Research Article

Evaluating Performance of Sesame (Sesamum indicum L.) Genotypes in Different Growing Seasons in Northern Ethiopia

Fiseha Baraki and Muez Berhe

Crop Research Core Process, Humera Agricultural Research Center, Ethiopia

Correspondence should be addressed to Fiseha Baraki; fish051bar@gmail.com

Received 1 September 2018; Accepted 2 January 2019; Published 3 March 2019

Academic Editor: Maria Serrano

Copyright © 2019 Fiseha Baraki and Muez Berhe. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Ethiopia is one of the famous and major producers of sesame in sub-Saharan Africa, and Ethiopian sesame is among the highest quality in the world. The experiment was conducted in Northern Ethiopia for three growing seasons (2013–2015) under a rain fed condition with the objective of identifying high-yielding genotypes and their agronomic traits. The experiment consisted of twelve genotypes laid down in randomized complete block design with three replications. The genotype, year, and genotype × year interaction components showed statistically highly significant variation ($p < 0.001$) for most of the agronomic traits which clearly confirms the presence of genotype × year interaction in this study. The highest combined mean grain yield (906.3 kg/ha) was obtained from Hirhir followed by Serkamo white (756.5 kg/ha), and from the three growing seasons, the highest grain yield (1161.5 kg/ha) was recorded from Hirhir grown in the second growing season (2014). The growing seasons were different from one another in allowing the genotypes to have a different performance, and all of the agronomic traits, except thousand seed weight, were statistically different across the three growing seasons. In the ordination of the genotypes and agronomic traits, PCA1, which accounted for 38.3% of the variation, was positively associated with grain yield, branches per plant, length of the pod-bearing zone, plant height, number of pods per plant, number of seeds per pod, and thousand seed weight. On the contrary, PCA2, which accounted for 19.7% of the variation, was positively associated with days to 50% flowering and days to 50% maturity.

1. Introduction

Sesame (Sesamum indicum L.), locally called “Selit” or “Simsim,” is one of the major economically important oil crops in Ethiopia. The sesame sector is millions of dollars industry that supports the livelihoods of thousands of small farmers and hundreds of medium-to-large-scale private farms along with thousands of other actors involved in the chain of production-to-consumption/export continuum. Ethiopia is one of the famous and major producers of sesame in sub-Saharan Africa, and Ethiopian sesame is among the highest quality in the world; especially seeds produced in the Humera and Gondar regions are renowned worldwide for their high quality (color, taste, and nutty aroma) [1]. From nutrition point of view, sesame is also rich in phosphorous, iron, magnesium, manganese, zinc, and vitamin B₁ [2].

Agriculture is the major source of economic growth in Ethiopia, as was corroborated by the sector’s contribution to GDP growth rate which rose from 22.3% to 24.5% for 2014/15 fiscal year [3]. Furthermore, sesame is the second major source of foreign currency for Ethiopia next to coffee from the agricultural products, and a huge amount of foreign currency was obtained from 2011/12-2016/17 (Figure 1) [4]. Given the high market demand and fairly favorable price for the farmer, it can be reckoned that sesame plays a significant role to directly ensuring food-security of millions of people by enabling them have access to food and nutrition in Ethiopia.

Despite its ideal adaptation to dry sites, sesame can also be cultivated in humid, tropical, and subtropical regions, and in different parts of the world, sesame is cultivated between 25°N and 25°S latitudes [5]. In Ethiopia, sesame is grown
mainly in low- and mid-altitude areas, altitudes between 500 and 1300 meters above the sea level (masl) being the most suitable. Sesame productivity can go up to 1200 kg/ha and up to 2100 kg/ha at rain fed and irrigation production conditions [6]. However, the productivity of the available sesame varieties released so far (both for rain fed and irrigation production) is lower than some of the producing countries. Hence, the objective of this study is to evaluate different available genotypes which may be indispensably important for further sesame breeding and to identify high-yielding genotypes with desirable agronomic traits.

2. Materials and Methods

The experiment was conducted in Northern Ethiopia, Western zone of Tigray, specifically in the Humera area for three growing seasons (2013-2015). The agroecology of the locations is described as hot to warm semiarid plain (SA1-1) with edaphic and climatic variations as indicated in Table 1 and Figure 2, respectively.

2.1. Experimental Design and Material. The experiment was conducted under the rain fed condition, and in both of the three cropping seasons, twelve genotypes (ten advanced lines, one standard check, and other one local check) were evaluated. The twelve genotypes viz. Acc-051-02-sel-(1), Acc-051-02-sel-1-(2), Acc-051-02-sel11--(1), Acc-051-02-sel-14, Acc-111-840, Acc-202-374, Cross22XT-85(24-2), Cross22XT-85(32-3)-sel-4, NN-038, Serkamo white, Hirhir (local check), and Tate (standard check) were evaluated for their grain yield and other agronomic traits. These ten advanced lines together with other 15 genotypes and advanced lines have been under preliminary variety trial for one year to evaluate their agronomic traits. After the data analysis, these ten advanced lines were selected and promoted for further regional variety trial.

Further description of the genotypes is given in Table 2.

The experiment was laid down in randomized complete block design (RCBD) having three replications in both of the cropping seasons. Each genotype was randomly assigned and sown in a plot area of 2.8 m by 5 m with 1 m between plots and 1.5 m between blocks keeping inter- and intrarow spacing of 0.4 m and 0.1 m, in that order. Each experimental plot was treated equally as per the recommendations of the crop for the growing area.

2.2. Data Collection. Each treatment was laid down in a total plot area of 10 m$^2$ area (5 meter row length having 5 number of rows at 0.4 m interrow spacing) and net plot area of 6 m$^2$. From the net plot area, seven plants were selected randomly and tagged to collect the agronomic traits data (except grain yield) and the average values of the agronomic traits from the seven plants were considered for further statistical analysis. Grain yield of the genotypes was taken from the net plot area (6 m$^2$) of the three replications, and the average yield was taken and converted in to yield per hectare. The detailed explanation of the agronomic traits collected from this study and analyzed for further interpretation is elucidated below:

(i) Days to 50% Flowering (DF): the number of days starting from emergence up to 50% of the plants in each plot becomes flowered

(ii) Days to 50% maturity (DM): the number of days starting from emergence up to 50% of the plants in each plot becomes matured

(iii) Plant height at maturity (PH) (cm): this growth parameter is the stature of the plants in centimeter (cm) from the ground up to the top of the plants

(iv) Length of the pod-bearing zone (LPBZ) (cm): the stature of the plant from the first pod-bearing zone to the tip of the plant was measured using a meter tape

(v) Number of branches per plant (BPP): number of productive branches with one or more number of pods
(vi) Number of pods per plant (PPP): refers to the total number of pods in a given plant counted at the time of maturity

(vii) Seeds per pod (SPP): the average number of sesame seeds counted per pod and the average number of seeds collected from five plants and one pod from each plant

(viii) Thousand seed weight (gram) (TSW): the average weight of 1000 seeds randomly collected from the harvested grain yield in grams

(ix) Grain yield (kg/ha): the total grain yield (kg/ha) harvested from the net plot area

3. Results and Discussion

3.1. Variance Estimation of the Agronomic Traits. The results of the agronomic traits obtained from the combined analysis of variance of the genotypes are illustrated in Table 3. The genotype, year, and genotype by year interaction (G × Y) variances were decomposed to provide a general overview in relation to the evaluated traits and overall performance of the genotypes (Table 3). As a result, the genotype, year, and genotype × year interaction components showed statistically highly significant variation (p < 0.001) for most of the agronomic traits. However, thousand seed weight (in gram) (TSW) was not statistically significant across years, and length of the pod-bearing zone (LPBZ) was not statistically significant in the genotype by year interaction (G × Y). This statistical difference was due to both of the main and interaction effectsof the genotypes and theyears. As indicated in Table 3, the genotypes were clearly different in their agronomic traits, and similarly the years, in which the experiment was conducted, were different mainly in the rainfall received during that specific growing season (Figure 2). Moreover, Table 3 clearly shows that the response of the genotypes were unstable and fluctuated in their trait expression with change in the growing seasons. These all observable facts clearly confirm the presence of genotype by year interaction (G × Y) in this study. [7] also reported
3.2. Agronomic Traits Performance of the Evaluated Sesame Genotypes. Combined analysis of the 12 sesame genotypes evaluated in three different growing seasons is depicted in Table 4. The result of the combined analysis showed that the genotypes were significantly different in their grain yield across the three different growing seasons showing that the genotypes were unstable in their grain yield. In addition to this, the grain yield analysis showed that there was a statistically significant difference among the genotypes in all of the agronomic traits and the genotypes were unstable, even all of the other agronomic traits. Similarly, the grand mean of the sesame genotypes were different in different growing seasons[10]. Most of the agronomic traits, except thousand seed weight, were statistically different across the three growing seasons (Table 5). [1] also found a significant difference of the genotype, year, and genotype × year interaction effects in sesame genotypes.

Table 3: Combined mean squares for different agronomic traits of sesame genotypes.

| Source of variation | d.f. | Yield | DF | DM | BPP | LPBZ | PH | PPP | SPP | TSW |
|---------------------|------|-------|----|----|-----|------|----|-----|-----|-----|
| Replication         | 2    | 5476  | 10.3| 5.28| 0.66| 148.6| 8.6 | 29.15| 22.9 | 0.06 |
| Genotype            | 11   | 94028 | 10.7***| 7.613***| 1.1***| 695.3**| 603.9***| 121**| 83.3***| 0.09***|
| Year                | 2    | 1166827 | 1080.3**| 1261.8**| 37.2**| 5396.3* | 11895.6**| 1951.2**| 69.4* | 0.006ns |
| Gen × year          | 22   | 28127 | 2.7**| 6.9***| 0.8***| 230.3ns | 332.2* | 117.1***| 35.3* | 0.071** |
| Residual            | 70   | 7079  | 1.21| 1.16| 0.25| 141.4 | 159 | 37.15| 17.5 | 0.02 |

ns: nonsignificant; * significant (p < 0.05); ** highly significant at p < 0.01; *** highly significant at p < 0.001; d.f.: degree of freedom; DF: days to 50% flowering; DM: days to 50% maturity; BPP: number of branches per plant; LPBZ: length of the pod-bearing zone (cm); PH: plant height (cm); PPP: pods per plant; SPP: seeds per pod; TSW: thousand seed weight (gram).

3.3. Performance of the Sesame Genotypes across the Three Years. Performance of the sesame genotypes in terms of their agronomic traits evaluated in three different growing seasons is depicted in Table 5. The growing seasons were different from one another in allowing the genotypes to have different performance [7]. The agronomic traits of the sesame genotypes were different in different growing seasons[10]. Most of the agronomic traits, except thousand seed weight, were statistically different across the three growing seasons Table 5. [1] also found a significant difference of different agronomic traits of wheat evaluated across years. There is a possibility for occurrence of such variation of genotypes in their agronomic traits across years and even across locations, and this may be both a challenge and an opportunity for plant breeding and breeders [11]. The highest grain yield of the sesame genotypes was recorded in the second growing season (2014). This might be because there was optimum and evenly distributed rainfall during this growing season (Table 5). On the contrary, the highest number of branches per plant, length of the pod-bearing zone, plant height, and number of pods per plant were recorded in the first growing season (2014).

The combined performance of the different agronomic traits of the sesame genotypes is depicted in Table 4. However, Table 6 is organized to clearly visualize the performance of the different agronomic traits of the sesame genotypes evaluated in the three growing years. From the three growing seasons, the highest grain yield (1161.5 kg/ha) was recorded from the local cultivar Hirhir grown in the second growing season (2014). Similarly, the highest length of the pod-bearing zone (81.8 cm) and plant stature (170.3 cm) was recorded from the local cultivar Hirhir grown in the first growing season (2013). In terms of the number of pods per plant, the highest PPP (41 PPP) and the highest SPP (64.7 SPP) were obtained from Acc-202-374 grown in 2013 and Hirhir grown in 2014 growing season, respectively (Table 6).
### Table 4: Combined mean yield (kg/ha) and yield components of the sesame genotypes evaluated in three years.

| Genotypes             | Yield (kg/ha) | DF (days) | DM (days) | BPP (cm) | LPBZ (cm) | PH (cm) | PPP (number) | SPP (number) | TSW (gram) |
|-----------------------|---------------|-----------|-----------|----------|-----------|---------|--------------|--------------|------------|
| Acc-051-02-sel-(1)    | 556.9de       | 44.2a     | 88cd      | 2.5cdef  | 49.7c     | 115.7de | 27.2bc       | 62.0a        | 2.7de      |
| Acc-051-02-sel-1-(2)  | 628.4cd       | 45.6b     | 86.89ab   | 2.8cde   | 49.4c     | 118.8cd | 31.02ab      | 58.68ab      | 2.9b       |
| Acc-051-02-sel11--(1) | 664.8c        | 45.2a     | 89.56f    | 2.5cdf   | 49.5c     | 135.7a  | 32.04ab      | 62.52a       | 2.9b       |
| Acc-051-02-sel-14     | 666c          | 45.2a     | 88.67def  | 2.8bced  | 62.7a     | 136.4a  | 34.13a       | 57.88bc      | 2.9b       |
| Acc-111-840           | 538e          | 47.9e     | 88.22cde  | 2.4ef    | 33.1d     | 120.6bcde| 22.84c       | 57.53b       | 2.7e       |
| Acc-202-374           | 633.7cd       | 46bc      | 87.56abc  | 2.9bc    | 53.2bc    | 130.6ab  | 31.09ab      | 58.93ab      | 2.8de      |
| Cross2XT-85-(24-2)    | 577.6de       | 46bc      | 87.89bcd  | 2.4fde   | 56.8bc    | 129.9abc | 31.31ab      | 57.78bc      | 2.8bcd     |
| Cross2XT-85-(32-3)-sel-4 | 564.7de     | 46.7cd    | 88.22cde  | 2.4fde   | 56.8bc    | 126.8absd| 27.13bc      | 53.6de       | 3a         |
| Hirhir (local check)  | 906.3a        | 45.2a     | 86.56a    | 3.1ab    | 68.4a     | 129.7abc | 35.16a       | 61.1ab       | 3a         |
| Grand mean            | 650.6         | 45.88     | 88.09     | 2.73     | 53.5      | 126.4   | 30.49        | 58           | 2.8        |
| LSD (<0.05)           | 137.01        | 1.79      | 1.7       | 0.82     | 19.3      | 20.5    | 9.9          | 6.8          | 0.22       |
| CV (%)                | 12.9          | 2.4       | 1.2       | 18.6     | 22.2      | 10      | 20           | 7.2          | 6.7        |

### Table 5: Agronomic traits of the sesame genotypes for the three years (growing seasons).

| Year | Yield (kg/ha) | DF (days) | DM (days) | BPP (cm) | LPBZ (cm) | PH (cm) | PPP (number) | SPP (number) | TSW (gram) |
|------|---------------|-----------|-----------|----------|-----------|---------|--------------|--------------|------------|
| 1    | 498.2c        | 51.9c     | 94.7c     | 3.88a    | 62.1a     | 145.5a  | 36.4a        | 58ab         | 2.9        |
| 2    | 849.2a        | 41.2a     | 86.2b     | 2.33b    | 59.1a     | 124.5b  | 32.8b        | 56.61b       | 2.883      |
| 3    | 604.4b        | 44.4b     | 83.3a     | 1.96c    | 39.5b     | 109.3c  | 22.2c        | 59.39a       | 2.894      |
| Grand mean | 650.6 | 45.89 | 88.09 | 2.73 | 53.5 | 126.4 | 30.49 | 58 | 2.89 |
| LSD (<0.05) | 67.5 | 0.74 | 0.82 | 6.93 | 7.29 | 3.71 | 2.49 | ns |
| CV (%) | 22.2 | 2.4 | 1.2 | 18.6 | 22.2 | 10 | 20 | 7.2 |

### Table 6: Yield and yield components of sesame genotypes evaluated in the three growing years.

| Genotype             | Yield (kg/ha) | DF (days) | DM (days) | LPBZ (cm) |
|----------------------|---------------|-----------|-----------|-----------|
| Acc-051-02-sel-(1)   | 428.8         | 724.9     | 517.0     | 50.7      |
| Acc-051-02-sel-1-(2) | 501.0         | 915.4     | 469.0     | 52.0      |
| Acc-051-02-sel-14    | 537.4         | 886.9     | 573.7     | 50.7      |
| Acc-051-02-sel11--(1)| 416.4         | 917.8     | 660.2     | 51.3      |
| Acc-111-840          | 320.9         | 783.1     | 509.9     | 55.3      |
| Cross2XT-85-(24-2)   | 405.2         | 605.1     | 722.5     | 51.3      |
| Cross2XT-85-(32-3)-sel-4 | 317.8     | 852.2     | 523.9     | 53.3      |
| Hirhir (local check) | 679.7         | 1161.5    | 877.7     | 52.3      |
| NN-038               | 538           | 752.4     | 592.1     | 50.7      |
| Serkamo white        | 564.7         | 917.8     | 769.4     | 51.0      |
| Tate                 | 695.9         | 850.4     | 537.1     | 52.7      |
| Grand mean           | 498.2         | 849.3     | 604.4     | 51.9      |
| LSD (<0.05)          | 137.01        | 1.79      | 1.7       | 0.82      |
| CV (%)               | 12.9          | 2.4       | 1.2       | 18.6      | 22.2     | 10      | 20      | 7.2     |

International Journal of Agronomy 5
3.4. Ordination of the Sesame Genotypes and Their Agronomic Traits. To clearly visualize the association of the sesame genotypes and their agronomic traits, a biplot is depicted in Figure 3. In the ordination of the genotypes and their agronomic traits, the first two principal components (PCs) accounted for 58% of the total variance (38.3% and 19.7% for PC1 and PC2, respectively) (Figure 3). A biplot was used by [12] to visualize the associations of different parametric and nonparametric stability measures in faba bean.

The importance and relationship between variables within a component are determined by the magnitude and direction of factor loadings within a PC [13]. The sign of the loading indicates the direction of the relationship between the components and the agronomic traits. Principal component axis one (PCA1) that accounted for 38.3% of the variation was positively associated with grain yield, branches per plant, length of the pod-bearing zone, plant height, number of pods per plant, number of seeds pod, and thousand seed weight. In contrast to this, PCA1 was negatively associated with days to 50% flowering and 50% maturity. [14] also found a similar result to this finding. In contrast to this, PCA1 was negatively associated with days to 50% flowering and 50% maturity (Figure 3). [11, 14] also found similar results to this finding from their study on sesame genotypes.

In any plant breeding program, the final objective is to boost quality and/or quantity of a required crop. Knowing the association between the required trait and other related traits is a prerequisite for such programs. Yield is a dependable complex inherited character as a result of interaction of several contributing factors that may be related or unrelated. Hence, it is paramount important to see the association of the sesame genotypes and their agronomic traits and the association of the different agronomic traits among each other. Hence, according to Figure 3, days to 50% flowering (DF) and days to 50% maturity (DM) were negatively associated with most of the agronomic traits like thousand seed weight (TSW), grain yield (Yield), length of the pod-bearing zone (LPBZ), plant height (PH), pods per plant (PPP), and seeds per pod (SPP). G9 (Hirhir) was positively and highly associated with the first principal component (PCA1) as well as with the agronomic traits like yield, pods per plant, and length of the pod-bearing zone. This is also similar with Table 4, indicating that Hirhir scored highest grain yield (yield), length of the pod-bearing zone (LPBZ), and pods per plant (PPP). In the contrary, G5 (Acc-111-840), G12 (Tâte), and G1 (Acc-051-02-sel-(1)) were positively associated with the second component (PCA2) and with the agronomic traits of days to 50% flowering and days to 50% maturity.

4. Conclusion and Recommendation

The genotype, year, and genotype×year interaction components showed statistically highly significant variation (p < 0.001) for most of the agronomic traits of the sesame genotypes which confirm the presence of genotype by year interaction (G×Y) in this study.

Regarding the grain yield, the highest grain yield (906.3 kg/ha) was obtained from Hirhir followed by Serkamo white (756.5 kg/ha). Generally, since there are some genotypes which are statistically nonsignificant with the best Hirhir in some of the major agronomic traits, the genotypes should be maintained for further sesame breeding program. On the contrary, the highest grain yield of the genotypes was recorded in the second growing season (2014), and the highest grain yield (1161.5 kg/ha) was recorded from the local cultivar Hirhir.

Principal component axis one (PCA1) that accounted for 38.3% of the variation was positively associated with grain yield, branches per plant, length of the pod-bearing zone, plant height, number of pods per plant, number of seeds pod, and thousand seed weight. On the contrary, the second component axis (PCA2) which accounted for 19.7% of the variation was positively associated with days to 50% flowering and days to 50% maturity.

Finally, this study is of paramount importance to identify the best genotypes in terms of the different agronomic traits and to investigate the agronomic performance of sesame genotypes across different growing seasons, and this study also forwards for sesame researchers to carry out different researches across locations and across years.

Data Availability

The supplementary material file includes data used for the analysis of this manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Supplementary Materials

The abbreviations and the words they stand for listed below: DF, days to 50% flowering; DM, days to 50% maturity; BPP,
number of branches per plant; PH, plant height (cm); PPP, pods per plant; SPP, seeds per pod; LPBZ, length of the pod-bearing zone (cm); TSW, thousand seed weight (gram). The experiment was conducted for three years in Humera in a randomized complete block design with three replications. 12 advanced lines which come from previous selections were used in the experiment, and these advanced lines were tested for three years. All of the yielded and other agronomic traits were collected from the 12 advanced lines conducted for three years. (Supplementary Materials)

References

[1] M. Taghouti, N. Nsarellah, F. Gaboun, and A. Rochdi, “Multi-environment assessment of the impact of genetic improvement on agronomic performance and on grain quality traits in Moroccan durum wheat varieties of 1949 to 2017,” Global Journal of Plant Breeding and Genetics, vol. 4, no. 7, pp. 394–404, 2017.

[2] R. K. Anilakumar, A. Pal, F. Khanum, and A. S. Bawa, “Nutritional, medicinal and industrial uses of sesame (Sesamum indicum L.) seeds,” Agriculturae Conspectus Scientificus, vol. 75, no. 4, 2010.

[3] NBE (National Bank of Ethiopia), “Annual report of (2014/15), of Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia,” National Bank of Ethiopia, Addis Ababa, Ethiopia, 2015.

[4] MoT, “Annual report of the Ministry of Trade of Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia,” Ministry of Trade, Addis Ababa, Ethiopia, 2017.

[5] A. Ashri, “Genetic resources of sesame: present and future perspectives,” in Sesame Biodiversity in Asia Conservation, Evaluation and Improvement, R. K. Arora and K. W. Riley, Eds., pp. 25–39, IPGRI Office for South Asia, New Delhi, India, 1994.

[6] K. Uçan, F. Kılıç, C. Gencoglan, M. Merdun, C. Gencoğlan, and H. Merdun, "Effect of irrigation frequency and amount on water use efficiency and yield of sesame (Sesamum indicum L.) under field conditions," Field Crops Research, vol. 101, no. 3, pp. 249–258, 2007.

[7] Baraki, F. Y. Tsehaye, and F. Abay, “Analysis of genotype × environment interaction and seed yield stability of sesame in Northern Ethiopia,” Journal of Plant Breeding and Crop Science, vol. 8, no. 11, pp. 240–249, 2016.

[8] O. Z Mehmet, “Yield and stability analysis of some sesame (sesamum indicum L.) genotypes in Turkey,” International Journal of Agriculture and Biology, 2017.

[9] F. Akbar, M. A. Rabbani, K. Z. Shinwari, and J. S. Khan, “Genetic divergence in Sesame (Sesamum indicum L.) landraces based on qualitative and quantitative traits,” Pakistan Journal of Botany, vol. 43, no. 6, pp. 2737–2744, 2011.

[10] M. B. S. Ahmed and F. A. Ahmed, “Genotype × season interaction and characters association of some Sesame (Sesamum indicum L.) genotypes under rain-fed conditions of Sudan,” African Journal of Plant Science, vol. 6, no. 1, pp. 39–42, 2012.

[11] F. Baraki, Y. Tsehaye, and F. Abay, “Assessing interrelationship of sesame genotypes and their traits using cluster analysis and principal component analysis methods,” International Journal of Plant Breeding and Genetics, vol. 9, no. 4, pp. 228–237, 2015.

[12] Temesgen, G. Keneni, T. Sefera, and M. Jarso, “Yield stability and relationships among stability parameters in faba bean (Vicia faba L.) genotypes,” The Crop Journal, vol. 3, no. 3, pp. 258–268, 2015.

[13] A. M. Azeez, O. C. Aremu, and O. O Olaniyan, “Assessment of genetic variation in accessions of Sesame (Sesamum indicum L.) and its crosses by seed protein electrophoresis,” Journal of Agroalimentary Processes and Technologies, vol. 19, no. 4, pp. 383–391, 2013.

[14] S. Chowdhury, A. K. Datta, A. Saha et al., “Traits influencing yield in Sesame (Sesamum indicum L.) and multilocational trials of yield parameters in some desirable plant types,” Indian Journal of Science and Technology, vol. 3, no. 2, pp. 163–166, 2010.
