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ASSESSMENT OF EGGPLANT (*Solanum melongen*a L.) GENOTYPES UNDER NORTH SINAI CONDITIONS

Mahmoud I. Mahmoud and A.B. El-Mansy*

Dept. Plant Prod., Fac. Environ Agric. Sci., Arish Univ., Egypt.

ABSTRACT

The present investigation aimed to assess twenty genotypes of eggplant under open field conditions of El-Arish region during two seasons (2016 and 2017) at the Experimental Farm, Faculty of Environmental Agricultural Sciences, Arish University. The evaluation was conducted using a randomized complete block design in three replications. Results of mean performance showed highly significant differences among genotypes for all traits, the best lines were Jor-2 for early flowering, PIG-4 for both early and total yield (kg/plant) and Spa-3 for average fruit weight (g). Estimation of phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all traits. However, close estimates of GCV and PCV indicated that genetic variance contributed with large portion in phenotypic expression of most characters. Therefore, phenotypic selection is effective and suitable for improvement. The genotypic (GCV) and phenotypic (PCV) coefficients of variation were moderate for plant height, early yield/plant, total yield and fruit firmness. On the other hand, estimations were high for number of branches/plant, average fruit weight, fruit length, fruit diameter and TSS (%), indicating sufficient genetic variability for these traits and so, genetic improvement through selection is effective. Heritability estimates in broad sense were high for early yield/plant, total yield /plant, average fruit weight, fruit length, fruit diameter and TSS (%). High heritability accompanied with high GAM were found for early yield/plant, total yield/plant, average fruit weight, fruit length, fruit diameter and TSS (%) , suggesting preponderance of additive gene action and improvement through selection is effective. The genetic divergence based on Euclidean distance among twenty genotypes were grouped into five divergent clusters. The pattern of distribution showed that cluster 5 involved the largest number (nine lines), followed by cluster 1 (consisted of six lines) and cluster 4 (included three lines). While, both clusters 2 and 3 involved one genotype. Cluster means showed that first cluster gave high performance for only fruit firmness, second cluster recorded the highest mean values for total yield /plant, fruit length and TSS (%). also, third cluster produced the highest mean value for plant height, early yield/plant, average fruit weight and fruit diameter. However, fourth cluster exhibited maximum values for number of branches/plant and early flowering. So, more emphasis should be given on clusters 1, 2, 3 and 4 for choosing parents for crossing which may produce new recombinants with desired economic traits.

Key words: Eggplant, variability, heritability, genetic advance, genetic divergence

INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of major vegetables grown and consumed in Egypt. It is rich in vitamins like thiamine, niacin, and folacin as well as essential minerals like Ca, Fe, K, Zn, Cu and Mn (**Kowalski *et al.*, 2003**). In Egypt yield potentiality of cultivated varieties is less and choice of eggplant size, shape, and skin colour varies in different locations. For developing eggplant varieties with high

* **Corresponding author:** Tel.: +201211343842
E-mail address: aelmansy@aru.edu.eg

productivity, colour, and environmental resistances, there is require for systemic breeding plane. Evaluation for most important traits help to collect information for development of the crop, also provide breeders with row picture of genotypes about genetic variability and diversity. Therefore, evaluation of germplasm is mandatory to understand the genetic background and calculate the breeding value of available germplasm and determined the best genotypes in concern to economic traits.

Variability is urgently needed for ultimate use in any crop improvement. Greater extent of variability in population, greater chance for effective selection (**Vavilov, 1951**). Success of selection is depend upon existing and magnitude of genetic variability. So, it is necessary to partition total variability to principal components (heritable and non-heritable) through estimation of some genetic parameters like phenotypic (PCV) and genotypic (GCV) coefficient of variability, heritability and genetic advance that gave complete indication of genetic variations of the studied traits.

Correlation analysis measure the relationship between any pairs of traits and determines the component characters that selection can be based for improvement the economic traits. Plant height was positively correlated with average fruit weight (**Muniappan *et al*., 2010; Prabakaran *et al*., 2015),** total yield/plant **(Nair and Mehta, 2007; Muniappan *et al*., 2010; Shekar *et al*., 2014; Ullah *et al*., 2014),** Fruit diameter **(Shekar *et al*., 2014**) and Fruit length (**Muniappan *et al*., 2010**). Also, significant positive correlations were found between number of branches and total fruit weight (**Tripathy *et al*., 2018**). Days to first flower anthesis positively correlated with fruit length (**Danquah and Ofori, 2012; Shekar *et al*., 2014; Prabakaran *et al*., 2015**), fruit diameter (**Prabakaran *et al*., 2015**), average fruit weight (**Prabakaran *et al*., 2015**). **Tripathy *et al*. (2018)** showed significant positive correlation between TSS (%) and total yield/plant.

Genetic diversity in crops help breeders to exclude some genotypes that closely related and concerted their efforts on distant genotypes. Mahalanobis D^2 is the method developed to assessing genetic divergence among accessions. Also, grouping genotypes in differ clusters will be more useful to identifying the better parents for the hybridization program. Many investigators studied genetic diversity in eggplant among them **Begum *et al*. (2013)**, **Kumar and Arumugam (2013), Shekar *et al*. (2014) and Nand *et al*. (2018)**. Genetic variability and diversity of eggplant for six yield contributed characters were studied by **Ullah *et al*. (2014)**, where they found that cluster analysis divided the lines to 3 clusters, as well as genotypes involved in cluster one showed high genetic distant for some important traits, so selection is effective in this cluster. Genetic divergence among 40 genotypes of eggplant was estimated by **Yadav *et al*. (2017)**, based on qualitative and quantitative traits, they divided the genotypes to seven clusters. Also, based on 19 traits using Mahalanobis D^2 method, **Ravali *et al*. (2017)** divided 35 genotypes of eggplant into 10 clusters. Therefore, the present study was undertaken to assessment twenty genotypes of eggplant for vegetative growth, yield and fruit quality, as well as estimate genetic parameters, correlation and genetic diversity to select the superior genotypes for future use.

MATERIALS AND METHODS

Twenty genotypes of eggplant were collected and evaluated under open field conditions at the Experimental Farm, Faculty of Environmental Agricultural Sciences, Arish University, Egypt, during two seasons 2016 and 2017. Fifteen genotypes (Jor-1, Jor-2, Jor-3, Jor-4, Jor-5, Spa-1, Spa-2, Spa-3, Spa-4, Spa-5, Spa-6, L-W, S2-1, Mashor and Black Beauty (Bl-B)) were obtained from Prof. **Dr. El-Mahdy Ibrahim Metwally**, Prof. of Vege. Crops, Hort. Dept., Fac. Agric. Kafr El-Sheikh Univ. The remaining genotypes (PIG-3, PIG-4, PIG-13, PIG-14 and PIG-15) were obtained from Prof. Dr. Abd El-Moniem A. Gad, Prof. Veg. Crops, Dept. Hort., Fac. Agric., Zagazig Univ., "Classic F_1" (Tezier Com.) was used as a check.

The experimental design used was a randomized complete block design with three replications. Each replicate contained 21 experimental unit. Each plot was a single row (10 m length and 1 m width), therefore, the plot area was 10 m^2. The distance between plants was 50 cm apart. In both seasons, seeds genotypes were sown on January 15^{th} in seedling trays and the seedlings were transplanted on March 15^{th}. Fertigation program was carried out according to recommendations under drip irrigation system.

After four months, five plants from each experimental unit were randomly chosen to determine the following vegetative traits, plant height (cm) and number of branches/ plant. Days to first flower anthesis was calculated. Early yield/ plant was calculated from the first three harvestings, also total yield/plant was calculated from all harvested fruits.

Average fruit weight (g), was determined by dividing total yield on total fruit number. Five fruits from each plot were taken at ripe stage from the fourth harvest to determine fruit length (cm), fruit diameter (cm), TSS (%), Fruit firmness (kg/cm^2) and fruit colour at the marketable stage.

Average data over two seasons (2016 and 2017) were calculated and subjected to statistical procedures to the analysis of variance for a randomized complete block design as outlined by **Cochran and Cox (1957),** and means separation was done according to **Duncan (1955).** Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated according to Burton and **Devane (1953),** heritability in broad sense was estimated according to **Allard (1960).** Genetic advance and genetic advance as percent of mean were calculated using the formula of **Johnson *et al.* (1955).** Phenotypic (rph) and genotypic (rg) correlations among pairs of studied traits were made as outlined by **Steel and Torrie (1980).** Genetic diversity between genotypes was estimated by the method of Mahalanobis D^2 statistics **(Mahalanobis, 1936)** using statistical software program $SPSS^{v.18}$.

RESULTS AND DISCUSSION

Mean performance

Mean performance results for twenty-one genotypes revealed highly significant differences among them, indicating presence of enormous amount of variability for all characters (Table 1). For plant height, values varied from 89.0 to 124.7 cm, among 20 genotypes, Spa-6 recorded the maximum value. All evaluated genotypes, except four ones exceeded significantly the check hybrid (Classic F_1). Eight genotypes gave values higher than the grand mean (104.6). Five genotypes (Jor-3, Jor-5, Spa-1, Spa-3 and Spa-4) gave the highest number of branches/plant (6.3, 7.0, 7.7, 6.7 and 7.0, respectively) without significant differences among them, while, eleven genotypes exhibited significantly higher number of branches compared to check hybrid (4.0). Nine lines exceeded the overall mean of this trait (5.2).

For days to first flower anthesis, the line Jor-2 was as earlier (28.3), followed by Jor-3 (30.7) and Spa-6 (30.7), while PIG-13 took the maximum days (41.0). Eight genotypes recorded less number of days compared to overall mean.

Early yield/plant ranged from 0.121kg to 0.251 kg, with overall mean 0.189 kg. Only genotype (PIG-4) exceeded the check hybrid (Classic F_1) (0.221 kg), however seven ones did not differ than the check hybrid. Total yield kg/plant of evaluated genotypes showed differences ranged from 1.4 to 2.2 kg. The highest yield was reflected by PIG-4 (2.2 kg), followed by Spa-6 (2.12 kg), and Mashor (2.1 kg). On the other hand, nine lines produced total yield/plant higher than the grand mean (1.84 kg).

The line Spa-3 produced the heaviest fruits (182 g), followed by both of Spa-1 (157 g) and Spa-4 (159 g), while both of Spa-2 and PIG-3 gave the lightest fruits (67 and 66 g, respectively), three lines significantly exceeded (classic F_1) (137 g), as well as six ones did not differ than the check hybrid. The mean fruit length was found to be highest in PIG-14 (27.67 cm) and lowest in Spa-3 (11.33cm). Seven lines gave longer fruits than the grand mean (17.52 cm), also all evaluated genotypes, except three ones (Spa-3, Spa-4 and BL-B) exceeded significantly the classic F_1 (12.77 cm). Fruit diameter among evaluated genotypes ranged from 3.67 cm (Jor-2) to 16.50 cm (Jor-4) with a grand mean of 8.62 cm, indicating wide variation among studied genotypes for this trait. Most evaluated lines had wider fruits compared to check hybrid (5.33 cm) which produce cylindrical fruits. Results of fruit length and diameter showed differ fruit shaped (round, longer and cylindrical) among lines.

Table 1. Mean performance of eggplant genotypes for different yield component and biochemical characters over two seasons (2016 and 2017).

Genotypes	Plant height (cm)	No. of branches/plant	Days to first flower anthesis	Early yield (Kg/plant)	Total yield (Kg/plant)	Average fruit Wight (g/plant)	Fruit length (cm)	Fruit diameter (cm)	TSS (%)	Fruit firmness (kg/cm^2)	Fruit colour
Jor-1	97.33 DE	4.33 D	33.67 BC	0.230 B	2.07 D	129.38 CD	17.83 D	10.17 E	6.83 B	2.467 HM	Black
Jor-2	100.0 CDE	5.00 CD	28.33 E	0.151 GH	1.80 K	85.714HI	15.33 EF	3.67 M	5.83 C	3.033 E-H	Black
Jor-3	101.3 CDE	6.33 ABC	30.67 D	0.181 E	1.90 H	95 GH	14.00 FG	9.50 E	6.83 B	3.200 C-G	Purple
Jor-4	95.00 DE	5.33 BCD	34.00 BC	0.201 D	1.40 Q	117.7 DEF	15.50 EF	16.50 A	4.17 EF	2.80 GH	Black
Jor-5	92.00 E	7.00 A	34.00 BC	0.211BCD	1.80 K	138.46 C	14.00 FG	14.33 B	5.50 CD	3.47 B-F	Black
Spa-1	101.0 CDE	7.67 A	33.67 BC	0.213BCD	1.73 M	157.27 B	14.00 FG	13.00 C	4.17 EF	3.87 ABC	Dark purple
Spa-2	89.00 E	5.33 BCD	34.00 BC	0.181 E	1.60 O	66.67 J	14.00 FG	9.17 EF	4.17 EF	3.97 AB	Purplish white
Spa-3	93.00 E	6.67 AB	35.33 B	0.221 BC	1.82 J	182.1 A	11.33 H	11.83 D	5.00 D	3.57 B-F	Dark purple
Spa-4	95.33 DE	7.00 A	35.33 B	0.211 CD	1.75 L	159.27 B	13.00 GH	10.17 E	8.33 A	3.03 E-H	Light green
Spa-5	95.00 DE	3.67 D	34.33 BC	0.141 HI	1.79 K	105 EFG	16.67 DE	7.67 GH	4.83 DE	3.47 B-F	Black
Spa-6	124.7 A	4.33 D	30.67 D	0.169 EF	2.12 B	112D-G	23.33 B	5.17 KL	4.17 EF	4.267 A	Purple
L-W	108.3 BCD	5.00 CD	33.33 BC	0.161 FG	1.91 GH	120 CDE	23.67 B	6.17 JK	7.00 B	2.80 GH	White
S2-1	111.7 ABC	4.00 D	34.00 BC	0.212BCD	2.00 F	118 DEF	18.33 D	8.50 FG	4.13 EF	3.77 CD	Purple
Mashor	118.0 AB	4.67 D	32.00 CD	0.129 IJ	2.10 C	100 FGH	20.33 C	4.67 L	5.00 D	2.93 FGH	Black
PIG-3	116.7 AB	5.33 BCD	34.00 BC	0.151 GH	1.72 M	66 J	22.67 B	6.67 IJ	6.83 B	3.80 A-D	Purple
PIG-4	91.00 E	4.33 D	35.33 B	0.251 A	2.20 A	105 EFG	16.83 DE	7.17 HI	5.83 C	3.73 A-D	White
PIG-13	101.0 CDE	4.33 D	41.00 A	0.121 J	1.63 N	74 IJ	15.33 EF	8.50 FG	3.50 FG	3.63 A-E	Black
PIG-14	120.0 AB	4.33 D	34.00 BC	0.219 BC	1.92 G	128 CD	27.67 A	4.63 L	6.83 B	3.63 A-E	Black
PIG-15	121.7 AB	5.33 BCD	35.00 B	0.222 BC	1.87 I	125 CD	13.50 FG	12.83 C	6.83 B	3.367B-G	Black
BL-B	119.0 AB	3.67 D	32.33 CD	0.201 D	1.51 P	137 C	13.00 GH	12.9 C	4.17 EF	4.033 AB	Black
Classic	87.33 E	4.00 D	33.33 BC	0.221 BC	2.05 E	137 C	12.77 GH	5.33KL	3.00 G	3.13 D-G	Black
$\bar{X}$	103.73	5.13	33.73	0.19	1.84	116.96	17.29	8.62	5.38	3.43	

Means followed by the same alphabetical letter(s) within each column are not significantly different at 5% level according to Duncan's Multiple Range Test.

Total soluble solids percentage (TSS%) varied from 3.5 (PIG-13) to 8.3 (Spa-4). The highest TSS (%) was recorded by Spa-4 followed by Jor-1, Jor-3, L–W, PIG-3, PIG-14 and PIG-15. All evaluated lines exceeded (Classic F_1) (3.0%), while, ten ones exhibited high TSS (%) than the grand mean (5.38%). Highly variations were observed among genotypes for fruit firmness which ranged from 2.467 to 4.267 kg/cm^2. The highest hardness fruits were found in Spa-1, Spa-2, Spa-6, S2-1, PIG-3, PIG-4, PIG-13, PIG-14 and PIG-15 without significant differences among them. Fourteen lines significantly produced hardness fruits than the check (Classic F_1) (3.13 kg/cm^2).

Regarding fruit colour at marketable stage, the studied genotypes showed wide range of colour variations. The genotypes divided into the following groups: first group (black) included Jor-1, Jor-2, Jor-4, Jor-5, Spa-5, Mashor, PIG-13, PIG-14, PIG-15 and BL-B; the second group (white colour) involved L-W and PIG-4. The third group (purplish white) included only line Spa-2. The fourth group included six lines with fruits of purple colour (Jor-3, Spa-1, Spa-3, Spa-6, S2-1and PIG-3); the fifth group gave fruits with light green colour (Spa-4). These variations enable the breeders to choose parents with different colours to produce high suitable hybrids to consumers. These results agree with those of **Nair and Mehta (2007), Kansouh and Hussein (2009), Shekar *et al.* (2014), Prabakaran *et al.* (2015) and Samlindsujin *et al.* (2017)** who found significant variations among evaluated genotypes of eggplant for studied characters.

Genetic variability

Genetic variability as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (HB), genetic advance (GA) and genetic advance as percent of mean (GAM) for ten studied characters are presented in Table 2.

Table 2. Genetic variability parameters for different yield components and biochemical characters of eggplant over two seasons.

Character	GCV (%)	PCV (%)	Heritability (h^2%)	Genetic Advance (GA)	Genetic Advance (% of Mean)
1- Plant height	10.89	12.99	70.23	19.499	18.798
2-Number of branches/plant	20.87	26.59	61.63	1.731	33.758
3- Days to first flower anthesis	6.78	7.83	74.98	4.078	12.089
4- Early yield (Kg/plant)	18.92	19.64	92.86	0.072	37.562
5- Total yield (Kg/plant)	11.25	11.2	99.77	0.427	23.146
6- Average fruit Wight (g/plant)	25.84	25.84	99.98	62.264	53.234
7- Fruit length (cm^2)	25.60	26.44	93.73	8.827	51.049
8- Fruit diameter (cm^2)	40.88	41.41	97.43	7.162	83.115
9- TSS (%)	26.25	27.36	92.10	2.792	51.905
10- Fruit firmness (kg/cm^2)	12.43	15.99	60.38	0.682	19.889

All studied traits showed wide range of variability as evident from determined genetic parameters, this providing the ample scope for selecting best genotypes. Estimation of PCV was higher than GCV in all traits, indicating influence of environmental factors. However, close estimates of GCV and PCV indicated that genetic variance contributed with large portion in phenotypic expression rather than environmental factors of most characters. Therefore, phenotypic selection is effective and suitable for improvement. Similar findings on eggplant were found by many researchers, among them, **Kumar *et al.* (2012), Kumar and Arumugam (2013), Yadav *et al.* (2016) and Pujer *et al.* (2017)**.

The genotypic (GCV) and phenotypic (PCV) coefficients of variation were moderate for plant height (10.89 and 12.99), early yield/plant (18.92 and 19.64), total yield (11.25 and 11.2) and fruit firmness (12.43 and 15.99), respectively, indicated presence of moderate genotypic variation and improvement through selection are suitable for these characters. On the other hand, estimation of genotypic (GCV) and phenotypic (PCV) coefficients of variation were high for number of branches/plant (20.87 and 26.59), average fruit weight (25.84 and 25.84), fruit length (25.60 and 26.44), fruit diameter (40.88 and 41.41) and TSS (%) (26.25 and 27.36), respectively, suggesting sufficient genetic variability for these traits, so, genetic improvement through selection is effective. However, the estimated values of GCV and PCV were low for days to first flower anthesis (6.78 and 7.83, respectively) indicating less effect of genetic variability in this trait and selection might be not effective. These results, were confirmed by many researchers among them, **Islam and Uddin (2009) and Kumar *et al.* (2012)** both for days to first flower anthesis, **Yadav *et al.* (2016)** for fruit length and diameter, **Samlindsujin *et al.* (2017)** for plant height, number of branches, average fruit weight and total yield/plant, and **Tirkey *et al.* (2018)** for TSS (%) .

Heritability estimates in broad sense were high for early yield /plant, total yield/ plant, average fruit weight, fruit length, fruit diameter and TSS (%) (92.86, 99.77, 99.98, 93.73, 97.43 and 92.10, respectively) (Table 2), indicating less environment effects on the phenotypic expression of these traits. So, selection based on phenotypic observation in individual plant is more effective to improve of these characters, while, it was moderate for the remaining traits (plant height, number of branches/plant, days to first flower anthesis and fruit firmness), therefore, these traits might be improved by selection. This result was in conformity with the findings of **Ansari *et al.* (2011), Rad *et al.* (2015) and Pujer *et al.* (2017)** who evaluated many genotypes of eggplant and found that selection is effective in the improvement of these traits.

Genetic advance (GA) help plant breeders to predict genetic gain that obtained in late generations of the breeding program. The values of genetic advance exhibited wide range from 0.071 for early yield/plant to 62.26 for average fruit weight (Table 2). However, genetic advance as percent of mean (GAM) varied from trait to another, it was high for, number of branches (33.76), early yield/plant (37.56), total yield/plant (23.45), average fruit weight (53.23), fruit length (51.05), fruit diameter (83.11) and TSS (%) (51.91), indicating that these traits are governed by additive gene action and selection will be effective in improvement of these traits. however, the remaining traits (plant height, days to first flower anthesis and fruit firmness) showed moderate values of GAM (18.80, 12.09 and 19.89, respectively).

Heritability associated with genetic advance as percent of mean (GAM) is more important in predicting the results and effect of selection. High heritability correlated with high GAM were found in early yield/plant, total yield/plant, average fruit weight, fruit length, fruit diameter and TSS (%), indicated the preponderance of additive gene action in the inheritance of these characters and that improvement through selection is effective. Similarly, moderate heritability coupled with high GAM gave the same way for improving number of branches/plant. On the other hand, moderate heritability associated with moderate GAM were noticed in plant height, days to first flower anthesis and fruit firmness, indicating predominance of additive gene effects and selection as breeding strategy might be effective to improve these traits. In this concern, high heritability associated with moderate and/or high GAM was also reported by **Yadav *et al.* (2016), Samlindsujin *et al.* (2017), Pujer *et al.* (2017) and Tirkey *et al.* (2018)**.

Correlations

The genotypic (rg) and phenotypic correlation coefficients (rph) among ten traits of eggplant were calculated and presented in Table 3. Correlation help in identifying characters that have little or no importance in the selection improvement programs. In general, genotypic correlations were higher than that of phenotypic ones for most traits, this might be due to the strong inherent genetic relationship between the studied characters and masking effect of environmental factors.

Highly significant positive correlations were observed between plant height and all studied traits, except fruit diameter. Similar results were obtained by **Nair and Mehta (2007), Shende *et al.* (2014)** both for total yield/plant, **Muniappan *et al.* (2010)** for yield/plant, fruit length and weight.

Table 3. Phenotypic (rph) and genotypic (rg) correlation coefficients among 10 characters of eggplant grown over two seasons (2016 and 2017).

		2	3	4	5	6	7	8	9	10
1- Plant highte	rph	0.511*	0.806**	0.583**	0.816**	0.526*	0.829**	0.258	0.618**	0.819**
	rg	0.589**	0.836**	0.576**	0.833**	0.513*	0.868**	0.338	0.695**	0.866**
2- Number of branches	rph		0.658**	0.613**	0.531**	0.665**	0.164	0.721**	0.609**	0.561**
	rg		0.729**	0.652**	0.585**	0.696**	0.254	0.787**	0.688**	0.635**
3 - Days to first flower anthesis	rph			0.723**	0.813**	0.624**	0.562**	0.542**	0.575**	0.823**
	rg			0.696**	0.803**	0.591**	0.611**	0.607**	0.658**	0.853**
4- Early yield/plant	rph				0.722**	0.798**	0.365	0.581**	0.548**	0.640**
	rg				0.686**	0.777**	0.385	0.626**	0.597**	0.637**
5- Total yield/plant	rph					0.599**	0.634**	0.249	0.627**	0.728**
	rg					0.553**	0.678**	0.305	0.702**	0.745**
6- Average fruit wight	rph						0.288	0.545**	0.455*	0.502*
	rg						0.299	0.577**	0.490*	0.488*
7- Fruit length	rph							-0.094	0.502*	0.625**
	rg							0.002	0.570**	0.685**
8- Fruit diameter	rph								0.305	0.325
	rg								0.380	0.397
9- TSS (%)	rph									0.373
	rg									0.469*

*and **means significant and highly significant at 0.05, 0.01 level of probability, respectively.

Also, number of branches/plant, was highly significantly positive correlated with days to first flower anthesis, early yield/ plant, total yield/plant, average fruit weight, fruit diameter, TSS (%) and fruit firmness. Similar finding was reported by **Tripathy *et al.* (2018)** for total yield/plant.

In addition, highly significant positive correlations were found between days to first flower anthesis and early yield/plant, total yield/plant, average fruit weight, fruit length, fruit diameter, TSS (%) and fruit firmness. **Danquah and Ofori (2012) and Shekar *et al.* (2014)** found similar results for fruit length, **Prabakaran *et al.* (2015)** for fruit length, diameter and fruit weight

Highly significant positive relations were detected between early yield/plant and total yield/plant, average fruit weight, fruit diameter, TSS (%) and fruit firmness. Similarly, total yield/plant, was highly significant and positively correlated with average fruit weight, fruit length, TSS (%) and fruit firmness. Hence, there is ample scope in the improvement of yield by selecting a genotype having higher fruit weight, fruit length, TSS (%) and fruit firmness since they are highly correlated.

Average fruit weight was significantly or highly significantly positive related with fruit diameter, TSS (%) and fruit firmness. These results confirmed by **Muniappan *et al.* (2010) and Danquah and Ofori (2012)** both for fruit diameter. Finally, there was significant or highly significant positive correlations between fruit length and both of TSS (%) and fruit firmness. On the other hand, TSS (%) exhibited significant positive genetic correlation (0.469) with fruit firmness.

Genetic diversity

Genetic diversity analysis in eggplant could provide useful additional information for studying interrelationships of germplasm and giving graphical assessment of genetic variability, also it helps in breeding vegetables where hybrids derived from distant genotypes exhibit hybrid vigour than those between closely genotypes.

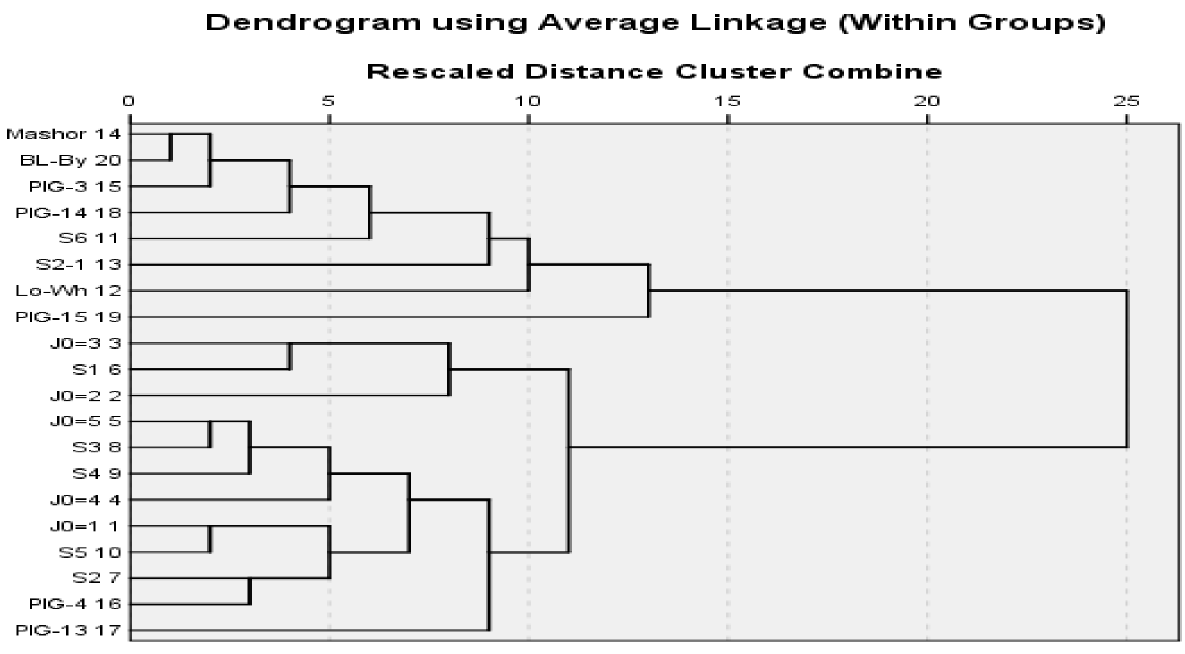

Fig. 1. Dendrogram represent of twenty genotypes of eggplant.

The genetic divergence based on Euclidean distance among twenty genotypes of eggplant are illustrated in Table 4, for vegetative traits, early and total yield/plant and fruit characteristics to identifying optimal breeding strategies for eggplant improvement. The coefficients were ranged from 3.72 (between Mashor and BL-B) to 37.20 (between Spa-2 and Spa-6), indicating that the genotypes Spa-2 and Spa-6 appeared to be widely divergent (37.20) than other genotypes. On the other hand, the genotypes (Mashor, BL-B, PIG-3, PIG-14 and Spa-6), (Jor-3, Spa-1 and Jor-2) (Jor-5, Spa-3, Spa-4, Jor-4, Jor-1, Spa-5, Spa-2 and PIG4) appeared to be nearly related, respectively also, S2-1, L-W, PIG-15 and PIG-13 seemed to be divergent among them. Similar results were reported by **Begum *et al.* (2013), Kumar and Arumugam (2013), Ullah *et al.* (2014), Yadav *et al.* (2017), Ravali *et al.* (2017) and Nand *et al.* (2018)** who studied genetic diversity in genotypes of eggplant for qualitative and quantitative traits and grouped to different clusters based on D^2 values.

On the basis of Euclidean distance, the twenty studied genotypes were grouped into five divergent clusters at 10 Euclidean distances (Table 5 and Fig. 1), indicating genetic diversity among genotypes to select the best lines which can be used for any breeding program. The pattern of distribution of genotypes showed that cluster 5 involved the largest number (Jor-5, Spa-3, Spa-4, Jor-4, Jor-1, Spa-5, Spa-2, PIG4 and PIG-13), followed by cluster 1 which consisted of six lines (Mas q`1a`hor, BL-B, PIG-3, PIG-14, Spa-6 and S2-1) and cluster 4 which included three lines (Jor-3, Spa-1 and Jor-2). However, both clusters 2 and 3 involved one genotype (L-W and PIG-15, respectively), indicating that genotypes consisted these clusters were relatively closer to each other, in compare to genotypes in other clusters, thus, hybridization between wide divers clusters is important to produce hybrids with high yielding and fruit quality.

Cluster means of the contributed traits revealed the distribution of traits in different clusters (Table 5). Genotypes in cluster 1 gave high performance for only fruit firmness (3.74 kg/cm^2). Cluster 2 included L-W recorded the highest mean values for each of total yield/plant (1.91kg), fruit length (23.67cm) and TSS (%) (7.0), therefore, L-W genotype could be used for improvement of total yield/plant and some fruit characters. Also, cluster 3 consisted of PIG-15 genotype and produced the highest mean value for each of plant height (121.67), early yield/plant (0.220kg), average fruit weight (124.67g) and fruit diameter (12.83cm), so, this line is effective in any breeding program for developing these traits. However, cluster 4 exhibited maximum values for number of branches/ plant (6.33) and days to first flower anthesis (30.89). On the other hand, cluster 5 did not give high performance in any trait in spite of included the largest number of genotypes. In general, more emphasis should be given on clusters 1, 2, 3 and 4 for choosing parents for crossing which may produce new recombinants with desired economic traits.

Breeding strategy

Generally, from the present investigation it may be concluded that, PIG-4 was the best line for early and total yield /plant and exceeded significantly the check hybrid (Classic F_1) and could be used in eggplant breeding program to increase productivity. The phenotypic selection is more effective and suitable as breeding method for improvement of most studied traits where the genetic variance contributed with large portion in phenotypic. Also, additive gene action plays the main role in the inheritance of studied characters and improvement through selection is effective. However, genetic divergence of twenty genotypes based on Euclidean distance were grouped into five divergent clusters, therefore, the lines belonging to most divergent clusters are predicted to give high heterosis and wide genetic variability.

Table 4. Euclidean distance among the twenty genotypic of eggplant Proximity Matri.

Case	Euclidean Distance																			
	1: Jor-1	2: Jor-2	3: Jor-3	4: Jor-4	5: Jor-5	6: Spa-1	7: Spa-2	8: Spa-3	9: Spa-4	10: Spa-5	11: Spa-6	12: L-W	13: S2-1	14: Mashor	15: PIG-3	16: PIG-4	17: PIG-13	18: PIG-14	19: PIG-15	20: BL-B
1: Jor-1	.000	9.431	6.783	7.622	8.464	7.643	9.826	9.132	6.459	4.292	28.64**	13.182	14.810	21.66**	20.41**	7.420	9.584	25.45**	24.94**	23.05**
2: Jor-2		.000	6.700	15.027	14.666	11.328	13.717	13.582	11.296	9.159	26.20**	13.512	14.347	19.09**	19.64**	12.141	13.826	24.58**	24.53**	21.19**
3: Jor-3			.000	10.596	11.102	5.555	13.086	10.426	7.872	8.734	25.68**	13.002	12.213	18.60**	18.40**	12.150	11.142	24.18**	21.14**	20.71**
4: Jor-4				.000	4.793	7.705	9.754	7.483	8.444	9.093	32.78**	18.88**	18.71**	26.28**	24.99**	10.539	12.337	30.31**	27.18**	27.51**
5: Jor-5					.000	9.236	6.370	4.286	6.259	8.591	35.43**	20.96**	21.19**	28.55**	27.47**	8.406	13.280	32.91**	29.83**	30.12**
6: Spa-1						.000	12.829	8.883	7.922	9.511	26.92**	14.715	12.831	20.19**	19.51**	12.661	9.331	25.42**	21.06**	21.95**
7: Spa-2							.000	6.059	8.036	7.116	37.20**	22.17**	23.10**	30.06**	29.35**	4.790	14.001	34.44**	33.03**	31.64**
8: Spa-3								.000	4.850	8.207	34.96**	21.13**	20.49**	27.80**	27.19**	8.267	11.459	32.88**	28.97**	29.69**
9: Spa-4									.000	6.832	32.21**	17.772	18.049	24.94**	24.04**	7.598	10.121	29.62**	26.65**	26.89**
10: Spa-5										.000	30.65**	15.362	16.775	23.54**	22.69**	4.343	9.347	27.56**	27.49**	24.95**
11: Spa-6											.000	16.992	14.715	7.652	9.263	34.65**	27.29**	8.124	13.28	6.005
12: L-W												.000	7.977	10.874	8.568	18.87**	14.562	12.527	18.09	11.339
13: S2-1													.000	8.021	7.900	20.88**	13.158	13.830	12.038	9.567
14: Mashor														.000	4.827	27.51**	20.32**	8.720	11.368	3.715
15: PIG-3															.000	26.47**	19.36**	6.413	12.048	4.429
16: PIG-4																.000	11.987	31.17**	31.39**	28.92**
17: PIG-13																	.000	24.60**	22.28**	21.78**
18: PIG-14																		.000	16.377	6.086
19: PIG-15																			.000	12.723
20: BL-B																				.000

* Significant compared with $X^2 = 18.31$ at df = 10 and 0.05 level of probability

Table 5. Distribution of parents into clusters and cluster means of the contributed characters.

No. of clusters	No. of genotypes in clusters	Representative genotypes	Contributed characters *									
			1	2	3	4	5	6	7	8	9	10
1	6	Mashor, BL-B, PIG-3, PIG-14, Spa-6 and S2-1	118.33	4.39	32.83	0.18	1.90	110.17	22.56	5.83	5.19	3.74
2	1	L-W	108.33	5.00	33.33	0.16	1.91	119.50	23.67	6.17	7.00	2.80
3	1	PIG-15	121.67	5.33	35.00	0.22	1.87	124.67	13.50	12.83	6.83	3.37
4	3	Jor-3, Spa-1 and Jor-2	100.78	6.33	30.89	0.18	1.81	112.66	14.44	8.72	5.61	3.37
5	9	Jor-5, Spa-3, Spa-4, Jor-4, Jor-1, Spa-5, Spa-2, PIG-4 and PIG-13	94.30	5.33	35.22	0.20	1.78	119.60	14.94	10.61	5.35	3.35

* 1- Plant highte 2- No. of branches 3- days to first flower anthesis 4- early yield 5- total yield
6- average fruit wight 7- fruit length 8- fruit diameter 9- TSS (%) 10- Fruit firmness (kg/cm^2)

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الملخص العربي

تقييم تراكيب وراثية من الباذنجان تحت ظروف شمال سيناء

محمود إبراهيم محمود، أحمد بلال المنسي

قسم الإنتاج النباتي، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

أجريت هذه الدراسة بهدف تقييم عشرون تركيبا وراثياً من الباذنجان في الحقل المكشوف بمنطقة العريش خلال موسمي ٢٠١٦ و٢٠١٧ بالمزرعة التجريبية بكلية العلوم الزراعية البيئية جامعة العريش، استخدم تصميم القطاعات كاملة العشوائية في ثلاث مكررات في تقييم التراكيب الوراثية، أظهرت متوسطات التراكيب الوراثية وجود اختلافات معنوية بينها في جميع الصفات تحت الدراسة، وكانت أفضل السلالات للصفات المدروسة هي: جى او ار-٢ للإزهار المبكر، وبى اى جى-٤ للمحصول المبكر والكلى/نبات، واس بي ايه-٣ لمتوسط وزن الثمرة، وأظهرت حسابات الاختلافات الوراثية وجود فروق بسيطة بين معامل الاختلاف الوراثي والمظهري لمعظم الصفات المدروسة مما يدل على مساهمه التباين الوراثي بنسبه كبيرة في التباين الكلى وبالتالي يكون الانتخاب المظهري فعالاً لتحسين هذه الصفات، وتباينت قيم معامل الاختلاف الوراثي والمظهري من متوسطة لصفات ارتفاع النبات، والمحصول المبكر والكلى/نبات، وصلابة الثمرة، إلى مرتفعة لصفات عدد الأفرع للنبات، ومتوسط وزن الثمرة، وطول الثمرة، وقطر الثمرة ومحتواها من المواد الصلبة الذائبة الكلية، مما يدل على وجود تباينات وراثية كافيه لتحسين هذه الصفات من خلال الانتخاب، وأعطت تقديرات درجه التوريث على النطاق الواسع قيما مرتفعة لمعظم الصفات المدروسة، وارتبطت قيم درجه التوريث العالية مع القيم المرتفعة للتقدم الوراثي (كنسبه مئوية من المتوسط) لصفات المحصول المبكر والكلى، ومتوسط وزن الثمرة وطولها وقطرها ومحتواها من المواد الصلبة الذائبة الكلية، ودل ذلك على سيادة الفعل الجيني المضيف وأهميته في التحسين بالانتخاب، كما أظهر تحليل التباعد الوراثي تقسيماً للتراكيب الوراثية في خمسة عناقيد متباعدة، فاحتوى العنقود الخامس على اكبر عدد من التراكيب (تسعه تراكيب)، ثم العنقود الأول والذي اشتمل على ستة تراكيب، فالعنقود الرابع الذي احتوى على ثلاث تراكيب، أما العنقودين الثاني والثالث فاحتوى كل منهما على تركيب واحد، وقد أعطى العنقود الأول أعلي متوسط لصلابة الثمار، أما العنقود الثاني فقد أعطى اعلي القيم لصفات المحصول الكلى، وطول الثمرة، ومحتوى الثمار من المواد الصلبة الذائبة الكلية، في حين سجلت أعلي القيم لصفات ارتفاع النبات، والمحصول المبكر، ومتوسط وزن الثمرة، وقطر الثمرة في العنقود الثالث، بينما أعطى العنقود الرابع أفضل القيم لصفتي عدد الأفرع، والإزهار المبكر. لذا يجب التركيز على العناقيد الأول، والثاني، الثالث، والرابع لاختيار أفضل التراكيب كآباء لإنتاج هجن متفوقة في الصفات الاقتصادية الهامة.

الكلمات الاسترشادية: الباذنجان، تقييم، درجة التوريث، الفعل الجيني، التباين الوراثي، الانتخاب.

المحكمـــون:

١- أ.د. على إبراهيم القصاص أستاذ الخضر، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

٢- أ.د. لطفى عبدالفتاح بدرى أستاذ الخضر ورئيس قسم البساتين، كلية الزراعة بمشتهر، جامعة بنها، مصر.