Scientific Journal of Agricultural Sciences 4 (1): 1-11, 2022
Print (ISSN 2535-1796) / Online (ISSN 2535-180X) DOI: 10.21608/sjas.2022.111478.1174

Improving Earliness-Related Traits of Egyptian Local Okra Cultivar (*Abelmoschus esculentus* L. Moench)

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Received on: 15-12-2021 **Accepted on: 12-2-2022**

ABSTRACT

This study aimed to improve the local okra cultivar (cv. Balady) by accessing superior earliness pure lines using an individual plant selection breeding program. Six cycles of individual plant selection were carried out at the Agricultural Experimental Station Farm at Abies region, Faculty of Agriculture, Alexandria University, Egypt, which resulted in ten pure lines with distinct horticultural traits. The selected pure lines were evaluated in the summer season of 2020 with the original population. The results showed that the pure lines L5 and L1 recorded significantly the lowest mean values compared to all the genotypes for the earliness traits, viz., days number to first flower and pod, as well as days number to 50% flowering, and days number to first harvest. Moreover, the selected pure lines significantly exceeded the original population in the characteristics of early and total yield per plant, and the three pure lines L4, L8, and L9 were the most distinguished for these traits. Concerning correlation estimates, the characteristics of earliness reflected positive and significant correlations between one another, as well as, with the characteristics plant height and early yield as the number of pods. The results of cluster analysis illustrated that the first group (I) was distinguished as being the earliest, while the third (III) and fourth (IV) clusters were the best for the productivity traits. So, it is recommended to use the pure lines L4, L8, and L9 to improve total and early yield as well as the earliness traits.

KEYWORDS: *Abelmoschus esculentus* L., Cluster analysis, Correlation, Earliness, Okra, Selection.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a vegetable crop of enormous economic importance in tropical and subtropical countries, belongs to Malvaceae family. It is a popular vegetable crop among people of all socioeconomic strata around the world since all parts of the plant can be used; immature pods are the most popular and can be eaten raw, steamed, boiled, or fried.

Okra flower is classified as a hermaphrodite, self-fertile and self-compatible, therefore pollination takes place naturally without the need for insects, but the petals of this crop have attractive colors and thus invite insects to visit. As a result, this crop has a notable level of open pollination, with a percentage ranging from 4 to 19% (Choudhury and Choonsai, 1970), with a maximum of 42.2% (Mitidieri and Vencovsky, 1974). Accordingly, variation in its characteristics can be expected, which reflects a large proportion of genetic diversity. Different okra cultivars show a great deal of variability in many traits, such as yield, days number to first flower, number of pods per plant, and plant height (Abo El-Khar 2003, Masoud *et al*., 2007, Helmy and Ragheb, 2019 and Kumar *et al.*, 2019). Thus, it is a rich source of diversity that can be used as a basic material to start any breeding program to improve the characteristics of this crop.

Okra research has typically focused on yield and its components, or traditional okra qualities, with little attention paid to early traits, especially in developing nations. There are several strategies to boost the productivity of any crop, and one of them is to adopt early production cultivars (Reddy *et al.*, 2014). Early fruiting or ripening is frequently a critical aspect of the success of any crop. Early cultivars provide various advantages, including improved productivity (in the early part of the harvest), an earlier start to harvest, and an earlier crop termination. Early harvesting okra cultivars also allow farmers more time to grow another crop (intensive production system). Moreover, it is important in mitigating the late-season risks of insect pests, diseases, and unfavorable weather conditions, and increasing the economic return by reducing the cost of inputs and fetching a high market price. Chemical insecticides, as well as other inputs like irrigation water and fertilizers, can also be reduced. Because water scarcity is a major issue these days, shortening the ripening period allows us to give the necessary irrigation water for okra. In Egypt, the harvesting of okra pods varies by cultivar and planting date. The harvest season for the Balady cultivar, which is considered one of Egypt's most important okra cultivars, begins from 70 to 90 days after planting and lasts 2-4 months. As a result, there is a need to develop local okra cultivars, especially for earliness characteristics so that they are characterized by early maturity with a short growth cycle and highest yield of pods. Therefore, okra breeding for early growth can be considered one of the most important goals of okra breeding.

Accordingly, this research was conducted to focus on improving the set of earliness characteristics of the Balady okra cultivar. This present study is a part of an integrated breeding program to improve some local okra cultivars, which aims to examine the efficiency of using an individual plant selection program to improve earliness traits without significantly affecting economic yield.

2. MATERIALS AND METHODS

The current breeding program was carried out at the experimental station farm, Faculty of Agriculture, Alexandria University in Abies, Alex, A.R.E. Okra seeds of Balady cultivar were obtained from several farms and planted on March 10th, 2014. In the first selection cycle, the plants were subjected to selection, and the best plants were phenotypically selected based on many criteria such as earliness, plant height, branching, and early and total yield. To promote genetic homogeneity in subsequent progeny, selected plants were self-pollinated. On March 15th, 2015, selfed seeds were sowed and the finest families were chosen to create more homozygous plants. During the four summer seasons from 2016 to 2019, the same selection technique was used with self-pollination. After six cycles of individual plant selection, the finest ten pure lines were identified at the end of the last selection season.

On March 10, 2020, a field experiment was conducted to assess the effectiveness of individual plant selection program for six generations; based on the overall performance of the researched characters of selected lines. Seeds of the 10 pure lines and their original population, which were gathered from dried pods from the previous season, were sown. A complete randomized block design with three replicates was used in this experiment. The experimental unit consisted of three rows that were 4.00 m long and 0.70 m wide, with a 0.30 m spacing between plants. Appropriate agricultural practices have been implemented such as weeding, use of organic manure, application of fertilizers, especially at the beginning of bud initiation as well as timely watering and when necessary. Data were taken on a random sample of five plants based on the following earliness and yield criteria: plant height, branches number per plant, days number to first flower, days number to first pod, days number to 50% flowering, days number to first harvest, days number to last harvest, fruiting period, average pod weight, early yield per plant (number and weight), and total yield per plant (number and weight). The early yield was estimated as 50% of the total yield.

2.1. Statistical analyses

The mean values for each character under study were analyzed statistically. Analysis procedures have been described by Al-Rawi and Khalf-Allah (1980), using the computer program Co-Stat (2004). The collected data were analyzed using SPSS (version 24) and Squared Euclidean distance, which was used as a measure of distance for cluster formation.

3. RESULTS AND DISCUSSION

3.1. Evaluation of genotypes after six cycles of individual plant selection

3.1.1. Mean performances of selected pure lines

The means of all analyzed attributes of the pure lines selected from the individual plant selection program with self-pollination for six cycles in the okra crop, as well as their original population, are presented in Tables 1 and 2. The results showed that at the completion of the selectorial program, all 10 pure lines showed statistically significant differences for all attributes investigated. The means' performance also revealed the superiority of all the selected pure lines over the original population, as well as the superiority of certain of them over others.

3.1.2. Vegetative growth traits

During this selection program, the focus was on medium-sized plants as shows in Table 1. The results illustrate that the original cultivar "Balady" generated plants with a significantly higher mean value than all pure lines in terms of plant height character. Concerning the selected pure lines, the plant height ranged from 125.05 to 100.08 cm in pure lines L_3 and L_2, respectively. Accordingly, pure line L_3 recorded the highest significant mean value (125.05 cm) for plant height, followed by pure line L_9 (123.03 cm) without any significant difference between them. The final height of the okra plant is of relevance in breeding programs since tall, thin stems are caused in

Table 1. Mean performance of Balady cultivar and selected pure lines after six cycles of individual plant selection.

Traits / Pure lines	Plant height (cm)	Branches no. per plant	Days no. to first flower	Days no. to first pod	Days no. to 50% flowering	Days no. to first harvest	Days no. to last harvest	fruiting period
L_1	120.08 bc	1.10 d	28.05 c	31.06 c	30.06 d	33.03 d	93.05 e	60.00 b
L_2	100.08 d	2.05 c	35.07 b	38.00 b	37.08 b	40.03 b	100.04 d	60.17 b
L_3	125.05 b	3.16 b	32.03 bc	35.08 bc	34.06 b-d	37.02 bc	112.10 b	75.00 a
L_4	114.07 bc	3.00 b	30.08 bc	33.01 bc	32.03 cd	35.04 cd	105.00 c	70.07 a
L_5	110.00 cd	2.02 c	28.06 c	31.04 c	30.08 d	33.03 d	93.04 e	60.07 b
L_6	110.22 cd	1.04 d	30.09 bc	33.01 bc	32.07 cd	35.03 cd	85.09 f	50.08 c
L_7	115.03 bc	1.00 d	30.05 bc	33.10 bc	32.03 cd	35.00 cd	90.03 e	55.03 bc
L_8	120.08 bc	2.00 c	30.08 bc	33.09 bc	32.06 cd	35.03 cd	105.07 c	70.10 a
L_9	123.03 b	2.06 c	32.04 bc	35.08 bc	34.00 b-d	37.07 bc	112.03 b	75.07 a
L_{10}	100.14 d	3.00 b	34.07 bc	37.04 bc	36.03 bc	39.05 b	99.03 d	60.06 b
Balady O.P.)	180.19 a	5.03 a	55.17 a	58.28 a	60.18 a	63.20 a	133.24 a	70.10 a

Values having the same alphabetical letter (s) within each column, don't significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

lodging during harvesting time and this could result in loss of dry matter and a consequent fall in pod production (Akinyele and Oseikita, 2006). It is in agreement with the findings of Eshiet and Brisibe, 2015. Also, Reddy et al., 2012 stated that shorter plants are associated with resistance to lodging. The number of branches per plant varies a lot among the genotypes that were evaluated. Among the selected pure lines, the pure line L3 possessed the largest number of branches/plant (3.16); while L7, L6, and L1 exhibited the lowest means (1.00, 1.04, and 1.10, respectively) with insignificant differences between one another. While the original population recorded the highest number of branches (5.03) among all evaluated genotypes.

The indeterminate growth nature of native or even spreading okra cultivars are traits that may have been chosen over the years by researchers and farmers because they allow for a long and continuous harvest of pods. This is considered an advantage if the prices of fruits are stable in the market, but when the prices of vegetables fluctuate, it is not considered an advantage in this case. Hence, the importance of selecting structures with a medium to short plant height with fewer branches of an erect nature with early flowering and fruiting, noting that this erect nature of the plant will allow the maximum and uniform exposure of the plant parts to the sun's rays better. This would lead to an increase in dry matter production and a subsequent increase in yield. This is consistent with the findings of Oppong-Sekyere et al., 2012. Therefore, selection for erect plants of medium to short height with fewer branches with early flowering and fruiting and a large total number of pods per plant is the desired goal from the breeding program.

3.1.3. Earliness and harvest characteristics

The results shown in Table 1 indicated that the differences among the ten selected okra pure lines were significant for all the studied earliness traits, i.e., days number to first flower, days number to first pod, days number to 50% flowering, days number to first harvest, days number to last harvesting and fruiting period. These pure lines also reflected a remarkable superiority in these traits compared to the original population. Concerning the four attributes: days number to first flower, days number to first pod, days number to 50% flowering, and days number to first harvest, the results revealed that the two pure lines L_1 and L_5 were the earliest, since they had the lowest mean values when compared to the remainder of the pure lines as well as the original population. While the pure line L_2 was too late compared to the other selected pure lines, which gave the highest mean values, but it is still earlier than the original population. The remaining seven pure lines had average performance, reflecting some significant differences among themselves as well as the original population while keeping the qualities of earliness when compared to the base population. This result is in accordance with the findings of Ashraful and Hossain, 2006 and Katung, 2007, who reported similar behavior among the different okra cultivars in terms of days to flowering. Several studies found statistically significant variations between several okra genotypes in terms of earliness and growth features, according to several researchers. The mean values for the features of days till 50% flowering, plant height, and number of branches, according to Amunu *et al.*, 2016, are 46.82, 1.25 m, and 2.92, respectively. For the traits days number to first flowering, number of primary branches, plant height, and days to maturity, Chandra *et al.*, 2014 reported ranges of 47.33 to 54.67, 1.47 to 3.53, 102.53 to 155.67 cm, and 53.33 to 63.33, respectively. Also, Shivaramegowda *et al*., 2016 scored mean values of 41, 2.08 and 96.73 cm for days to first flower, number of primary branches, and plant height, respectively.

As for the characteristics of days number to last harvest and the fruiting period, the results shows that the original population recorded the highest significant value for the trait of days number to last harvest (133.24 days), followed by the pure line L_3 and L_9 with mean values of 112.10 and 112.03 days, respectively, without significant difference between them. While the pure line L_7 gave the least days number to last harvest (90.03 days), which did not differ significantly from the two pure lines L_1 and L_5, where the mean values of 93.05 and 93.04 days, respectively, were recorded. In terms of the fruiting period trait, it ranged from 50.08 to 75.07 days in both pure lines L_6 and L_9, respectively. As can be seen in Table 1, there is clear and considerable diversity in this crucial feature among the genotypes tested.

By presenting the previous results of earliness it can be concluded that early flowering not only gives early pickings and better returns but also could be widened the fruiting period of the plant. Accordingly, the plant breeder must be interested in improving such traits, early traits, as they can be exploited to improve the return for the farmer. These genotypes will enable the farmer to make optimal use of the unit area by planting a second crop after harvesting the early crop or planting the next crop at an early date. In addition, the farmer can also save on production requirements that are currently very high prices, such as fertilizers and pesticides, as well as the necessary water meter; This is in addition to the great benefit from the high prices of early harvesting in okra crop.

3.1.4. Early and total pod yield

The average pod weight is an important parameter in any crop, but especially in okra. Because this trait reflects the length and diameter of the fruit, which affects the price of the product as well as productivity and thus profitability in general, whether for the farmer or the merchant. From Table 2, the mean values of pod weight were somewhat near among the studied genotypes, where the average pod weight ranged between 4.94 to 3.55 g. Accordingly, pure line L_{10} recorded the highest mean value of pod weight (4.94 g), followed by pure line L_4 (4.88 g) without any significant difference between them, while pure line L_1 recorded the lowest pod weight mean (3.55 g).

Table 2. Mean performance of Balady cultivar and selected pure lines after six cycles of individual plant selection.

Traits / Pure lines	Average pod weight (g)	Early yield		Total yield	
		No. pods per plant	Pod weight per plant (g)	No. pods per plant	Pod weight per plant (g)
L_1	3.55 e	25.08 b	87.57 de	50.11 cd	174.95 de
L_2	4.58 a-c	17.11 d	76.76 e	35.10 f	153.26 e
L_3	3.68 e	32.46 a	115.74 bc	65.11 a	232.27 bc
L_4	4.88 ab	30.00 a	144.36 a	62.06 ab	292.02 a
L_5	4.55 a-c	22.05 c	98.65 cd	43.50 e	198.50 cd
L_6	4.33 cd	23.04 bc	98.54 cd	47.06 c-e	197.14 cd
L_7	3.74 e	23.07 bc	84.70 de	45.04 de	169.41 de
L_8	4.43 b-d	30.03 a	131.37 ab	60.00 b	262.74 ab
L_9	4.00 de	31.01 a	124.06 ab	62.09 ab	248.30 b
L_{10}	4.94 a	25.03 b	121.14 b	50.30 c	242.28 b
Balady (O.P.)	4.30 cd	22.49 bc	98.45 cd	45.25 c-e	196.83 cd

Values having the same alphabetical letter (s) within each column, don't significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

Data in Table 2 generally indicate that most of the selected pure lines produced significantly higher early yield than the original population. Besides, the results reflected significant differences in the production of early pods, whether the number or weight. Pure line L_3 produced the highest mean value for early pods number per plant, followed by the pure lines L_9, L_8, and L_4; where their mean values reached 32.46, 31.01, 30.03, and 30.00, respectively, with insignificant differences between one another. While the three pure lines L_4, L_8, and L_9 recorded the highest mean values of early yield as the weight of 144.36, 131.37, and 124.06 g per plant, respectively. The difference in arrange of the superior pure lines with respect to the early yield in terms of number or weight is due to the increase in the average mean weight of the pod in pure lines L4 and L8 compared to L3 and L9 (Fig. 1).

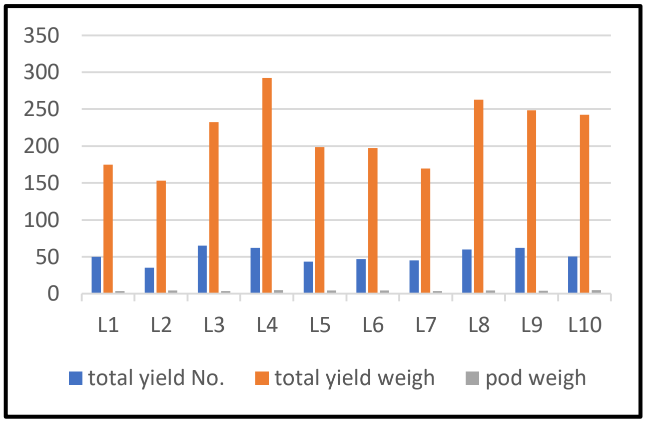

Fig. 1. Average pod weight and early yield as weight and number

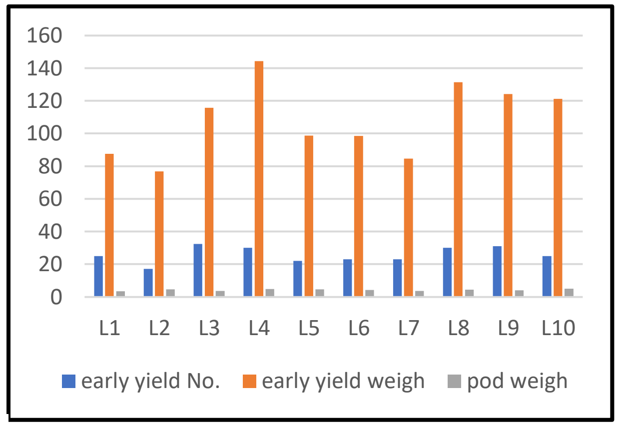

Fig. 2. Average pod weight and total yield as weight and number

Table 2 reveals also that most pure lines surpassed the original population in terms of total pod yield, as measured by number of pods per plant and pod weight per plant (g/plant). Pure line L3 generated the highest mean value of pods number, followed by lines L9 and L4, all of which exhibited insignificant differences (65.11, 62.09 and 62.06 pods per plant, respectively). As for pods yield per plant as weight, pure line L4 showed the highest significant mean value (292.02 g), followed by pure line L8 and then pure line L9 without a significant difference between these two pure lines. This suggests that the three pure lines L4, L8, and L9 outperformed in terms of production, whether in terms of number or weight; the slight differences among them can be attributed to differences in the average pod weight Fig 2. It is also clear from what was previously shown that the three pure lines L8, L4 and L9 also excelled in the trait of the early yield, whether by weight or number. Similar results were obtained by Abo-El-Khar 2003, Masoud et al., 2007; Metwally et al., 2011; Ibrahim et al., 2013; Ibrahim et al., 2018 and Helmy and Ragheb, 2019, who practiced inbreeding with selection to develop new strains of okra and stated that this method resulted in producing superior genotypes derived from Egyptian local cultivars.

3.2. Clustering pattern of ten selected pure lines and their original population

It is clear from the dendrogram that the eleven genotypes have been divided into two main clusters, based on the 13 traits under study (Fig. 3). The first cluster was called A and included only Balady cultivar, which represents the original population, as this main cluster was considered the most remote at all, especially in earliness traits. The second main cluster is B, which included the ten promising pure lines, where the genetic distance between the two main clusters (A and B) was 106.02. On the other hand, cluster B was repeatedly divided into two subclusters B1 and B2. In sub-cluster B1, there were five pure lines, named L1, L7, L5, L6, L2, and the two pure lines L1 and L7 had the smallest genetic distance (12) between two pure lines within the cluster, while the two pure lines L2 and L6 had the greatest (43.69). Furthermore, due to a rise in the genetic distance between pure line L2 and the rest of the pure lines in the same cluster, pure line L2 was separating into its own cluster. Sub-cluster B2 included the remaining five pure lines (3,9,8,10, and 4), with a genetic distance of 18.52 between the two closest pure lines (L3 and L9) and 52.59 between the two furthest pure

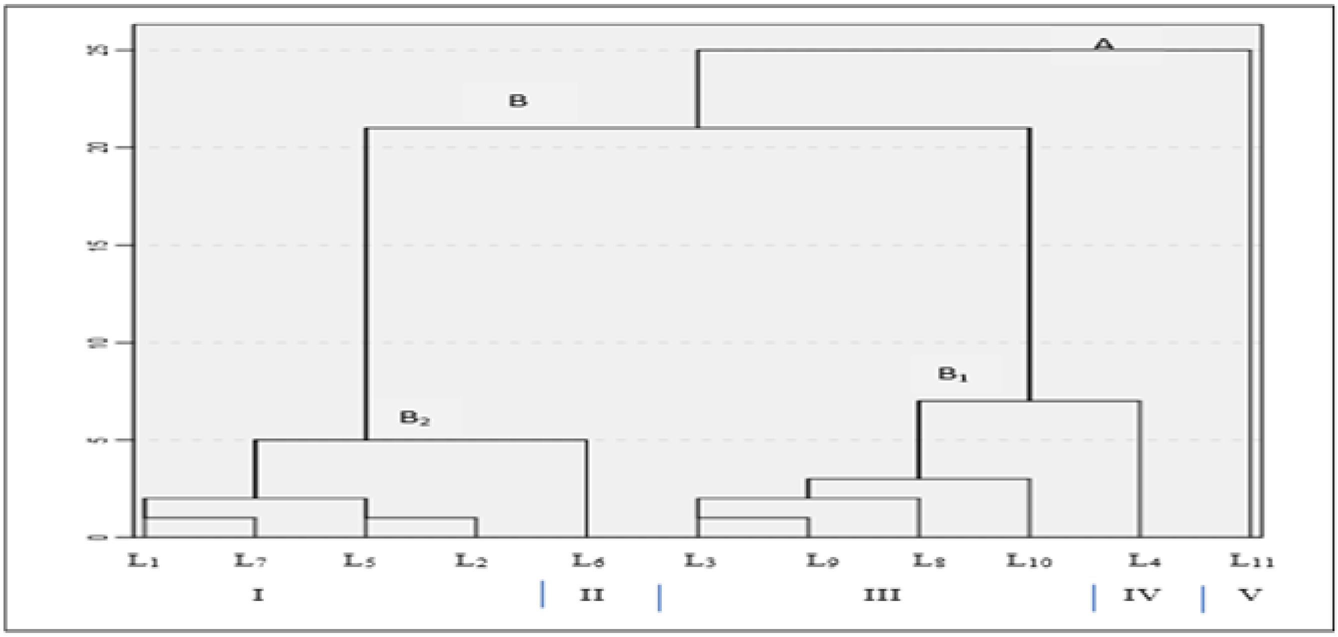

Fig 3. Dendrogram of genetic relationship among 11 okra genotypes based on 13 phenotypic

lines (L3 and L4) in the same cluster, and this pure line (L4) was separated into a single cluster due to the increase in this distance, as shown in Fig. 3. Based on the foregoing, the distribution of different genotypes in distinct clusters is shown in Table 3. The different 11 genotypes were divided into five clusters (I, II, III, IV, and V) as shown in Fig. 3 and Table 3. Among the five clusters formed, the first and third clusters were the largest as it consisted of 4 genotypes (36.36%), while the remaining three clusters (the second, fourth, and fifth) were solitary with one genotype in each cluster (9.09%).

In general, genotypes clustered together are less divergent than genotypes clustered separately. Furthermore, higher intracluster distance shows a lot of divergence within that cluster. Also, pure lines in solitary clusters may be different from others and thus may serve as potential parents for breeding programs. They indicate their independent identity and importance due to the different traits they possess (Priyanka *et al*., 2017).

The data in Table 4, which shows the values of the cluster means for the different traits that were studied, indicating that there are noticeable differences among the different clusters. In terms of plant height, the maximum plant height was recorded in cluster V (180.19 cm), followed by cluster III (117.07 cm) and cluster IV (114.07 cm), meanwhile, the lowest mean value of plant height recorded in cluster II (100.08 cm), which preceded by cluster I (113.83 cm). In terms of number of branches per plant, cluster V (5.03) had the greatest mean value, followed by cluster IV (3.00), cluster III (2.55) and cluster II (2.05); and cluster I had the lowest mean (1.29).

Table 3. Clustering pattern of genotypes of okra.

Cluster	Genotypes number	Genotypes including in cluster	% of each cluster to total genotypes
I	4	1, 7, 5, 6	36.36
II	1	2	9.09
III	4	3, 9, 8, 10	36.36
IV	1	4	9.09
V	1	Balady cultivar	9.09

Table 4. Cluster means of genotypes for 13 agro-economic traits of okra.

Traits	Clusters				
	I	II	III	IV	V
Plant height (cm)	113.83	100.08	117.07	114.07	180.19
Branches number per plant	1.29	2.05	2.55	3.00	5.03
Days no. to first flower	29.06	35.07	32.05	30.08	55.17
Days no. to first pod	32.05	38.00	35.07	33.01	58.28
Days o to 50% flowering	31.06	37.08	34.03	32.03	60.18
Days no. to first harvest	34.02	40.03	37.04	35.04	63.20
Days no. to last harvest	90.30	100.04	107.05	105.07	133.24
fruiting period	56.29	60.17	70.05	70.07	70.10
Pod weight (g)	4.10	4.33	4.26	4.88	4.30
Early yield (no. per plant)	22.57	23.04	29.63	30.00	22.49
Early yield (weight per plant, g)	90.63	98.54	123.07	144.36	98.45
Total yield (no. per plant)	44.71	47.06	59.37	62.06	45.25
Total yield (weight per plant, g)	181.76	197.14	246.39	292.02	196.83

Cluster I was the earliest of the five clusters in terms of earliness traits (days number to first flower and pod, days number to 50% flowering, and days number to first harvest). According to the results, clusters IV, III, and II were the next earliest, with the least number of days for the earliness traits, days number to first flower and pod, days number to 50% of flowering, and days number to the first harvest. While, the cluster V (Balady cultivar) had the highest mean values of these traits, indicating the amount of late in earliness as compared to the other improved clusters. Cluster V had the longest time to last harvest (133.24 days), followed by clusters III (107.05 days), IV (105.07 days), and I (100.04 days), while cluster II had the shortest time (90.30 days). Cluster V had the longest fruiting period (70.10 days), followed by cluster IV (70.07 days), cluster III (70.05 days), and cluster II (60.17 days), with cluster I's pure lines having the shortest fruiting period (56.29 days).

In terms of total and early yield, as well as average pod weight, the cluster means revealed that the pure lines of cluster IV (4.88 g) produced the heaviest pod (4.88), followed by cluster II (4.33 g), cluster V (4.30), and cluster III (4.26 g), while the pure lines of cluster I produced the lightest pod (4.10 g). As for the yield of the early pods per plant in terms of number and weight, the pure lines in cluster IV recorded the highest means (30.00 and 144.36 g), followed by cluster III (29.63 and 123.07) and cluster II (23.04 and 98.54), while, cluster V had the lowest number and weight of early yield (22.57 and 90.63 g), preceded by cluster IV (22.49 and 98.45 g) for the two features. The total yield per plant, whether measured in terms of number or weight, followed the same pattern.

Through what was presented from mean values of clusters which represented the selected pure lines, it can be noted that clusters IV and III reflected the longest number of days to last harvest, the longest fruiting period, and the highest early and total yield in terms of number and weight with a good structural structure. Also, all the selected clusters reflected the least number of days to first flower and pod, least number of days to 50% flowering, the least number of days to first harvest, and cluster I was the most earliness. So, selection of lines based on individual attributes may not be beneficial as the one based on a number of important traits taken together. These has been agreement with many researchers such as Binalfew and Alemu (2016), Amiteye *et al*. (2019) and Konan *et al*. (2020) who used cluster analysis to classify some okra genotypes based on their morphological characteristics.

Based on the foregoing; the selected pure lines were grouped into clusters based on their genetic distance, which represents the degree of divergence between them. Accordingly, it can be considered a preliminary study to select distinct and different pure lines, especially in terms of earliness and productivity, which allows the possibility of making hybrids among them. As a result of the degree of variance that was observed, the most divergent pure lines can be chosen and make hybridization among them; to be able to reach distinct hybrids that show heterosis, especially in the characteristics of earliness, growth strength, and early productivity with a distinguished yield.

3.3. Correlation

Correlation levels between 13 quantitative traits of ten pure lines of okra are shown in Table 5. A weak and non-significant correlation appeared between plant height and branches number per plant,

Table 5. Phenotypic correlation coefficients among different pairs of the studied characters in okra genotypes.

Traits	BN	DNFF	DNFP	DNF	DNFH	DNLH	FP	PW	EYN	EYW	TYN	TYW
PH	0.041	0.377*	0.381*	0.374*	0.376*	0.698**	0.777**	-0.785**	0.778**	0.152	0.695**	0.150
BN		0.274	0.276	0.277	0.280	0.639**	0.564**	0.313	0.557**	0.758**	0.618**	0.760**
DNFF			0.999**	0.999**	0.999**	0.554**	0.429*-	-0.358	0.391*	0.066	0.305	0.059
DNFP				0.999**	0.999**	0.559**	0.433*-	-0.360	o.396*	0.069	0.311	0.063
DNF					0.998**	0.553**	0.426*-	-0.352	0.388*	0.068	0.304	0.062
DNFH						0.557**	0.431*-	-0.354	0.392*	0.071	0.306	0.065
DNLH							0.974**	-0.316	0.941**	0.649**	0.924**	0.644**
FP								-0.371*	0.966**	0.635**	0.942**	0.632**
PW									-0.392*	0.414*	-0.285	0.416*
EYN										0.661**	0.968**	0657**
EYW											0.718**	0.999**
TYN												0.719**

* Significant at 0.05 level of probability. ** Highly significant at 0.01 level of probability.

PH: Plant height, **BN:** Branches number, **DNFF:** Days number to first flowering, **DNFP:** Days number to first pod, **DNF:** Days number to 50% flowering, **DNFH:** Days number to first harvest, **DNLH:** Days number to last harvest, **FP:** Fruiting period, **PW:** Pod weight, **EYN:** Early yield per plant (number), **EYW:** Early yield per plant (weight), **TYN:** Total yield per plant (number), **TYW:** Total yield per plant (weight).

while plant height recorded a positive significant correlation with the characteristics of the earliness (days number to first flower, days number to first pod, days number to 50% flowering and days number to first harvest). This means that the selection of plants with lower plant height will be earlier and produce an early yield in fewer days. This result agreed with Amiteye *et al*., 2019, while the estimated correlation by Rambabu *et al.*, 2019; exhibited negative and significant values of plant height with days to first flower, days to 50% flowering and days to first harvest. With regard to the trait branches number per plant, insignificant correlation value was recorded between it and any of the previous earliness characteristics.

Days number to first flower and pod, as well as days number to 50% flowering, days number to first harvest, are indicators of earliness in okra. Early flowering not only gives early picking and better return but also extends the fruiting period of the plant, as well as getting an early yield. This was clearly observed during this study, where the characteristic of the fruiting period reflected a significant negative association with the group of the aforementioned earliness traits. The characteristic of the fruiting period was also positively correlated to the characteristics of the early and total yield, whether in number or weight, as well as days number to last harvest. The results also showed that there is a significant and positive correlation between the previous traits of earliness and each other. Similar results were reported by Simon *et al*. (2013) and Rambabu *et al*. (2019).

As mentioned previously, the characteristics of earliness, days number to first flower and pod, as well as days number to 50% of flowering, days number to first harvest, reflected positive and significant correlations among them. It also reflected positive and significant correlations with the characteristic of the early yield as the number of pods. While insignificant correlations were recorded with the trait of the total yield per plant, whether number or weight.

4. CONCLUSION

The philosophy of this research is to focus on certain traits of okra (Balady cv.) to attain the intended improvement. This was achieved by selecting plants with a medium structure, early flowering and fruiting, early yield, and high output. When the mean values of the selected pure lines were compared to the original population, the results reversed that all selected pure lines having a distinct structural structure and better earliness attributes. Where the selected pure lines had a medium plant height and fewer branches, and all of them were also earlier than the original population by 23-30 days. As for early and total yield, most of the selected pure lines outperformed the original population in these traits. The cluster analysis confirmed these results, where the genotypes under study were divided into five clusters (I, II, III, IV, and V). These clusters reflected a noticeable discrepancy between them that could give an initial indication of the possibility of selecting divergent genotypes, the success of hybridization between them, as well as heterosis. Also, by estimating the correlation between the set of traits under study, reached significant and desirable correlations between earliness traits and each other, as well as between them and plant height and early yield, while negative and desirable correlations were recorded between earliness characteristics and the fruiting period.

Through the estimation of cluster analysis as well as the behavior of the selected pure lines, it is recommended to use the pure lines L_4, L_8, and L_9 to increase the total and early yield and to improve the earliness traits. Accordingly, the above pure lines can be considered promising and suitable genotypes for producing promising hybrids for growth under local environmental conditions.

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الملخص العربى

تحسين الصفات المرتبطة بالتبكير فى صنف الباميا المحلى

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هدفت هذه الدراسة إلى تحسين صنف البامية المحلي (الصنف البلدي) من خلال الوصول إلى سلالات نقية متميزة باستخدام برنامج انتخاب السلالة النقية. تم تنفيذ ست دورات من البرنامج في مزرعة المحطة التجريبية الزراعية بمنطقة أبيس ، كلية الزراعة ، جامعة الإسكندرية ، مصر والتي نتج عنها عشرة سلالات نقية ذات سمات بستانية مميزة. تم تقييم السلالات النقية المنتخبة في موسم صيف ٢٠٢٠ مع العشيرة الاصلية. أوضحت النتائج أن السلالات النقية L5 و L1 كانت االاكثر تبكير ، حيث سجلت أدنى قيم متوسط مقارنة بجميع الطرز الوراثية لصفات التبكير ، عدد الأيام حتى ظهور اول زهرة وقرن ، كذلك عدد الأيام حتى ٥٠٪ من التزهير ، وعدد الأيام حتى أول حصاد. علاوة على ذلك ، تجاوزت السلالات النقية المختارة بشكل كبير العشيرة الاصلية في خصائص المحصول المبكر والكلى للنبات ، وكانت السلالات النقية الثلاثة L4 و L8 و L9 هي الأكثر تميزًا لهذه الصفات. وفيما يتعلق بتقديرات معامل الارتباط بينت النتائج أن صفات التبكير عكست ارتباطات موجبة ومعنوية بين بعضها البعض. كما عكست ارتباطات موجبة ومعنوية مع خصائص ارتفاع النبات والمحصول المبكر مثل عدد القرون. أوضحت نتائج التحليل العنقودي أن المجموعة الأولى (I) بأ نها الاكثر تبكيرا، بينما كانت المجموعتان الثالثة (III) والرابعة (IV) الأفضل بالنسبة لصفات الإنتاجية سواء كانت محصول مبكر أو محصول كلي. لذلك ، يوصى باستخدام السلالات النقية L4 و L8 و L9 لتحسين المحصول الكلى والمبكر وكذلك صفات التبكير.