seed contains approximately 50−60% fat and 25% protein. It is a quality cooking oil in terms of fatty acids (Tan, 2012). In addition to being an important oil seed, it has wide uses in the pharmaceutical and cosmetic industries due to its antioxidant compounds. Sesame oil is rich in oleic and linoleic fatty acids (Sharar *et al.*, 2000).

Mathew *et al.* (2013) and Baraki *et al.* (2016) has reported average yield of sesame as 585.9, to 614.3−926.8 kg ha^{-1} respectively.

Stability can be defined in different ways depending on the method applied and the parameters used. A genotype can be considered stable if it has low inter-environmental variance (Sabanci, 1997). The different responses of the same genotype between the years (i.e., genotype-environment interactions) make it difficult to select appropriate genotypes. Different stability analysis methods have been developed to determine the performance stability of genotypes where the genotype-environment interactions determined by the variance analysis are significant (Akgun and Altindal, 2011).

The use of regression coefficients in determination of stability has been adopted by many researchers. Finlay and Wilkinson (1963) defined a stable genotype is one with a regression coefficient close to the average regression coefficient. The same researchers emphasised that if the regression coefficient of a genotype is close to 1.0, the genotype has average stability over all environments. This also shows that the examined genotype performs in a manner consistent with the average of all genotypes tested; this definition is an example of stability as explained by Lin *et al*. (1986).

Eberhart and Russell (1966) stated that the deviations from the regressions calculated fromthe environmental averages of genotypes should also be considered as a stability parameter.

The same authors considered the deviations from regression as a second stability parameter as well as the regression coefficient. According to them, genotypes with high seed yield, the regression coefficient close to 1 and coefficient of deviation from the regression is close to 0 are considered stable.

Genotypes with a regression coefficient greater than 1.0 have below average stability, and show special adaptation to good environments. If the environment is poor, the yield potentials are difficult to achieve and high yields are produced under good conditions. Genotypes with a coefficient less than 1.0 show above average stability do not respond to good conditions, and have superior performance compared to other genotypes in poor conditions (Mohammadi *et al*., 2012; Hassan *et al*., 2013).

The closeness to 1 of the regression coefficient (bi) represents the reaction to the environment of the genotypes, a positive and high value of the regression constant (a) indicates that the genotype shows good performance to poor environments. The determination coefficient (r^2) expresses the rate of reflection to yield of the environmental changes. A low value of the meansquare of deviation from regression (S^2d) indicates the stability

of the genotype (Mut *et al.,* 2014). Therefore aim of this research was to determine the stability status of some sesame genotypes in terms of seed yield per hectare.

Materials and Methods

Fifteen (15) indigenous varieties Golmarmara, Boydak, Sarisu, Tanas, Muganli-57, Cumhuriyet 99, Osmanli 99, Tan 99, Kepsut 99, Hatipoglu, Aslanbey, Baydar 2001, Batem Aksu, Ozberk-82, Orhangazi 99, and one exotic line from Pakistani (local line) were used in the study.

The test field is flat and the altitude is 25 m. The soil of the test area was found to be composed of mildly alkaline (pH 7.8), moderate calcareous (81 kg ha^{-1}), saltless (0.48 dS m^{-1}), moderate organic matter (1.9%), poor in total nitrogen and rich in potassium (1395 kg ha^{-1}). No drainage problems were observed on the 1.5 m soil profile of the test area.

The experiments were carried out as three replications in a random block design design in 2015 and 2016 at the experimental field of Mustafakemalpasa Vocational School of Uludag University, Bursa, Turkey (40°02'N, 28°23'E). The distance between the rows was of 70 cm, and the intra-row distance of was 15 cm with plot length of 5 m, such that each plot contained and each parcel has 4 rows. Sowing was performed on May 25 in the first year and on May 29 in the second year. Irrigation was not done at any stage of the trial. During the seeding, 25 kg of 20−20−0 compound fertilizer was appliedper hectare. The weed struggle was made by hand hoe if necessary. Pesticide was not used.

It is determined that the total rainfall in September 2015 was higher compared to the average of the 2016 and the past ten years. Whereas, the precipitation values of October 2016 were lower compared to the average of 2015 and past ten years (Fig. 1).

The temperature values measured for the year 2016 are very similar to the average values of the past, and the average temperature of September 2015 is slightly higher compared to the average temperatures of both months (Fig. 2).

The seed yield values were obtained using 10 plants randomly selected from the second and third rows of each plot. Drying of the capsules had already begun when the plants were harvested and were left on a clean surface to complete dry. The completely dried capsules were then shaken until all dry and clean seeds could be recovered.

The regression coefficients (bi), coefficients of deviation from regression (S^2d), intercept value (a) and determination coefficient value (r^2) of genotypes were determined using the JMP statistical software (SAS Institute, 2007).

Results

Seed Yield

According to the results, the highest seed yields were taken from the Boydak variety (1989 kg ha^{-1}).

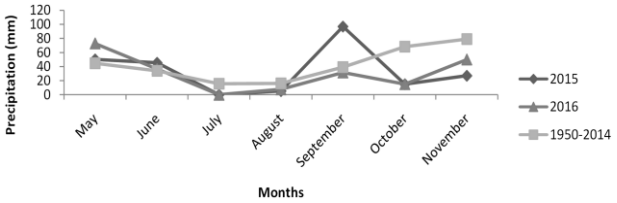

Fig. 1: Monthly total precipitation values determined for the years of trial (2015 and 2016) and long years (1950-2014)

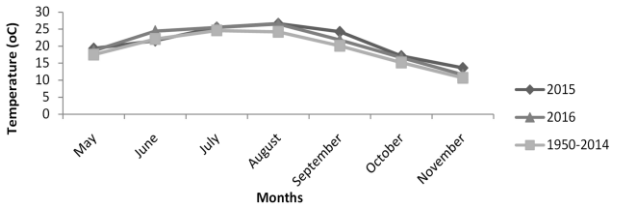

Fig. 2: Monthly average temperature values determined for the years of trial (2015 and 2016) and long years (1950-2014)

The Aslanbey variety had a yield of 1968 kg ha^{-1}, followed by the Golmarmara variety at 1753 kg ha^{-1}. The lowest yield was obtained from the Pakistan local line (1035 kg ha^{-1}). The average yield of all genotypes was 1613 kg ha^{-1} (Table 1). The Boydak, Orhangazi and Golmarmara varieties had the highest seed yields of 1833, 1673 and 1633 kg ha^{-1} in 2015 in the same order. The average yield for year 2015 was 1480 kg ha^{-1} and 1745 kg ha^{-1} in 2016. The highest seed yield of 2304 kg ha^{-1} was obtained from the Golmarmara variety, followed by the Boydak (2146 kg ha^{-1}), Aslanbey (2033 kg ha^{-1}), Kepsut (1908 kg ha^{-1}), Baydar 2001 (1900 kg ha^{-1}) and Muganli-57 (1854 kg ha^{-1}). The Pakistani local line again ranked last. Compared with the 2015, a 17.9% higher seed yield occurred during the 2016.

Stability Analysis

The regression coefficient is a measure of the reaction shown in different environments of the genotypes. Generally, genotypes with a regression coefficient greater than 1 produce higher seed yields because of better adaptation to good environmental conditions. A "b" value close to 1 is determined to be desirable for genotypes. While the regression coefficients of the genotypes used in the study showed that, the distributions according to the average yield of the genotypes of regression coefficients are shown in Table 2 and Fig. 3. Seed yield averages, regression coefficient (bi), deviation from regression (S^2d), intercept value (a) and determination coefficient value (r^2) of genotypes were examined as stability parameters.

The regression coefficients (bi) were calculated between -0.793 and 2.530 in this trial. The genotypes Boydak (1.054), Muganli-57 (1.084), Tan 99 (1.115),

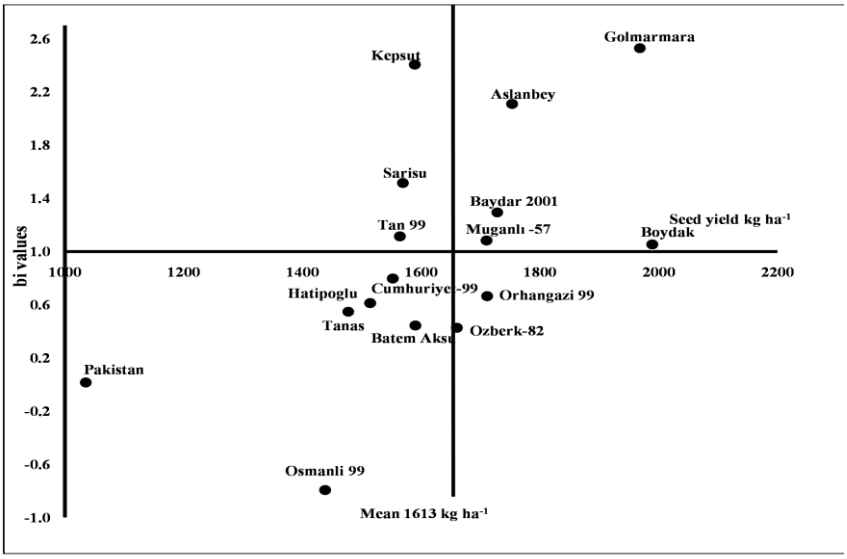

Fig. 3: Graph of bi values determined for the sesame genotypes used in the trial

Cumhuriyet 99 (0.798) and Baydar 2001 (1.295) could be adapted well to all environmental conditions compared to the rest of the genotypes. The means of seed yields of the varieties Boydak and Muganli-57 exceeded the mean of all genotypes; seed yields of these genotypes will increase if the conditions improve. Showing that the varieties Baydar 2001, Aslanbey and Golmarmara varieties could be adapted to good environmental conditions.

Osmanli 99, Pakistan, Batem Aksu, Tanas, Ozberk-82 and Hatipoglu genotypes were not stable in good or poor conditions. Additionally, the varieties of Kepsut 99 and Sarisu showed good performance in poor environmental conditions.

When the genotypes in this trial were evaluated in terms of regression coefficients, it was noted that the cv. Baydar and Golmarmara, with bi values greater than 1, adapted to better environmental conditions and could maintain a certain level of productivity even in poor environmental conditions.

The values determined as the deviations from the regression are also accepted as parameters in the evaluation of stability. Values of deviation from the regression ranked between 9.708 and 1415.030 in this study. Cv. Cumhuriyet 99 (9.708) and Boydak (62.030) were determined to be the most suitable genotypes in terms of this criterion (Table 2).

Another parameter that determines the stability of genotypes in this study is the intercept value (a). As seen in Table 2, the highest positive value was found in the cv. Osmanli 99 with 271.80, and this variety was followed by the Pakistan local line and cv. Ozberk-82 (100.91 and 97.03, respectively).

The determination coefficient (r^2) was also used as another stability parameter. And r^2 values ranged 0.002 for local line Pakistan to 0.945 for Cumhuriyet 99.

Table 1: Sesame seed yields determined as single years and average of two years seed yields (kg ha^{-1})

Genotypes	2015	2016	Means of 2015-2016
Golmarmara	1633 abc[x]	2304 a	1968 ab
Boydak	1833 a	2146 ab	1989 a
Sarisu	1368 cd	1770 bcd	1569 cd
Tanas	1404 bcd	1549 cd	1477 cd
Muganli-57	1566 bc	1854 abc	1710 bcd
Cumhuriyet 99	1446 bcd	1658 bcd	1552 cd
Osmanli 99	1543 bcd	1333 de	1438 d
Tan 99	1416 bcd	1712 bcd	1564 cd
Kepsut 99	1270 cd	1908 abc	1589 cd
Hatipoglu	1433 bcd	1596 cd	1514 cd
Aslanbey	1473 bcd	2033 abc	1753 abc
Baydar 2001	1556 bc	1900 abc	1728 bc
Batem Aksu	1530 bcd	1650 bcd	1590 cd
Ozberk-82	1603 abc	1716 bcd	1660 cd
Orhangazi 99	1673 ab	1749 bcd	1711 bcd
Pakistan (Line)	1033 e	1037 e	1035 e
Means	1480 A	1745 B	1613

[x]: Means shown by the different letters within a column are statistically different at 0.01 level

Discussion

Seed Yield

Seed yield is an important plant characteristic. The seed yields in the experiment ranged 1035 and 1989 kg ha^{-1}. In the work carried out in Sicily (Southern Italy), Anastasi *et al*. (2017) determined sesame seed yields between 1900 to 3500 kg ha^{-1}. These values are higher than the yield values determined in this study. Bhardwaj *et al*. (2014) reported 1427 kg ha^{-1} as the sesame seed yield in Virjinia, USA. Tan (2011) noted that seed yields in Menemen conditions were 1720−2580 kg ha^{-1} and the highest seed yield was taken

Table 2: Seed yield averages, intercept (a), regression coefficient (bi), deviations of regression (S^2d) and determinaton coefficient (r^2) values determined for the sesame genotypes used in the trial

Genotypes	Seed yield (kg ha^{-1})	a	b_i	S^2d	r^2
Golmarmara	1968	-211.227	2.530	115.280	0.936
Boydak	1989	30,661	1.054	62.030	0.825
Sarisu	1569	-87.646	1.516	465.510	0.565
Tanas	1477	59.266	0.548	295.863	0.211
Muganlı-57	1710	-3.806	1.084	358.530	0.463
Cumhuriyet 99	1552	26.452	0.798	9.708	0.945
Osmanli 99	1438	271.802	-0.793	453.282	0.267
Tan 99	1564	-23.460	1.115	224.950	0.593
Kepsut 99	1589	-229.317	2.407	773.360	0.663
Hatipoglu	1514	52.485	0.613	158.907	0.384
Aslanbey	1753	-165.235	2.111	1415.030	0.453
Baydar 2001	1728	-36.081	1.295	665.390	0.399
Batem Aksu	1590	85.794	0.454	544.032	0.090
Ozberk-82	1660	97.037	0.427	247.428	0.162
Orhangazi 99	1711	58.852	0.665	682.689	0.145
Pakistan (Line)	1035	100.913	0.016	236.698	0.002

from the TUR-S-90 line. Kashani *et al.* (2015) found sesame yields in Pakistan from 657.5 to 682.1 kg ha^{-1}. Seed yield was also reported as 1100–1248 kg ha^{-1} (Kadam *et al.*, 2015). Eryigit *et al.* (2016) reported that sesame seed yields vary between 523.3 and 1005.8 kg ha^{-1}.

Stability Analysis

The seed yields of these genotypes are stable only in good environmental conditions. If environmental conditions are improved, increased yields of these genotypes are expected to be higher. Stability values reported by Mirza *et al*. (2013) showed similarities with the experimental findings. Mekonnen *et al.* (2015) explained that regression coefficients (bi) ranged 0.25 to 1.44. If the regression coefficient measures < 1, it indicates that the plant can show adaptation to poor environmental conditions. However, if the bi value of a genotype is >1, the genotype will perform at a higher level in good environmental conditions (Akgun and Altindag, 2011).

The values determined as the deviations from the regression are also accepted as parametersin the evaluation of stability. For genotypes accepted as stable, this value should be low andclose to zero (Eberhart and Russell, 1966; Aycicek and Yildirim, 2006; Hassan *et al*., 2013). The deviation values from the regression were calculated between 639.6 to 36400.7 (Mekonnen *et al.*, 2015). According to Daba *et al*. (2014), bi values ranged between 0.42 and 1.82. Raikwar (2016) reported variations of 439.90−712.80 kg ha^{-1} for sesame seed yields, bi values of -9.59-18.58 and S^2d values of -545.29−1814.76. These values are similar to the values we found in this research. Stability analysis was also evaluated by other crops also (Anwar *et al.*, 2007).

Another parameter that determines the stability of genotypes in this study is the intercept value (a). This value explains the reaction shown to poor environmental conditions by the genotypes. These can be regarded as genotypes that cannot achieve a certain level of yield in good environmental conditions, but are well adapted to poor environmental conditions. It is desirable that this value be as high as the stability parameter (Akgun and Altindag, 2011).

The determination coefficient (r^2) was also used as another stability parameter. The determination coefficient value (r^2) is accepted as an important statistic because it allows comparison of the stability of genotypes evaluated in different trials and in different measures (Bibro and Roy, 1976). An expression coefficient close to 1 indicates that the genotype is stable. However, it is also desirable that a genotype has a positive regression constant (a).

Conclusion

According to the seed yields and stability values examined in this study, The results of the study suggest that seed yield and adaptation capability of the cv Boydak was higher compared to other evaluated genotypes; therefore this cultivar should be promoted for high yield under diverse geographical conditions of Turkey.

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