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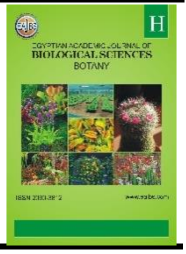

Estimation of the Coefficient of Variation and Some Genetic Parameters of Some Local Varieties of Turnip and Radish

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ABSTRACT

Since there are no (or few) formal Egyptian (registered) cultivars of turnip and white radish, So, this investigation was carried out for studying the coefficient of variation and genetic differences within and between nine native landraces of turnip and white radish, unregistered cultivars, which were collected from different regions (nine governorates) of Egypt as a first step towards registering them, if they were genetically pure or including them in breeding programs to improve and establish new cultivars. This investigation was carried out at a private farm in Arab Elsabha, Dar Elsalam, Sohag governorate, during the winter seasons of 2017/2018 and 2018/2019.

Results indicated that both turnip and radish Genotypes exhibited obvious differences among the native landraces of them for most of the studied characters. On the other hand, coefficients of variations (C.V.%) of the nine Balady landraces both of turnip and radish were less than 25 % for all the studied characters except a few exceptions. These results indicate that there were no significant differences within the nine Balady landraces for turnip and radish, separately. Consequently, these Balady landraces are largely genetically identical.

Mean squares of genotypes were found significant or highly significant for all characters except for both of No. of leaves/plant and weight of 1000 seeds regarding turnip and for the weight of 100 seeds concerning radish. With regard to the genotype × year component of variance, it was highly significant in only weight of 1000 seeds for turnip and it was insignificant for the studied traits of radish. The insignificance of this component showed that the selected genotypes succeeded to possess the same good performances in the two years of the test.

The partitioning of variance into its various components that a large portion of total variances of most studied traits, in all turnip and radish genotypes, would be attributed to genotypes. It should be mentioned here that genetic variance would be biased upward since it contains a non-partitioned genotypic × location source of variance; so, these results could be accepted under the designed conditions of this investigation and any wider implications warrant further research. The estimated broad-sense heritability of the various studied characters reflected high values (> 70%) in most studied traits of all turnip and radish genotypes These results gave information on the magnitude of genetic variation.

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INTRODUCTION

Egypt had been gifted a tremendous treasure of Flora and Fauna. However, it subjects to either extinction or stolen by other countries. These varieties could be had special characteristics. Thus, this causes great loss for the national economy. These varieties include turnip and radish. Most of these varieties are not registered.

Radish (*Raphanus sativus* L.; 2n=18) and Turnip (*Brassica rapa* L., 2n=20) are members of the Cruciferae crops. It is a cool season annual crop. The white type of radish is one of the popular winter vegetable salad crops in Egypt. Before the building of pyramids, in the days of the pharaohs, the radish was extensively cultivated in ancient Egypt (Sadhu, 1993,).

Radish and turnip are important vegetable crops cultivated in both tropical and temperate regions. Its fleshy edible roots are rich in Ca, K, P and vitamin C. The young tender tuberous roots are sometimes eaten raw as salad. Tender leaves contain high vitamin C and supply a variety of minerals (Sadu, 1986).

Studying differences between the genetic and morphological of genotypes is the first step in breeding programs to improve or establish new cultivars. Therefore, many researchers have studied these differences for both turnip and radish (Allah and Moussa, 2011; Zhang, 2014; Chen *et al.*, 2015; Takahashi *et al.*, 2015; Kim *et al.*, 2016; Raihan and Jahan, 2019)

Since there are no (or few) formal Egyptian (registered) cultivars of turnip and white radish, So, this investigation was carried out for studying the coefficient of variation and genetic differences within and between these unregistered Balady landraces collecting from different regions of Egypt as a first step towards registering them, if they were genetically pure or including them in breeding programs to improve and establish new cultivars.

MATERIALS AND METHODS

This investigation was carried out at a private farm in Arab Elsabha, Dar Elsalam, Sohag governorate, during the winter seasons of 2017/2018 and 2018/2019. They used genetic materials were nine native landraces of turnip and white radish, which were collected from different regions (nine governorates) of Egypt. The sources are illustrated in Table (1).

Table 1: sources of nine native landraces of turnip and white radish

No.	Source region of native turnip	Source region of native radish
1	Alexandria governorate	Alexandria governorate
2	Assiut governorate	Aswan governorate
3	Beheira governorate	Beheira governorate
4	Fayoum governorate	Gharbiya governorate
5	Gharbiya governorate	Kafr El-Sheikh governorate
6	Kafr El-Sheikh governorate	Minya governorate
7	Minya governorate	New Valley governorate
8	New Valley governorate	Qena governorate
9	Sohag governorate	Sohag governorate

On the first week of October 2018 and 2019, seeds of each genotype of turnip and radish were drilled 0.5 to 1.0 cm deep, in 4 rows, 25 cm apart and 4 m long. The plants were thinned out to only one plant each 5 cm, using a randomized complete blocks design (RCBD), with three replications. Every two rows were considered as a sub-plot. All the agricultural practices were followed according to common recommendations for commercial production to obtain the best-growing plants.

Recorded Data:

After 45 days from sowing, plants were picked up, from two rows, (harvested) with root. The other two rows were left to obtain seed yield. The following characters were recorded on individual plants in each entry.

Leaves characters; i.e., leaves length (cm), leaves weight (g), number of leaves/plants.

Root characters; i.e., Root length (cm), root diameter (cm), root weight (g).

Seed yield; i.e., Seed weight / plant (g), Weight of 1000 or 100 seeds (g) and No. of seed / silique or No. of peduncle / plant.

Statistical Procedures:

Data of the studied characters were statistically analyzed, using a combined analysis of variance for the two evaluated seasons, according to Herbert *et al.* (1955) and as illustrated in Table (2). The studied characters were measured on an individual plant basis and used to calculate means, ranges, and coefficient of variations (C.V.%). The differences among the various means were tested, using Duncan's multiple range test. Data were analyzed using the COSTAT computer package (*CoHort software*, Berkeley, USA).

Table 2: The combined analyses of variance

S.O.V.	D.F.	S.S.	M.S.	E.M.S.
Reps./y	y(r-1) = 2	S.S.r/y	S.S.r/y/ y(r-1)	
Years (Y)	(y-1) = 1	S.S. y	S.S.y/(y-1)	$\sigma^2_e + r\,\sigma^2_{gy} + gr\,\sigma^2_y$
Genotypes (G)	(g-1) = 8	S.S.g	S.S.g/(g-1)	$\sigma^2_e + r\,\sigma^2_{gy} + ry\,\sigma^2_g$
G × Y	(y-1) (g-1) =8	S.S.gy	S.S.gy/(y-1) (g-1)	$\sigma^2_e + r\,\sigma^2_{gy}$
Combined error	y(r-1) (g-1) =36	S.S.e/y	S.S.e/y/y(r-1) (g-1)	σ^2_e

$$\sigma_g^2 = \frac{M.S.g - (\sigma_e^2 + r\sigma_{gy}^2)}{ry}$$

$$\sigma_y^2 = \frac{M.S.y - (\sigma_e^2 + r\sigma_{gy}^2)}{rg}$$

$$\sigma_{gy}^2 = \frac{M.S.gy - \sigma_e^2}{r}$$

$$\sigma_{ph}^2 = \sigma_e^2 + \sigma_g^2 + \sigma_{gy}^2$$

Where; σ^2_g, σ^2_y, σ^2_{gy} and σ^2_{ph} types of variances of genotypes, years, genotypes × years interaction and phenotypes, respectively.

Heritability in a broad sense was calculated as illustrated by Falconer (1989), using the following formula

$$H_{bs}^2 = \frac{\sigma_g^2}{\sigma_{ph}^2} \times 100$$

Genotypic coefficient of variation (GVC) and phenotypic coefficient of variation (PCV) was estimated according to the procedure outlined by Burton (1952) as follows:

$$GVC = \frac{\sqrt{\sigma_g^2}}{\bar{x}} \times 100 \qquad PCV = \frac{\sqrt{\sigma_{ph}^2}}{\bar{x}} \times 100$$

Simple correlation coefficients (r) were calculated for different pairs of the studied characters as shown by Dospekhove (1984).

Dendrograms were constructed using the unweighted pair-group method with arithmetic mean (UPGMA) clustering. Cluster analysis and dendrograms carried out using the computer program SPSS version 25.

RESULTS AND DISCUSSION

Turnip:

Figure (1) and results in Table (3) reflected obvious differences among the nine native landraces of Balady turnip for most of the studied characters. Concerning leaves characters, the highest number of leaves / plants was obtained by Balady Fayoum (9), and there were no significant differences among this landrace and Balady landraces of Alexandria (8.3), Gharbiya (7.9), Kafr El-Sheikh (7.8) and Sohag (8.1). Meanwhile, Balady Sohag gave the highest significant mean values for both leaf length (37.6 cm) and leaves wight / plant (30.4 g). Regarding root characters, Balady Fayoum gave the highest mean value for root diameter (13.7 cm), and there were no significant differences among this landrace and Balady landraces of Alexandria (12.8 cm), Assiut (12.9 cm) and Sohag (13.3 cm). However, Balady Assiut surpassed the others regarding root length (4.2 cm). Meanwhile, the highest significance mean values of root weight /plant were obtained by Balady Kafr El-Sheikh (30.2 g) followed by Balady Sohag (28.3 g) and Balady Gharbiya (26.1 g). With respect to seed yield, the highest number of seeds/siliques was obtained by Balady landraces of Alexandria (20.9), and there were no significant differences among this landrace and Balady landraces of Beheira, Fayoum, Gharbiya, New Valley, and Sohag. Concerning the weight of 1000 seeds, there were no significant differences among the nine genotypes, but Balady Beheira was the lowest of them. On the other hand, coefficients of variations (C.V.%) of the nine Balady landraces were less than 25 % for all the studied characters except a few exceptions such as a number of seed/siliques in Balady Fayoum (34%). These results indicate that there were no significant differences within the nine Balady landraces, consequently, these native landraces are largely genetically identical. Variability, the genetic base of a crop, is the basic requirement for crop improvement. It is assumed that parents from any breeding program should be selected from diverse sources. Information about the relationship between elite breeding populations and the genetic diversity in available germplasm is important for the optimal design of any breeding program. This helps to choose desirable parents for establishing new breeding populations (Chowdhury *et al.*, 2002).

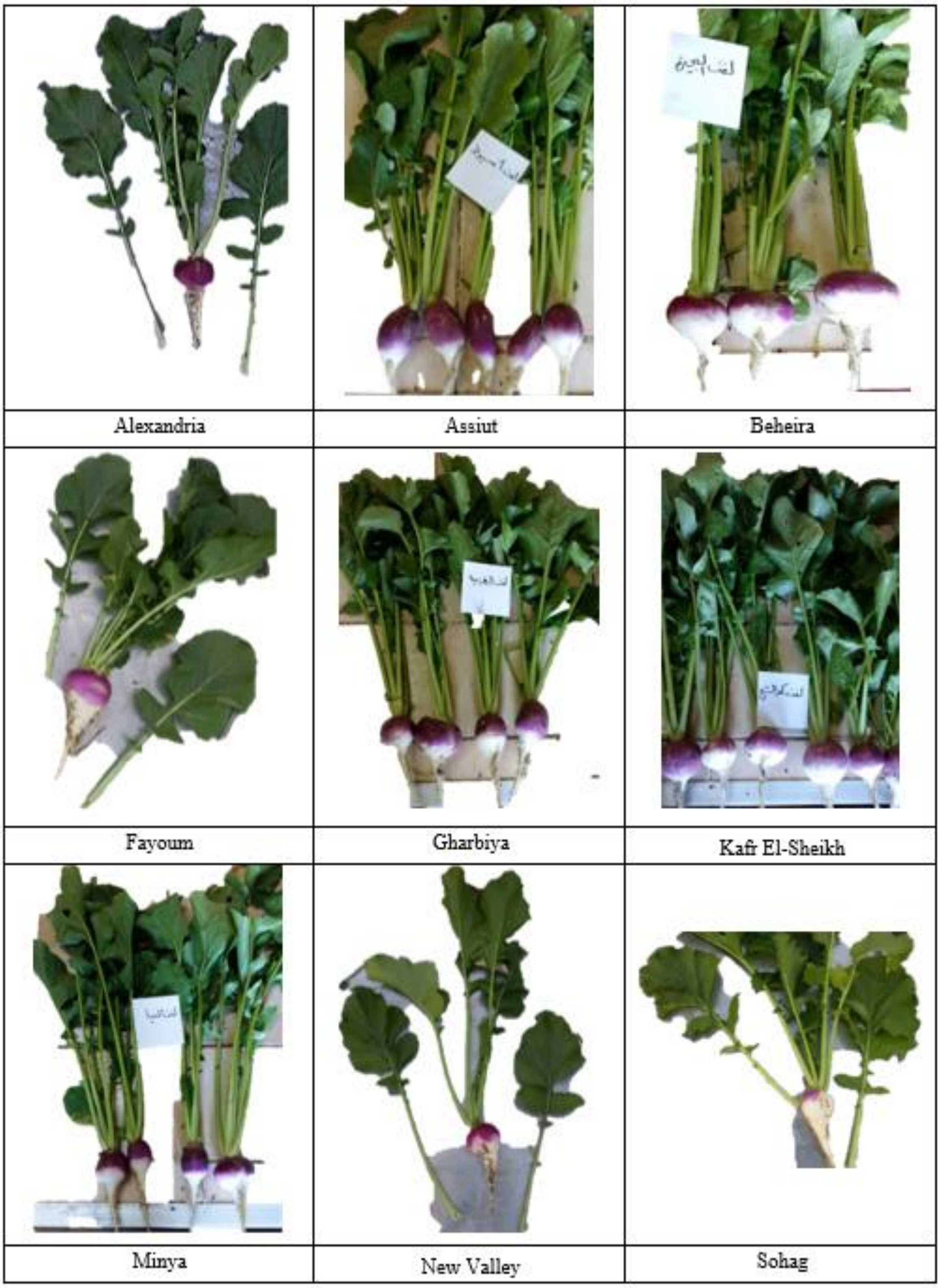

Fig. 1: Collected Balady turnip landraces from certain regions (gvernorates).

Table 3: Mean performances, ranges and coefficients of variations (C.V.%) for leaves and root characters and seed yield of the nine native landraces of Balady turnip, calculated from the combined data over two winter seasons, 2017/2018 and 2018/2019.

Balady landrace	leaves characters								
	No. of leaves / plant			Leaf length (cm)			Leaves weight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	8.3 ab#	6.5 - 10.0	16.2	20.8 d	17.5 - 23.5	11.8	22.5 cd	17.1 - 26.5	14.5
Assiut	7.5 b	6.1 - 9.2	15.9	27.3 c	23.0 - 33.0	13.8	24.7 bc	23.0 - 26.8	5.9
Beheira	7.4 b	6.9 - 8.4	8.0	22.8 d	17.0 - 31.2	22.4	20.1 d	16.5 - 22.5	11.7
Fayoum	9.0 a	7.2 - 10.5	15.3	31.2 b	27.2 - 36.4	10.1	27.6 ab	25.6 - 30.7	7.3
Gharbiya	7.9 ab	6.5 - 9.0	13.0	22.4 d	18.2 - 25.6	11.7	22.7 cd	20.5 - 24.6	7.2
Kafr El-Sheikh	7.8 ab	6.8 - 9.3	11.3	22.9 d	20.0 - 27.8	13.9	26.3 b	22.3 - 32.4	13.3
Minya	7.5 b	6.3 - 8.5	12.7	26.9 c	25.0 - 30.4	7.7	21.2 d	20.1 - 22.6	5.5
New Valley	7.2 b	6.5 - 7.6	6.0	20.9 d	17.3 - 25.0	13.7	22.2 cd	19.7 - 24.8	9.8
Sohag	8.1 ab	7.5 - 9.1	8.0	37.6 a	33.0 - 42.0	9.6	30.4 a	26.4 - 32.2	7.8
Balady landrace	Root characters								
	Root diameter (cm)			Root length (cm)			Root weight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	12.8 abc	10.5 - 14.3	11.1	3.6 bc	3.2 - 4.0	8.3	25.3 bc	21.6 - 31.9	17.3
Assiut	12.9 ab	11.0 - 16.1	15.4	4.2 a	3.6 - 4.8	10.2	24.3 bcd	12.3 - 28.3	26.2
Beheira	11.2 bcd	9.1 - 13.7	17.2	2.9 de	2.0 - 3.9	23.7	24.8 bcd	22.0 - 28.3	9.6
Fayoum	13.7 a	11.5 - 15.0	9.6	2.7 e	2.2 - 3.1	14.0	22.1 cd	19.5 - 25.3	12.3
Gharbiya	9.4 d	6.9 - 12.2	22.3	3.6 bc	3.2 - 4.0	7.9	26.1 abc	18.9 - 31.2	16.6
Kafr El-Sheikh	10.5 cd	7.4 - 13.0	20.6	3.7 b	3.5 - 4.0	5.1	30.2 a	26.7 - 34.3	9.5
Minya	9.3 d	7.3 - 11.7	18.7	2.9 de	2.2 - 3.7	20.1	24.6 bcd	20.9 - 27.4	9.8
New Valley	10.4 d	7.1 - 12.3	18.0	1.8 f	1.4 - 2.2	19.0	20.6 d	16.8 - 23.2	12.5
Sohag	13.3 ab	11.7 - 15.6	11.0	3.2 cd	2.9 - 3.5	7.4	28.3 ab	26.4 - 29.3	4.1
Balady landrace	Seed yield								
	No. of seed / silique			Weight of 1000 seeds (g)			Seed wight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	20.9 a	12.8 - 26.2	24.1	0.504 ab	0.355 - 0.660	22.4	19.4 bc	11.4 - 25.5	25.0
Assiut	15.6 b	12.0 - 18.0	14.5	0.475 ab	0.410 - 0.610	16.8	20.8 bc	19.0 - 24.1	10.0
Beheira	17.5 ab	15.4 - 21.2	13.2	0.410 b	0.260 - 0.563	28.4	16.7 cd	13.1 - 18.8	13.1
Fayoum	18.5 ab	10.0 - 28.8	34.3	0.484 ab	0.380 - 0.610	19.4	19.2 bc	12.9 - 24.0	22.9
Gharbiya	18.5 ab	14.6 - 21.8	15.1	0.503 ab	0.382 - 0.680	22.0	14.5 d	11.1 - 21.5	26.0
Kafr El-Sheikh	14.8 b	11.2 - 20.0	22.3	0.556 a	0.400 - 0.730	21.2	17.5 cd	16.0 - 19.7	8.0
Minya	14.7 b	13.2 - 16.6	8.0	0.473 ab	0.421 - 0.595	13.9	18.0 cd	14.3 - 21.7	17.1
New Valley	17.2 ab	14.2 - 20.2	15.2	0.498 ab	0.330 - 0.600	22.9	23.1 ab	15.2 - 29.3	21.8
Sohag	18.4 ab	16.1 - 19.4	7.2	0.542 a	0.450 - 0.730	20.9	26.4 a	21.4 - 30.0	11.1

Values with the same alphabetical letters, within a comparable group of means, do not significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

Mean squares of the combined analysis for the studied traits of all studied turnip genotypes were tabulated in Table (4). Mean squares of genotypes were found significant or highly significant for all characters except for both of No. of leaves / plant and weight of 1000 seeds. With regard to the genotype × year component of variance, it was highly significant in only the weight of 1000 seeds. The insignificance of this component showed that the selected genotypes succeeded to possess the same good performances in the two years of the test. the extent of variability present in a population and the heritability, genetic gain, genetic and phenotypic correlation among the traits are the basic keys for efficient selection in plant breeding programs, particularly in selecting superior genotypes. Knowledge of genetic variability and character (Raihan and Jahan, 2019).

Table 4: Mean squares calculated from the combined analysis for the studied traits of all studied turnip genotypes.

.S. O. V	.d.f	Foliage characters			Root characters			Seed yield		
		No. of leaves / plant	Leaf length	leaves weight / plant	Root diameter	Root length	Root weight / plant	No. of seed / silique	Weight of 1000 seeds	Seed weight / plant
(Y) Year	1	0.0091	9.13	0.11	0.043	4.87	2.67	41.33 *	0.0055	53.12 *
(G) Genotype	8	1.9137	188.55 **	67.49 **	3.053 **	17.11 **	50.93 **	24.59 *	0.0107	75.86 **
Y × G	8	0.6595	10.51	1.84	0.193	1.20	14.67	9.04	0.0267 **	2.14
Error	34	1.0373	10.14	6.07	0.144	3.29	11.53	9.47	0.0060	11.55

*, ** Significant differences at 5 and 1% levels of probability, respectively.

The partitioning of variance into its various components in Table (5) revealed that a large portion of total variances of most studied traits, in all turnip genotypes, would be attributed to genotypes. It should be mentioned here that genetic variance would be biased upward since it contains a non-partitioned genotypic × location source of variance (Comstock and Robinson, 1952); so, these results could be accepted under the designed conditions of this investigation and any wider implications warrant further research.

The estimated broad-sense heritability of the various studied characters reflected high values (> 70%) in most studied traits of radish ecotypes (Table, 5). These results gave information on the magnitude of genetic variation (Dully and Moll, 1969). However, Herbert et al. (1955) pointed out that heritability alone gives no - indication of the amount of progress expected from the selection. However, it seems to be most meaningful when accompanied by the estimates of the genetic coefficient of variability (Burton, 1952). On the other hand, Herbert et al (1955) stated that heritability estimates, when related to the expected genetic advance, considerable progress in modifying some characters by selection could be expected. Depending on these points of view, when the relatively high or moderate estimates of heritability are related to relatively high or moderate estimates of the genetic coefficient of variability, it would result in noticeable gain from the selection. Therefore, No. of leaves, might be improved by selecting the top 5% of the studied genotypes of turnip.

Table 5: Genotypic (δ^2_g), phenotypic (δ^2_{ph}), year (δ^2_y), genotypic × year (δ^2_{gy}) variances, heritability (H%), and genetic and phenotypic coefficients of variability (GCV, PVC), calculated from the combined data over the two seasons for the studied traits of all turnip genotypes.

	leaves characters			Root characters			Seed yield		
	No. of leaves / plant	Leaf length	leaves weight / plant	Root diameter	Root length	Root weight / plant	No. of seed / silique	Weight of 1000 seeds	Seed weight / plant
δ^2_g	1.254	178.04	65.64	2.86	15.90	36.26	15.55	0.016	73.72
δ^2_{ph}	2.166	188.30	70.30	3.02	18.50	48.84	24.87	0.029	82.14
δ^2_y	-0.024	-0.051	-0.064	-0.006	0.136	-0.445	1.196	-0.001	1.888
δ^2_{gy}	-0.126	0.123	-1.407	0.016	-0.696	1.046	-0.141	0.007	-3.137
H%	57.92	94.55	93.37	94.69	85.98	74.25	62.50	55.22	89.75
GCV	14.27	51.59	33.52	14.71	125.88	23.96	22.76	25.56	44.02
PVC	18.75	53.06	34.68	15.11	135.75	27.80	28.78	34.40	46.46

Table (6) shows the estimated values of correlation coefficients among the studied traits of the nine turnip genotypes. The number of leaves / plant was positively correlated with No. of seed / silique and leaves wight / plant. Furthermore, leaf length was positively correlated with seed weight / plant, root length and leaves wight / plant. Meanwhile, leaves weight/plant was positively correlated with seed weight / plant and root length.

Table 6: Simple correlation coefficient values calculated among the studied traits of the eight turnip genotypes.

Parameters	No. of leaves / plant	Leaf length	leaves weight / plant	Root diameter	Root length	Root weight / plant	No. of seed / silique	Weight of 1000 seeds
Seed weight / plant	0.075	0.354**	0.320*	-0.169	0.284*	-0.020	0.031	0.033
Weight of 1000 seeds	-0.038	0.166	0.241	-0.021	0.043	0.095	-0.078	
No. of seed / silique	0.377**	0.063	0.014	0.013	0.069	-0.035		
Root weight / plant	0.079	0.065	0.171	0.361**	-0.179			
Root length	0.176	0.434**	0.284*	0.139				
Root diameter	0.019	0.004	0.148					
leaves wight / plant	0.359**	0.546**						
Leaf length	0.179							

*, ** Significant differences at 5 and 1% levels of probability, respectively.

The dendrogram obtained from the studied traits grouped the nine Balady turnip into 4 main clusters (Fig. 2). The first cluster includes Sohag and the second cluster includes Fayoum. The third cluster includes New Valley genotype. The fourth cluster includes the other genotypes. The genetic distance between turnip genotypes is shown in Table 7. The

Balady Sohag landrace was the closest to Gharbiya, Beheira, New Valley and Alexandria followed by Kafr El-Sheikh and Minya, whereas Gharbiya and Beheira were the most distant.

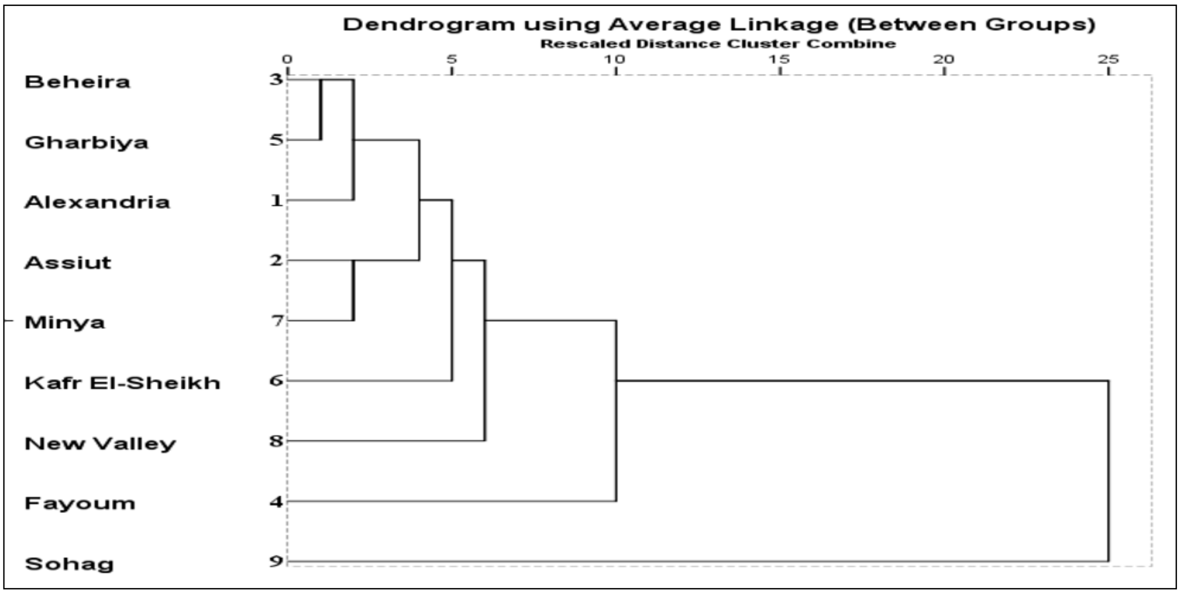

Fig. 2: Dendrogram using average Linkage of the nine Balady turnip landraces based on the studied traits, rescaled distance cluster combine**.**

Table 7: Similarity matrix of the nine turnip genotypes.

Balady landrace	1:Alexandria	2:Assiut	3:Beheira	4:Fayoum	5:Gharbiya	6:Kafr El-Sheikh	7:Minya	8:New Valley	9:Sohag
1:Alexandria	.000	79.521	32.121	152.671	44.208	88.915	91.521	58.964	411.512
2:Assiut	79.521	.000	67.876	44.809	92.389	73.500	36.029	83.039	195.159
3:Beheira	32.121	67.876	.000	150.843	17.989	76.840	31.065	68.293	439.728
4:Fayoum	152.671	44.809	150.843	.000	161.170	165.983	103.860	170.561	141.738
5:Gharbiya	44.208	92.389	17.989	161.170	.000	53.731	51.573	112.887	454.011
6:Kafr El-Sheikh	88.915	73.500	76.840	165.983	53.731	.000	74.978	154.232	337.588
7:Minya	91.521	36.029	31.065	103.860	51.573	74.978	.000	87.891	314.559
8:New Valley	58.964	83.039	68.293	170.561	112.887	154.232	87.891	.000	432.356
9:Sohag	411.512	195.159	439.728	141.738	454.011	337.588	314.559	432.356	.000

Radish:

Figure (3) and results in Table (8) reflected wide differences among the nine native landraces of Balady radish for most of the studied characters. the highest number of leaves / plants was obtained by Balady Aswan (11.9), and there were no significant differences among this landrace and Balady landraces of Beheira (10.3), Gharbiya (10), Qena (10.1) and Sohag (10.8). Meanwhile, the longest leaf was obtained by Balady Gharbiya (36.3 g), and there were no significant differences between this landrace and Balady landraces of Gharbiya and New Valley. However, the highest significance mean values of leaves weight /plant was obtained by Balady Beheira (61 g) and Balady Gharbiya (58.3 g) followed by Balady Kafr El-Sheikh (56 g). on the other hand, Balady Gharbiya gave the highest mean value for root diameter (3.4 cm). Meanwhile, the highest significance mean values of root length /plant were obtained by Balady Sohag (25.9 cm) followed by Balady New Valley (24.4 cm) and Balady Gharbiya (24.2 cm). The highest significance mean values of root weight /plant were obtained by Balady Beheira (46 g) followed by Balady Gharbiya (44 g) and Balady Kafr El-Sheikh (43.7 g). The best number of peduncle / plants was obtained by Balady Beheira (15), New Valley (13.9), and Qena (13.8). Concerning the weight of 100 seeds, there were no significant differences among the nine genotypes, but Balady Kafr El-Sheikh was the lowest of them. Regarding Seed weight / plant, Balady both of Aswan and Beheira surpassed the others. On the other hand, coefficients of variations (C.V.%) of the nine Balady landraces were less than 25 % for all the studied characters except a few exceptions, such as the number of seeds weight / plant in Balady Aswan (31.5%). These results indicate that there were no significant differences within the nine Balady landraces, consequently, these Balady landraces are largely genetically identical. In this regard, Abd - Allah and Moussa (2011) reported that there were wide differences among and within base populations of three balady ecotypes of white radish in most of the studied characters. The coefficients of variation values were higher than 25% in base populations of the three ecotypes for most characters.

Fig. 3: Collected Balady radish landraces from certain regions (gvernorates).

Table 8: Mean performances, ranges and coefficients of variations (C.V.%) for leaves and root characters and seed yield of the nine native landraces of Balady white radish, calculated from the combined data over two winter seasons, 2017/2018 and 2018/2019.

Balady landrace	leaves characters								
	No. of leaves / plant			Leaf length (cm)			leaves weight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	8.3 bc#	7 - 10	15.9	27.4 bc	21.4 - 31.3	16.7	48.0 cd	45.0 - 51.0	5.4
Aswan	11.9 a	9 - 14	18.7	26.4 c	20.0 - 33.0	21.4	43.0 de	38.0 - 49.0	11.2
Beheira	10.3 abc	9 - 12	12.8	31.8 abc	27.0 - 35.0	11.6	61.0 a	58.0 - 63.0	3.8
Gharbiya	10.0 abc	8 - 13	23.0	36.3 a	33.5 - 40.0	8.0	58.3 a	55.0 - 61.0	4.5
Kafr El-Sheikh	8.3 bc	7 - 10	15.9	29.2 bc	24.3 - 33.5	13.8	56.0 ab	52.0 - 59.0	5.6
Minya	9.5 bc	9 - 10	4.6	28.8 bc	27.3 - 30.3	4.5	45.0 de	42.0 - 47.0	5.1
New Valley	8.1 c	7 - 9	10.8	32.6 ab	30.2 - 34.0	5.5	48.3 cd	45.0 - 51.0	5.5
Qena	10.1 abc	9 - 11	9.9	29.7 bc	27.6 - 32.3	6.9	52.3 bc	47.0 - 62.0	13.9
Sohag	10.8 ab	9 - 12	13.4	26.4 c	21.0 - 30.2	15.8	41.3 e	37.0 - 44.0	7.9
Balady landrace	Root characters								
	Root diameter (cm)			Root length (cm)			Root weight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	2.7 bc	2.4 - 3.1	11.6	21.2 cd	20.0 - 22.0	4.3	37.0 c	35.0 - 38.0	4.1
Aswan	2.9 b	2.8 - 3.1	4.6	19.6 d	17.8 - 21.6	8.4	29.3 d	25.0 - 35.0	15.2
Beheira	2.6 bc	2.4 - 2.7	5.2	20.0 cd	18.0 - 22.6	10.2	46.0 a	45.0 - 47.0	1.9
Gharbiya	3.4 a	3.1 - 3.5	6.0	24.2 ab	23.0 - 25.0	3.8	44.0 ab	42.0 - 46.0	3.9
Kafr El-Sheikh	2.4 c	2.0 - 2.7	13.6	22.6 bc	19.7 - 25.2	10.6	43.7 ab	40.0 - 47.0	7.0
Minya	2.3 c	2.2 - 2.5	5.8	19.1 d	18.0 - 19.8	4.5	32.0 d	30.0 - 33.0	4.7
New Valley	2.7 bc	2.6 - 2.8	3.2	24.4 ab	23.7 - 25.5	3.4	32.0 d	30.0 - 34.0	5.4
Qena	2.5 c	1.9 - 2.9	18.0	15.6 e	15.3 - 16.0	2.0	40.0 bc	36.0 - 48.0	15.0
Sohag	2.6 bc	2.3 - 2.9	10.0	25.9 a	22.5 - 32.0	17.7	28.0 d	25.0 - 30.0	8.2
Balady landrace	Seed yield								
	No. of peduncle / plant			Weight of 100 seeds (g)			Seed weight / plant (g)		
	Mean	Range	C. V. %	Mean	Range	C. V. %	Mean	Range	C. V. %
Alexandria	12.3 b	12.0 - 12.5	1.8	0.783 bc	0.702 - 0.943	15.4	17.5 b	15.1 - 18.7	10.2
Aswan	10.8 c	10.0 - 11.5	6.0	0.910 ab	0.894 - 0.923	1.4	23.9 a	16.9 - 33.6	31.5
Beheira	15.0 a	14.0 - 16.0	5.8	0.773 bc	0.709 - 0.856	8.5	23.4 a	18.0 - 30.0	22.6
Gharbiya	9.8 cd	9.0 - 10.5	6.7	0.921 ab	0.818 - 0.992	8.6	16.8 b	14.9 - 19.0	10.8
Kafr El-Sheikh	10.6 c	10.0 - 11.3	5.4	0.736 c	0.627 - 0.863	14.0	15.7 b	11.2 - 18.8	22.1
Minya	9.0 d	7.0 - 10.0	16.7	0.832 abc	0.712 - 0.921	11.2	16.9 b	15.2 - 19.2	10.8
New Valley	13.9 a	13.3 - 15.0	5.8	0.977 a	0.856 - 1.083	10.1	17.2 b	13.9 - 18.9	14.3
Qena	13.8 a	11.5 - 16.0	14.1	0.886 abc	0.611 - 1.024	23.3	16.0 b	15.2 - 16.8	4.3
Sohag	10.1 cd	9.5 - 10.8	5.6	0.842 abc	0.737 - 0.963	11.7	14.2 b	11.9 - 16.2	13.1

Values with the same alphabetical letters, within a comparable group of means, do not significantly differ from one another, using Duncan's multiple range test at 0.05 level of probability.

Mean squares of the combined analysis for the studied traits overall studied radish genotypes were tabulated in Table (9). Mean squares of genotypes were found significant or highly significant for all characters except for both weights of 100 seeds. With regard to the genotype × year component of variance, it was insignificant for the studied traits. The insignificance of this component showed that the selected genotypes succeeded to possess the same good performances in the two years of the test. However, Abd - Allah and Moussa (2011) reported that mean squares of genotypes were found highly significant, only, for the number of leaves. The genotype × year component of variance did not reach the significance level in all studied traits.

Table 9: Mean squares calculated from the combined analysis for the studied traits of all studied radish genotypes.

.S. O. V	.d.f	leaves characters			Root characters			Seed yield		
		No. of leaves / plant	Leaf length	leaves weight / plant	Root diameter	Root length	Root weight / plant	No. of peduncle / plant	Weight of 100 seeds	Seed weight / plant
(Y) Year	1	2.83	0.34	37.6	0.001	6.85	11.11	0.007	0.0006	1.38
(G) Genotype	8	6.61 *	41.92 *	193.3 **	0.397 **	41.22 **	186.68 **	18.154 **	0.0249	45.54 *
Y × G	8	1.61	14.49	11.7	0.072	2.85	9.02	1.534	0.0134	8.99
Error	34	2.13	11.52	12.1	0.055	3.40	7.88	0.662	0.0104	13.67

*,** Significant differences at 5 and 1% levels of probability, respectively

The partitioning of variance into its various components in Table (10) revealed that a large portion of total variances of most studied traits, in all radish genotypes, would be attributed to genotypes. It should be mentioned here that genetic variance would be biased upward since it contains a non-partitioned genotypic × location source of variance (Comstock and Robinson, 1952); so, these results could be accepted under the designed conditions of this investigation and any wider implications warrant further research. Broad sense heritability was high in general, with most of the studied traits having heritability values greater than 70%. This high heritability indicates little influence of the environment on these characters. The highest heritability was recorded for Root weight / plant (95.56%) and the lowest was for Weight of 100 seeds (50.25%). These results are in agreement with those obtained by Mallikarjunarao *et al*. (2015).

Table 10: Genotypic ($\boldsymbol{\delta^2_g}$), phenotypic ($\boldsymbol{\delta^2}_{ph}$), year ($\boldsymbol{\delta^2_y}$), genotypic × year ($\boldsymbol{\delta^2_{gy}}$) variances, heritability (H%), and genetic and phenotypic coefficients of variability (GCV, PVC), calculated from the combined data over the two seasons for the studied traits of all radish genotypes.

	leaves characters			Root characters			Seed yield		
	No. of leaves / plant	**Leaf length**	**leaves weight / plant**	**Root diameter**	**Root length**	**Root weight / plant**	**No. of peduncle / plant**	**Weight of 100 seeds**	**Seed weight / plant**
δ^2_g	4.995	27.43	181.57	0.33	38.37	177.66	16.62	0.01	36.54
δ^2_{ph}	6.953	39.93	193.55	0.39	41.58	185.92	17.57	0.023	48.65
δ^2_y	0.045	-0.524	0.960	-0.003	0.148	0.078	-0.057	0.000	-0.282
δ^2_{gy}	-0.172	0.991	-0.134	0.006	-0.183	0.379	0.291	0.001	-1.558
H%	71.85	68.68	93.81	84.33	92.27	95.56	94.58	50.25	75.11
GCV	23.04	17.55	26.75	21.30	28.93	36.13	34.85	12.60	33.69
PVC	27.18	21.17	27.62	23.20	30.11	36.96	35.84	17.77	27.18

The estimated values of correlation coefficients among the studied traits of the nine radish genotypes are illustrated in Table (11). Leaf length was positively correlated with leaves weight / plant, root length and root wight / plant. Meanwhile, seed weight/plant was positively correlated with root length. The same trend was obtained by Abd - Allah and Moussa (2011).

Table 11: Simple correlation coefficients values calculated among the studied traits of the eight radish genotypes.

Parameters	**No. of leaves / plant**	**Leaf length**	**leaves weight / plant**	**Root diameter**	**Root length**	**Root weight / plant**	**No. of peduncle / plant**	**Weight of 100 seeds**
Seed weight / plant	0.073	-0.098	0.048	0.270	-0.377*	0.013	0.259	0.095
Weight of 100 seeds	-0.035	0.324	-0.141	0.379	-0.074	-0.219	-0.095	
No. of peduncle / plant	-0.142	0.046	0.264	-0.165	-0.199	0.227		
Root weight / plant	-0.245	0.443**	0.967**	0.113	-0.115			
Root length	-0.038	0.078	-0.008	0.262				
Root diameter	0.136	0.247	0.151					
leaves weight / plant	-0.244	0.491**						
Leaf length	-0.087							

*, ** Significant differences at 5 and 1% levels of probability, respectively.

The dendrogram obtained from the studied traits grouped the nine Balady radish into one main cluster and two submain clusters (Fig. 4). The first inter-cluster includes Sohag, Alexandria, Aswan, Minya, New Valley. The second inter-cluster includes Qena, Beheira, Gharbiya, and Kafr El-Sheikh. The genetic distance between turnip genotypes is shown in Table (12). The genotypes Sohag and Beheira were the closest, whereas Alexandria and Minya were the most distant.

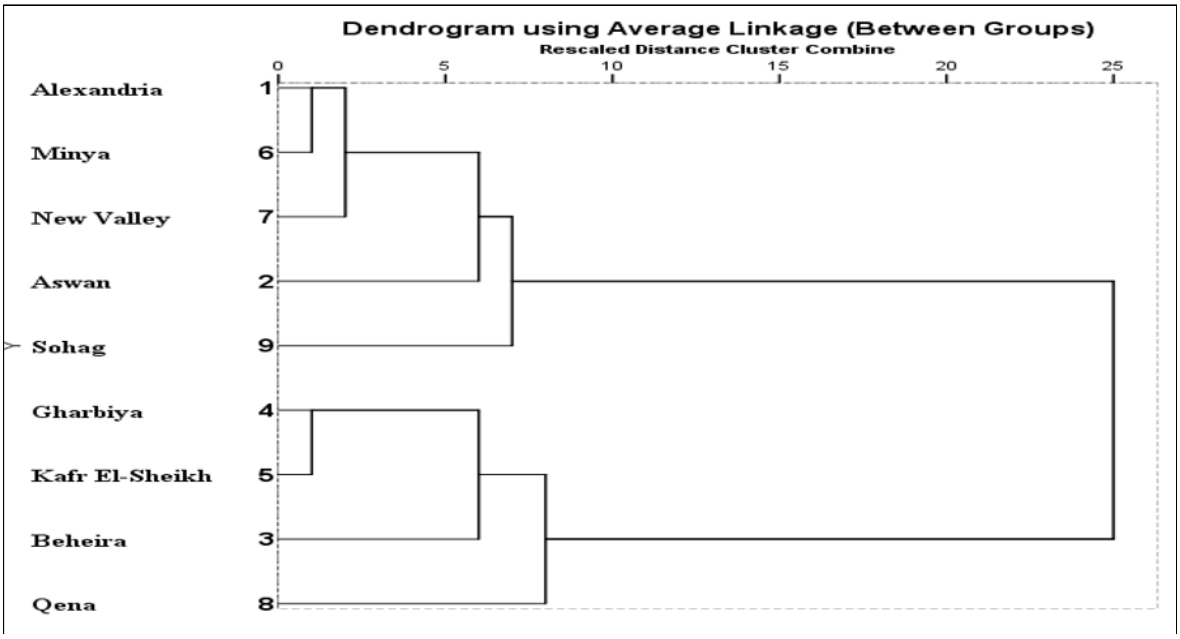

Fig. 4: Dendrogram using average Linkage of the nine Balady radish landraces based on the studied traits, rescaled distance cluster combine

Table 12: Similarity matrix of the nine radish genotypes.

Balady landrace	1:Alexandria	2:Aswan	3: Beheira	4:Gharbiya	5: Kafr El-Sheikh	6:Minya	7: New Valley	8: Qena	9:Sohag
1: Alexandria	.000	144.318	316.992	252.945	119.868	52.726	64.913	71.787	170.020
2: Aswan	144.318	.000	652.515	624.796	473.181	76.025	166.499	302.887	140.157
3: Beheira	316.992	652.515	.000	119.984	126.761	540.765	420.645	190.473	883.033
4: Gharbiya	252.945	624.796	119.984	.000	63.690	405.187	279.330	186.220	653.245
5: Kafr El-Sheikh	119.868	473.181	126.761	63.690	.000	275.106	223.510	89.989	488.024
6: Minya	52.726	76.025	540.765	405.187	275.106	.000	79.885	155.208	91.272
7: New Valley	64.913	166.499	420.645	279.330	223.510	79.885	.000	171.173	136.284
8: Qena	71.787	302.887	190.473	186.220	89.989	155.208	171.173	.000	399.235
9: Sohag	170.020	140.157	883.033	653.245	488.024	91.272	136.284	399.235	.000

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ARABIC SUMMARY

تقدير معامل الاختلاف وبعض المقاييس الوراثية لبعض الأصناف البلدية من اللفت والفجل

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نظرًا لعدم وجود (أو قلة) أصناف رسمية مصرية (مسجلة) من اللفت والفجل الأبيض، فقد تم إجراء هذا البحث لدراسة معامل التباين والاختلافات الوراثية داخل وبين تسعة أصناف محلية من كل من اللفت والفجل الأبيض - غير المسجلة- والتي تم جمعها من مناطق مختلفة (تسع محافظات) في مصر كخطوة أولى نحو تسجيلها، إذا كانت نقية وراثيا أو يتم تضمينها في برامج التربية لتحسين أو استنباط أصناف جديدة. وقد أجري هذا البحث بمزرعة خاصة بعرب الصبحة بدار السلام بمحافظة سوهاج خلال فصلي شتاء 2018/2017 و2019/2018.

أشارت النتائج إلى أن الطرز الوراثية لكل من اللفت والفجل أظهرت اختلافات واضحة بين السلالات المحلية لمعظم الصفات المدروسة. من ناحية أخرى، كانت معاملات التباين (CV٪) للأنواع المحلية التسعة من كل من اللفت والفجل أقل من 25٪ لجميع الصفات المدروسة باستثناء بعض الصفات. وتشير هذه النتائج إلى عدم وجود فروق ذات دلالة إحصائية داخل السلالات المحلية التسعة للفت أو الفجل. وبالتالي، فإن السلالات المحلية لبلدية هي إلى حد كبير متطابقة وراثيًا.

وجد أن متوسط مربعات الطرز الوراثية معنوي أو عالي المعنوية لجميع الصفات المدروسة باستثناء عدد الأوراق / النبات ووزن 1000 بذرة من اللفت ووزن 100 بذرة للفجل. فيما يتعلق بمكون التباين في التركيب الوراثي × سنة، فقد كان معنوياً للغاية في وزن 1000 بذرة فقط للفت وكان غير معنوي لكل صفات الفجل المدروسة. أظهرت عدم معنوية هذا المكون أن التراكيب الوراثية المختبرة نجحت في امتلاك نفس الأداء الجيد في عامين من الاختبار.

تقسيم التباين إلى مكوناته المختلفة، حيث يُعزى جزء كبير من الفروق الإجمالية لمعظم الصفات المدروسة، في جميع التراكيب الوراثية للفت والفجل، إلى المكون الوراثي. وتجدر الإشارة هنا إلى أن التباين الوراثي سيكون متحيزًا إلى الأعلى لأنه يحتوي على مصدر وراثي غير مقسم × مصدر تباين؛ لذلك، يمكن قبول هذه النتائج وفقًا للشروط المصممة لهذا البحث وأي آثار أوسع تتطلب مزيدًا من البحث. تعكس التوريث بالمعنى الواسع المقدرة لمختلف الصفات المدروسة قيمًا عالية (< 70 ٪) في معظم الصفات المدروسة لجميع التراكيب الوراثية للفت والفجل. أعطت هذه النتائج معلومات عن حجم التباين الجيني.

عكست القيم المقدرة لمعاملات الارتباط بين الصفات المدروسة التراكيب الوراثية التسعة للفت أن عدد الأوراق / النبات كان مرتبطًا ارتباطًا إيجابيًا بعدد البذور / الخردلة ووزن الأوراق / النبات. علاوة على ذلك، كان طول الورقة مرتبطا إيجابيا بوزن البذور / نبات وطول الجذر ووزن الأوراق / نبات. في حين أن وزن الأوراق / نبات كان مرتبطا إيجابيا مع وزن البذور / النبات وطول الجذر. أما بالنسبة للفجل، فقد كان طول الورقة مرتبطا إيجابيا بوزن الأوراق / النبات، طول الجذر ووزن الجذر / النبات. في حين أن وزن البذور / نبات كان مرتبطا إيجابيا بطول الجذر.

جمعت شجرة اللفت التي تم الحصول عليها من الصفات المدروسة اللفت البلدي التسعة إلى 4 عناقيد رئيسية. المجموعة الأولى تضم بلدي سوهاج والثانية تضم بلدي الفيوم. المجموعة الثالثة تشمل التركيب الوراثي للوادي الجديد. وتتضمن المجموعة الرابعة التراكيب الوراثية الأخرى. أظهرت المسافة الوراثية بين الطرز الوراثية للفت أن سلالة بلدي سوهاج كانت قريبة من الغربية والبحيرة والوادي الجديد والإسكندرية تليها كفر الشيخ والمنيا، بينما كانت الغربية والبحيرة الأبعد. جمّع مخطط الشجرة الذي تم الحصول عليه من الصفات المدروسة الفجل البلدي التسعة في عنقود رئيسي واحد وعنقدين فرعيين. التجمع الأول يشمل سوهاج، الإسكندرية، أسوان، المنيا، الوادي الجديد. أما المجموعة الثانية فتتضمن قنا والبحيرة والغربية وكفر الشيخ. أظهرت المسافة الوراثية بين التراكيب الوراثية للفت أن الطرز الوراثية سوهاج والبحيرة هي الأقرب، بينما كانت الإسكندرية والمنيا الأبعد.