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GENETIC VARIATION AND INTERRELATIONSHIPS AMONG AGRONOMIC TRAITS IN EGYPTIAN BREAD WHEAT LANDRACES AND LOCAL CULTIVARS

Mohammed A.H. Gharib[1], A.H. Salem[2], M.M.A. Ali[2*], E. Mansour[2] and Naglaa Qabil[2]

1. Field Crops Res. Inst., Agric. Res. Cent., Giza, Egypt

2. Agron. Dept., Fac. Agric., Zagazig Univ., Egypt

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ABSTRACT: The aim of this work was to investigate the genotypic variation of thirty five bread wheat genotypes as well as to clarify the association between grain yield and the other important agronomic traits. Two field experiments were carried out in the Experimental Farm of Genetic Resources Department, Bahteem Agricultural Research Station, Egypt during 2015-2016 and 2016-2017 growing seasons. Thirty two wheat landraces collected from eleven Districts in Egypt, in addition to three local cultivars were evaluated for earliness traits, plant height, yield and its components. The results indicated significant differences among the evaluated wheat genotypes for all investigated traits during the two seasons. The highest grain weight/plant and contributing traits were assigned for genotypes; G3, G8, G18, G27, G29, G33 and G35 at two growing seasons. The phenotypic variance (σ^2_{ph}) was found slightly higher than the genotypic variance (σ^2_g) for all studied traits under two seasons, and accordingly, phenotypic coefficient of variation (PCV) values were relatively greater than genotypic coefficient of variation (GCV) values for all traits. Heritability in broad sense (h^2b) values were high for plant height (90.63 and 97.81 %), number of grains/spike (95.33 and 84.66 %), 1000-grain weight (76.42 and 84.03 %), days to heading (77.4 and 87.06 %) and days to maturity (86.18 and 66.56 %) in 1st and 2nd seasons, respectively. Besides, it was low in 1st season (43.38 %) and high in 2nd season (71.91 %) for grain weight/plant, whereas it was moderate for number of spikes/plant (52.87 and 58.09 %) in 1st and 2nd seasons, respectively. Furthermore, positive genotypic and phenotypic correlations were found between studied traits and grain weight/plant during two growing seasons except days to heading. Additionally, path analysis was calculated and it was found that the direct effects on wheat grain yield of all studied traits were positive in both seasons except days to 50% heading at two seasons and days to maturity and plant height at the second season.

Key words: Bread wheat, local landraces and cultivars, phenotypic and genotypic coefficients of variation, genotypic and phenotypic correlation coefficients, broad sense heritability.

INTRODUCTION

Wheat is the first strategic crop grown during the winter season. It is stable food for about third of the world population due to its multiple uses, wider adaptation, high nutritive value (**Rangare *et al*., 2010**). Its cultivated area in the world in 2017 was 218.54 million hectares produced 771.72 million tons (**FAOSTAT, 2019**). Whereas, Egypt contributed in these values with low acreage which was 1.34 hectares produced 8.8 million tons and imported 8.73 million tons (about 50 % of the consumption).

Assessing of genetic diversity for local wheat landraces and cultivars contributes in determining potential of these materials for breeding efficiency and hence forward their use for wheat breeding, particularly under recent climate changes **(Lopes *et al*., 2015; Rufo *et al*., 2019)**. The continued providing wheat breeding

***Corresponding author: Tel. :** +20 01026061006
E-mail address: abd_lhamed@yahoo.com

programs with new germplasm materials as a donor of adapted genes is essential for further improving wheat cultivars **(Fu, 2015; Cobb *et al*., 2019)**. Since, the parents with wide genetic distance present good hybrid vigor with high yield performance. For that reason, obtaining information on nature, pattern and degree of genetic diversity helps breeders in identifying diverse parents to be crossed in wheat breeding programs **(Ahmadi *et al.*, 2012; Sajjad *et al.*, 2018)**.

Landraces are mixture of different genes and evolved by natural and artificial selection under environmental conditions where they were grown. They are very important genetic resource for diversity and specific adaptation to local environmental conditions and increasing agronomic traits in breeding programs **(Desiderio *et al.*, 2019; Zhao *et al.*, 2019)**. Agronomic, morphological and phenological traits are very important for grouping wheat genetic recourses, and also are essential and useful for plant breeders seeking to improve wheat germplasm **(Najaphy *et al.*, 2012)**.

The phenotypic (PCV) and genotypic (GCV) coefficients of variability, heritability and genetic advance for yield and contributing traits are a major concern for wheat plant breeder (**Rahman *et al*., 2016; Rajput 2019**). The direction and magnitude of the association between grain yield and contributing traits determine the efficiency of breeding programs. Furthermore, the relative importance of each trait involved in contributing to grain yield **(Naik *et al*., 2015; Rahman *et al*., 2016; Shamuyarira *et al*., 2019)**. Selection for grain yield by considering other related traits as indirect selection criteria is an alternative breeding approach. Consequently, genotypic and phenotypic correlations among traits could help in breeding through indirect selection for important traits by selecting least important traits that are easier to measure **(Anil *et al*., 2012; Jassim, 2019)**. Likewise, path analysis is a useful statistical model in breaking down the correlations of agronomic traits with grain yield into their direct and indirect effects **(Anand *et al*., 2016; Meles *et al*., 2017; Rajput, 2019)**.

The aim of this study was to (i) assess the association between grain yield and the other important agronomic traits in some Egyptian bread wheat landraces and local cultivars, (ii) to determine the amount of direct and indirect effects of some agronomic traits on grain yield, (iii) also to study the interrelationships among the tested traits.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Genetic Resources Department, Bahteem Agricultural Research Station, Egypt, during the two winter growing seasons of 2015/2016 and 2016/2017. The trials in both seasons were sown on third week of November within the optimal Districts for wheat cultivation. Thirty-two wheat landraces were collected from eleven Egyptian District, in addition to three local cultivars were evaluated in this study. The pedigree, site and collection data of wheat landraces and cultivars are presented in Table 1. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each genotype in each plot was sown in three rows, 2 m length, with row to row and plot to plot distances 0.25 m and 0.50 m, respectively. Ten plants were taken at random from each plot to estimate the following traits: plant height (cm), number of spikes/plant, number of grains/spike, 1000-grain weight (g) and grain weight/plant (g). Also days to heading (day) and days to maturity (day) were recorded.

The obtained data were statistically analyzed and differences among wheat genotypes means were tested using a revised LSD test at the 0.05 level according to **Steel *et al.* (1997)**.

Genotypic and phenotypic correlation coefficients were computed among the studied traits according **Kwon and Torrie (1964)**. Path analysis of above listed traits on grain yield was also performed according to **Dewey and Lu (1959)**. Microsoft Excel program, SPSS and SAS 9.1 Computer program for Windows were used for the statistical analysis. Variance components included phenotypic (σ^2P) and genotypic (σ^2G) components were estimated according to **Kwon and Torrie (1964)** for the two growing seasons. The phenotypic and genotypic coefficients of variation were calculated according to the method suggested by **Burton and Devane (1953)** using the following formulae:

Phenotypic Coefficient of variation:

$$PCV=\frac{\sigma ph}{\bar{\bar{X}}}\times 100$$

Genotypic Coefficient of variation

$$GCV=\frac{\sigma g}{\bar{\bar{X}}}\times 100$$

Where:

σph and σg are the phenotypic and genotypic standard deviations in the same rank, and ($\bar{x}$) is the general mean.

Heritability values in broad sense (h^2_b) and genetic advance (G.s) for the studied traits were estimated according to **Hanson *et al.* (1956)** using the following formulae:

$$h^2_b=\frac{\sigma^2 g}{\sigma^2 ph}\times 100$$

$$G.s=K\times h^2_b\times \sigma ph$$

$$G.s\ (\%)=\frac{G.s}{\bar{\bar{X}}}\times 100$$

Where:

h^2_b = heritability in broad sense

σ^2 g= genotypic variance

σ^2 ph= phenotypic variance

$G_{.S.\%}$= genetic advance as percentage of mean

K= a selection differential with a value of 2.06 under 5% selection intensity

σ ph= phenotypic standard deviation

$\bar{x}$ = general mean for the certain trait

RESULTS AND DISCUSSION

Analysis of Variance

The analysis of variance for days to 50% heading, days to maturity, plant height, number of spikes/plant, number of grains/spike, 1000-grain weight and grain weight/plant showed highly significant differences among the thirty-five bread wheat landraces and local cultivars in both 1st and 2nd seasons, reflecting the wide genetic diversity (Table 2). The coefficients of variation (CV %) were low (<10 %) in the two seasons for all traits except number of spikes/ plant and grain weight/plant were relatively moderate (10 to 20 %) in the two seasons. These results showed that the dependability level of results for these traits were high.

Mean Performance

The results in Table 3 indicate that, the environmental season caused a reduction in all studied traits except 1000-grain weight in the 1st season compared with the 2nd season for most landraces and local cultivars. Wheat genotypes number; G1, G6, G7, G8, G9, G16, G26, G27 and G29 exhibited the earliest values for days to 50% heading and maturity under the two seasons. Conversely, the genotypes G11, G14, G19, G21, G23, G30, G31, G32, G33 and G35 had the latest ones on both seasons.

The average of days to 50 % heading varied from 79.0 and 85.0 (G29) to 101.0 and 111.0 days (G30) with an average 86.3 and 94.7 days on 1st and 2nd seasons, respectively. For days to the maturity, the average for 1st season ranged from 127.0 (G16) to 143.7 days (G32) with an average 134.3 day, as well as from 144.3 (G16) to 151.7 days (G33) with an average 148.8 days for 2nd season.

Obviously, the wheat genotypes G2, G8, G9, G15, G20, G23, G24, G25, and G33 presented the shortest one for plant height among the studied genotypes on both seasons. On the other hand, G17, G21, G29, G30, G34 and G35 were the tallest one across the two environments. The average of plant height varied from 68.67 (G9) to 119.67 cm (G30) with an average of 89.05 cm in 1st season, and from 86.67 (G9) to 132.9 cm (G29) with an average of 105.76 cm in 2nd season.

Genotype No. 35 had the highest values for number of spikes/plant followed by G17, 18, 16 and 8. On the other side, G6, G1, G7, G21, G22, G24, G25 and G33 had the lowest values in both seasons. Its average varied from 3.33 and 3.73 (G24) to 8.43 and 8.23 (G35) with an average of 5.16 and 5.19 in the 1st and 2nd seasons, respectively.

The mean values of number of grains/spike are shown in Table 3. It varied from 42.33 and 40.83 (G17) to 80.33 and 77.0 (G3) with an average 55.67 and 58.25 in the 1st and 2nd seasons, respectively. In both seasons, wheat genotypes No. G3, G9, G21, G23, G27, G29 and G33 had the highest values. While, G2, G6, G11, G16, G17 and G35 recorded the lowest values during the two growing seasons.

Table 1. Wheat landraces and cultivars used in the two growing seasons (2015/ 2016 and 2016/ 2017)

Code	Accession	District	Site	Collection year
G1	2735	Aswan	Salamun	1990
G2	2745	Aswan	Beheira-ldfu	1990
G3	2733	Aswan	El-bisaliya	1990
G4	2778	Aswan	El-kilh Gharib	1990
G5	2787	Aswan	Habri, Idfu	1990
G6	1061	Qalyubiya	Kafr El-hissa, Benha Center	1987
G7	1062	Qalyubiya	Assafena, Tukh Center	1987
G8	1087	Monufia	Hurein	1987
G9	1089	Kafr El-sheikh	5km nw of Ibshan	1987
G10	1090	Kafr El-sheikh	Deiba, 2knw of Biyala	1987
G11	3209	Qena	El-hilaila	1990
G12	3218	Qena	El-hilaila ,25km N of El-hilla	1990
G13	3262	Qena	El-rizeiqat	1990
G14	3282	Qena	Almaris	1990
G15	3307	Qena	Naqaa Gharib, near El-gabalin	1990
G16	1070	Sharkia	Mity Azit,7km ne of Shiblanga	1987
G17	9	Marsa Matruh	Pasmialah, 8km E Matruh	1987
G18	Giza-168	Local cultivar	Mil/Buckseri cM930-16-8M-oy-om-2y-oB	1999
G19	Gemmeiza-9	Local cultivar	Ald”s”Ruac”s”//CMH74A63015xGm4583-5GM-1gm-oG	1999
G20	Sakha-93	Local cultivar	Sakha92/tr810328s8815-s-2s-15-0s	1999
G21	2790	Gharbia	Semille,3/4 km N of Sibirba	1990
G22	2796	Gharbia	Amyut,2km N of Qutur	1990
G23	2805	Sohag	El-hamdiya	1990
G24	2806	Sohag	Shandwill	1990
G25	2810	Sohag	NAgAL Kawi,9km Se of Tahta	1990
G26	2817	Sohag	Nag Assaw Amei,2kmNof Tahta	1990
G27	2900	Sohag	Shatura, 8km. SofTIma	1990
G28	2905	Sohag	Sohag, Haud Aisa	1990
G29	2906	Asyut	Beni feez, near Sidfa	1990
G30	2916	Asyut	Baqur	1990
G31	3305	Asyut	Al-wan,19km S of Manfalut	1990
G32	3309	Asyut	10km,S of Manfalut	1990
G33	3313	Asyut	Beni Rafi	1990
G34	3315	Asyut	Kom Boha,near Manfalut	1990
G35	Sinai	North Sinai	6km-E El-arish	1987

Table 2. Mean squares of earliness traits, plant height, yield and its components for 35 wheat landraces and cultivars during the two seasons (2015/2016 and 2016/2017)

SOV	df	Season	Days to 50% heading	Days to 50% maturity	Plant height (cm)	Number of spikes/ plant	Number of grains/ spike	1000- grain weight (g)	Grain weight/plant (g)
Replication	2	1st S	47.59	52.84	25.87	6.58	7.97	14.49	14.48
		2nd S	0.15	3.92	16.33	0.40	15.49	7.77	12.95
Genotypes	34	1st S	59.82**	59.21**	301.41**	3.65**	210.79**	46.62**	10.17**
		2nd S	67.42**	13.75**	312.13**	3.03**	171.80**	47.34**	20.02**
Error	68	1st S	5.31	3.00	10.04	0.84	3.38	4.35	3.08
		2nd S	3.18	1.97	2.32	0.59	9.79	2.82	2.31
CV (%)		1st S	2.67	1.29	3.56	17.71	3.30	5.45	17.31
		2nd S	1.88	0.94	1.44	14.78	5.37	4.47	14.23

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

1st S and 2nd S refer to the first season (2015/2016) and the second season (2016/2017), respectively.

Table 3. Mean performance of earliness traits, plant height, yield and its components for 35 wheat landraces and cultivars during the two seasons (2015/2016 and 2016/2017)

Trait	Days to 50% heading		Days to 50% maturity		Plant height (cm)		Number of spikes/ plant		Number of grains/ spike		1000- grain weight (g)		Grain weight/plant (g)	
Genotype	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S
G1	83.3	92.7	128.7	146.0	94.33	108.57	4.20	4.67	60.00	57.33	38.67	39.93	9.67	10.85
G2	86.0	93.0	133.7	151.0	81.33	99.50	5.20	5.67	51.00	46.77	34.00	36.50	9.33	8.02
G3	87.7	88.3	143.0	146.3	98.00	103.40	5.00	5.47	80.33	77.00	34.00	31.90	12.73	12.90
G4	87.3	99.0	128.3	144.3	87.00	104.20	5.00	5.70	56.33	56.00	34.67	36.00	8.17	11.49
G5	85.3	92.0	128.3	144.7	94.33	106.30	5.00	4.87	57.00	55.33	32.33	34.60	9.37	8.38
G6	85.0	91.0	128.0	145.3	84.00	101.80	4.33	4.20	44.67	51.17	43.67	42.97	9.07	8.05
G7	84.3	94.0	134.0	149.3	92.67	103.67	4.50	4.17	51.67	66.83	40.33	37.63	9.77	8.35
G8	82.3	89.0	130.7	148.0	88.33	99.33	6.33	6.00	56.33	51.33	41.67	44.83	12.43	15.70
G9	83.3	90.3	130.7	149.0	68.67	86.67	5.00	4.33	61.00	62.67	34.33	32.93	9.90	7.67
G10	82.7	91.0	136.0	149.3	88.33	104.07	5.00	4.37	54.33	62.33	37.00	35.83	9.40	11.49
G11	89.7	92.0	139.0	150.7	90.67	119.13	5.50	6.37	49.33	51.33	45.33	34.73	11.77	9.52
G12	83.0	91.7	136.0	148.7	85.67	113.73	5.67	4.40	50.33	53.50	39.33	39.37	8.33	11.32
G13	85.7	99.0	134.7	150.7	97.00	109.03	5.73	5.83	52.67	57.83	38.33	41.70	11.13	12.74
G14	88.0	100.0	139.0	151.0	86.67	101.60	5.67	6.50	52.67	54.33	36.00	33.17	10.03	13.38
G15	85.3	95.0	130.7	146.3	78.67	93.53	5.00	4.67	56.33	61.00	40.33	38.30	9.63	9.41
G16	79.3	89.3	127.0	144.3	83.00	102.47	6.17	6.30	44.67	51.37	39.00	33.23	7.93	12.56
G17	84.0	94.7	133.7	148.3	106.67	125.30	8.33	7.43	42.33	40.83	39.00	34.67	12.40	10.22
G18	86.0	94.3	136.0	149.3	85.67	103.20	7.47	7.00	58.33	59.00	38.33	33.93	11.90	15.60
G19	91.3	94.7	138.7	149.7	89.33	104.73	4.93	4.87	53.67	54.33	41.93	37.87	9.47	11.52
G20	82.0	94.7	133.0	148.7	75.00	90.40	4.67	4.80	53.33	53.13	41.73	40.60	7.30	6.60
G21	93.3	98.0	133.7	149.0	94.00	113.20	4.00	4.77	66.27	66.83	35.67	35.93	9.93	10.52
G22	84.3	94.0	129.3	149.7	92.33	105.00	4.37	4.17	54.33	57.50	42.33	37.83	9.00	10.17
G23	89.7	99.0	135.0	150.7	82.00	99.70	4.67	5.13	69.00	70.83	34.33	34.80	11.00	12.60
G24	88.0	94.0	132.3	147.3	83.00	99.13	3.33	3.37	56.33	60.83	38.87	35.57	8.50	7.49
G25	86.0	94.3	130.3	149.7	75.00	90.57	4.00	4.63	60.00	57.17	32.33	35.43	7.93	8.52
G26	82.0	92.0	133.3	148.7	90.33	111.13	4.67	4.87	54.33	58.83	38.33	44.83	9.10	10.61
G27	83.0	91.3	133.0	148.3	88.33	102.60	4.67	4.63	70.00	74.33	44.33	42.57	11.40	16.40
G28	80.3	95.0	134.7	150.3	86.00	106.83	4.67	4.67	58.33	62.33	33.93	41.40	11.33	8.59
G29	79.0	85.0	132.0	146.0	103.00	132.90	5.00	5.63	64.00	61.67	40.00	40.90	13.87	13.37
G30	101.0	111.0	141.0	151.3	119.67	117.67	4.83	4.83	49.67	55.33	37.00	38.73	9.43	9.43
G31	91.7	101.7	140.7	151.3	82.00	107.37	4.33	5.00	45.00	62.17	31.33	28.07	7.57	7.39
G32	91.7	97.7	143.7	151.0	82.67	100.90	5.67	4.67	48.67	53.67	34.67	36.07	9.00	8.36
G33	91.7	98.7	141.7	151.7	82.33	94.13	4.33	4.40	71.00	68.83	47.00	45.60	14.20	12.85
G34	86.3	99.3	136.3	149.7	91.33	111.50	5.00	4.67	50.00	51.33	37.00	37.30	9.20	7.84
G35	89.3	98.7	133.7	150.7	109.33	128.50	8.43	8.23	45.33	53.50	42.87	38.57	13.87	13.45
Mean	**86.3**	**94.7**	**134.3**	**148.8**	**89.05**	**105.76**	**5.16**	**5.19**	**55.67**	**58.25**	**38.29**	**37.55**	**10.14**	**10.67**
LSD $_{0.05}$	3.5	2.6	2.6	2.2	4.63	2.19	1.52	1.24	2.66	4.63	3.16	2.49	3.07	2.33
Min.	79.0	85.0	127.0	144.3	68.67	86.67	3.33	3.73	42.33	40.83	31.33	28.07	7.30	6.60
Max.	101.0	111.0	143.7	151.7	119.67	132.90	8.43	8.23	80.33	77.00	47.00	45.60	14.20	16.40

Moreover, mean values for 1000-grain weight in the first season varied from 31.33 for G31 to 47.00 g for G33 with an average of 38.29 g. Also, in the second season varied from 28.07 g for G31 to 45.60 g for G33 with an average 37.55 g. Overall, G6, G8, G20, G27, G29, G33 and G35 had the heaviest values for 1000-grain weight under the two environments. Whereas, the wheat genotypes G2, G3, G4, G5, G9, G14, G25, G31 and G32 were the lightest 1000-grain weight on the two seasons.

Finally, mean values for grain weight/plant varied from 7.3 (G20) to 14.2 g (G33) with an average 10.14 g in the 1st season and from 6.6 (G20) to 16.4 g (G27) with an average 10.67 g in the 2nd season. To clarify, G3, G8, G18, G27, G29, G33 and G35 had the highest values for grain yield under two seasons. On the contrary, G2, G5, G6, G7, G9, G15, G20, G25 and G31 had the lowest values for this trait across the two seasons.

Various researchers demonstrated significant differences among wheat landraces and local cultivars in agronomic traits as **Hassan *et al.* (2016), Ali (2017), Ali and Abdulhamid (2017)**, **Shoeva *et al*. (2017), Mathew *et al.* (2018), Rajput (2019) and Sheoran *et al*. (2019)**.

Estimates of Variance Components

Variance components for earliness traits, plant height, number of spikes/plant, number of grains/spike, 1000-grain weight and grain weight/plant at the two seasons are shown in Table 4. In general from previously Table, the results indicated that the phenotypic variance (σ^2_{ph}) was found slightly higher than the genotypic variance (σ^2_{g}) for all studied traits under the two growing seasons, showing that the apparent variation is not only genetic but likewise influenced by the growing environment in the expression of the traits. Accordingly, phenotypic coefficient of variation (PCV) values were relatively greater than genotypic coefficient of variation (GCV) values for all traits.

Earliness traits

The GCV values for days to 50 % heading were 4.94 and 4.89 % in 1st and 2nd seasons, respectively. Similarly, the PCV values for this trait were 5.62 and 5.24 % in the 1st and 2nd seasons, respectively**.** Correspondingly, days to maturity had similar trend as days to 50% heading, the GCV values were 3.22 and 1.33% in 1st and 2nd seasons, respectively. Likewise, the PCV values were 3.47 and 1.63 % in 1st and 2nd seasons, respectively. Additionally, the GCV values were near to PCV values for earliness traits, demonstrating high contribution of genotypic effect for phenotypic expression of earliness traits. Moreover, the earliness traits had low GCV and PCV values (<10) under both seasons according to **Deshmukh *et al.* (1986)**. The results in Table 4 showed that high to moderate broad sense heritability estimates (>50) coupled with low (>10) genetic advance in percentage of mean (GAM) were obtained for days to 50 % heading and days to maturity under the two seasons, representing wide scope for improvement through of plant selection of these traits.

Plant height (cm)

The GCV values were 11.07 and 9.61 % in the 1st and the 2nd seasons, respectively. Equally, the PCV values were 11.63 and 9.72 % in the 1st and 2nd seasons, respectively. The results indicated that very little difference was observed between GCV and PCV values under both seasons, indicating the predominance of genetic factors. Very high broad sense heritability estimates (90.63 and 97.81 %) coupled with high GAM (21.7 and 19.57 %) for plant height on the 1st and the 2nd seasons, respectively.

Number of spikes/plant

The GCV values for number of spikes/plant were 18.76 and 17.40 %, whereas, the PCV values were 25.8 and 22.83 % in 1st and 2nd seasons, respectively. These results showed that the difference between GCV and PCV values under both environments were remarkably large, indicated to more influence of environmental factor for the expression of number of spikes/ plant. This suggests that selection for this trait would not be effective. Heritability values for number of spikes/plant under two seasons were moderate (52.87 and 58.09 % for the 1st and the 2nd seasons, respectively). Too, the GAM values were high for this trait with 28.10 and 27.32 % in the 1st and the 2nd seasons, respectively.

Number of grains/spike

The GCV values for number of grains/spike were 14.93 and 12.62 %, as the PCV values were 15.3 and 13.71 % in the 1st and the 2nd seasons, respectively.

Table 4. Variance components of earliness traits, plant height, yield and its components for 35 wheat landraces and cultivars during the two seasons (2015/2016 and 2016/2017)

Trait	Days to heading		Days to maturity		Plant height (cm)		Number of spikes/plant		Number of grains/spike		1000- grain weight (g)		Grain weight/plant(g)	
Variance component	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S
MS_v	59.82	67.42	59.21	13.75	301.41	312.13	3.65	3.03	210.79	171.80	46.62	47.34	10.17	20.02
MS_e	5.31	3.18	3.00	1.97	10.04	2.32	0.84	0.59	3.38	9.79	4.35	2.82	3.08	2.31
$\sigma^2 g$	18.17	21.41	18.73	3.93	97.12	103.27	0.94	0.82	69.13	54.00	14.09	14.84	2.36	5.90
$\sigma^2 Ph$	23.48	24.59	21.74	5.90	107.17	105.59	1.77	1.40	72.52	63.79	18.44	17.66	5.45	8.21
GCV (%)	4.94	4.89	3.22	1.33	11.07	9.61	18.76	17.40	14.93	12.62	9.81	10.26	15.15	22.78
PCV (%)	5.62	5.24	3.47	1.63	11.63	9.72	25.80	22.83	15.30	13.71	11.22	11.19	23.01	26.86
h^2_b (%)	77.40	87.06	86.18	66.56	90.63	97.81	52.87	58.09	95.33	84.66	76.42	84.03	43.38	71.91
Genetic advance (GA)	7.73	8.89	8.28	3.33	19.33	20.70	1.45	1.42	16.72	13.93	6.76	7.27	2.09	4.24
GA as (%) of mean (GAM)	8.96	9.39	6.16	2.24	21.70	19.57	28.10	27.32	30.04	23.91	17.66	19.37	20.56	39.79

1st S and 2nd S refer to the first season (2015/2016) and the second season (2016/2017), respectively.

These results revealed that the difference between GCV and PCV values under the two seasons were small and their values were moderate to high (10 – 30 %), indicated the role of genetically influence over number of grains/ spike at the two seasons, representing that the selection would be effective. Hence, heritability values for number of grains/spike were very high (95.33 and 84.66 % in both seasons, respectively). Moreover, the GAM values were high in the 1st season (30.04 %) and in the 2nd season (23.91 %). Therefore, number of grains/spike was controlled by genetic factors.

1000 grain weight (g)

The GCV values for 1000-grain weight were 9.81 and 10.26 %, and PCV values were 11.22 and 11.19 in the 1st and 2nd seasons, respectively, however, GCV values under the two environments were near to PCV and these values were moderate (10-20 %). Heritability values for 1000-grain weight were high (<75) in both seasons. Correspondingly, the GAM values were moderate in the 1st season (17.66 %) and in the 2nd season (19.37 %).

Grain weight/plant (g)

The PCV values for grain weight were relatively greater than GCV, however, GCV values under the two seasons were wide to PCV, indicated distinct contribution of environmental factors in addition to genotypic effect for expression of the trait. Moreover, the GCV values were 15.15 and 22.78%, while, the PCV values were 23.01 and 26.86% in the 1st and 2nd seasons, respectively. Heritability values for grain yield/plant were 43.38% and 71.91% in the 1st and 2nd seasons, respectively. Similarly, the GAM values were moderate to high (20.56% and 39.79% in both seasons, respectively).

It could be concluded that under this study at two different seasons, the traits of days to 50% heading, days to maturity, plant height, number of grains/spike and 1000-grain weight were controlled by genetic factors. On the other hand, number of spikes/plant and grain weight/plant were controlled by a number of genetic and environmental factors.

The PCV and GCV values under the two growing seasons were low for earliness traits, moderate for plant height, number of grains/spike and 1000-grain weight and high for number of spikes/plant and grain weight/plant. Heritability in broad sense (h^2b) values were high for plant height (90.63 and 97.81 %), number of grains/spike (95.33 and 84.66 %), 1000-grain weight (76.42 and 84.03 %), days to heading (77.4 and 87.06 %) and days to maturity (86.18 and 66.56 %) in the 1st and 2nd seasons, respectively. Moreover, it was low in the 1st season (43.38 %) and high in the 2nd season

(71.91%) for grain weight/plant, whereas it was moderate for number of spikes/plant (52.87 and 58.09%) in the 1st and 2nd seasons, respectively.

These obtained results for phenotypic and genotypic coefficients of variation and heritability are in agreement with the findings of **Ghuttai *et al.* (2015), Tripathi *et al.* (2015), Ghallab *et al.* (2016), Abdul Hamid *et al.* (2017), Lone *et al.* (2017), Sharaan *et al.* (2017), Mathew *et al.* (2018)** and **Rajput (2019)**. Besides, the results of genetic advance are in harmony with those of **Rajput (2019)** who stated similar results for having low genetic advance values for earliness traits. However, **Ghallab *et al.* (2016), Abdul Hamid *et al.* (2017), Lone *et al.* (2017)** and **Rajput (2019)** recorded either high or moderate genetic advance for plant height, yield and its components.

Genotypic and Phenotypic Correlation Coefficients

Genotypic and phenotypic correlation coefficients based on the two seasons data were calculated among all possible combinations of the all studied traits are listed in Table 5. Days to 50% heading had positive and significant genotypic and phenotypic correlations with days to maturity in the 1st season (0.649** and 0.529**, respectively) and in the 2nd season (0.498** and 0.391**, respectively), as well as, plant height with number of spikes/plant in the 1st season (0.400* and 0.312*, respectively) and in the 2nd season (0.471** and 0.344**, respectively). On the other hand, number of spikes/plant had negative and significant genotypic correlations with number of grains/spike (-0.445** and -0.423** in 1st and 2nd seasons, respectively).

Furthermore, positive and significant genotypic correlations were found between plant height, number of spikes/plant, number of grains/spike and 1000-grain weight with grain weight/plant during the first season (0.525**, 0.663**, 0.458** and 0.541**, respectively). While in the 2nd season, positive and significant genotypic and phenotypic correlations were observed between number of spikes/plant with grain weight/plant (0.532** and 0.404**, respectively). Thus, resulting positive and significant associations suggest that increased grain yield could be achieved through selection based on both traits. These results are in agreement with those obtained by **Tripathi *et al.* (2015)**, **Abdul Hamid *et al.* (2017), Mathew *et al.* (2018)** and **Rajput (2019)** who recorded positive and significant correlation between grain weight/plant and yield components.

Path Coefficient Analysis

Direct and indirect effects of wheat grain yield and other various metric traits of 35 landraces and local cultivars during the two seasons relative to genotypic and phenotypic correlation coefficients are presented in Tables 6 and 7. The direct effect on wheat grain yield of all studied traits were positive in both seasons relative to genotypic and phenotypic correlation coefficients except days to 50 % heading during the 1st season and days to 50 % heading, days to maturity and plant height during the second season. The results during the first season showed that number of grains/spike had the largest direct effect on wheat grain yield (0.912 and 0.438) followed by number of spikes/plant (0.886 and 0.279), 1000-grain weight (0.446 and 0.169), then plant height (0.225 and 0.262) and days to maturity (0.140 and 0.091) relative to genotypic and phenotypic correlation coefficients, respectively, but the direct effects of plant height and days to maturity were low in magnitude. While, the largest direct effect during the second season was number of spikes/plant (0.997 and 0.601), followed by number of grains/spike (0.717 and 0.411), then 1000-grain weight (0.510 and 0.319) relative to genotypic and phenotypic correlation coefficients, respectively.

Positive indirect effects on wheat grain yield under the first season were often observed for the days to maturity and plant height *via* days to 50 % heading, likewise plant height, number of spikes/plant and number of grains/spikes *via* days to maturity. Also, days to maturity, number of spikes/plant and 1000-grain weight *via* plant height, as well as, plant height and number of spikes/plant *via* 1000-grain weight. On the other side, days to maturity and number of grains/ spikes had negative indirect effect on grain yield *via* 1000-grain weight, also plant height and number of spikes/plant *via* number of grains/ spikes. Moreover, during the second season, positive indirect effects were observed for the number of spikes/plant *via* days to 50% heading, likewise plant height, number of spikes/plant

Table 5. Genotypic and phenotypic correlation coefficients of earliness traits, plant height, yield and its components for 35 wheat landraces and cultivars during the two growing seasons (2015/2016 and 2016/2017)

Trait	Correlation coefficient	Days to 50% maturity		Plant height (cm)		Number of spikes/plant		Number of grains/spike		1000- grain weight (g)		Grain weight/plant (g)	
		1^{st} S	2^{nd} S	1^{st} S	2^{nd} S	1^{st} S	2^{nd} S	1^{st} S	2^{nd} S	1^{st} S	2^{nd} S	1^{st} S	2^{nd} S
Days to 50% heading	r_g	0.649**	0.498**	0.312	0.238	-0.107	0.151	0.002	-0.106	-0.062	-0.079	-0.039	-0.079
	r_{ph}	0.529**	0.391**	0.277	0.226	-0.092	0.104	0.001	-0.088	-0.095	-0.074	0.048	-0.051
Days to 50% maturity	r_g			0.180	0.030	0.054	0.111	0.126	0.051	0.028	-0.061	0.304	-0.034
	r_{ph}			0.176	0.029	0.067	0.098	0.101	-0.003	-0.004	-0.023	0.183	-0.036
Plant height (cm)	r_g					0.400*	0.471**	-0.128	-0.193	0.140	-0.063	0.525**	0.102
	r_{ph}					0.312*	0.344*	-0.108	-0.178	0.112	-0.048	0.328*	0.091
Number of spikes/plant	r_g							-0.445**	-0.423**	0.173	-0.257	0.663**	0.532**
	r_{ph}							-0.318*	-0.305	0.079	-0.174	0.244	0.404*
Number of grains/spike	r_g									-0.108	0.004	0.458**	0.293
	r_{ph}									-0.087	-0.011	0.315*	0.229
1000- grain weight (g)	r_g											0.541**	0.255
	r_{ph}											0.185	0.214

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

r_g and r_{ph} refer to genotypic and phenotypic correlation coefficients, respectively.

Table 6. Direct (Diagonal) and indirect effect of various metric traits of 35 wheat landraces and cultivars on grain weight/plant during the 1st season (2015/2016)

Trait	Path coefficient	Days to 50% heading	Days to 50% maturity	Plant height (cm)	Number of spikes/ plant	Number of grains/ spike	1000-grain weight (g)	Correlation with grain weight/plant (g)
Days to 50% heading	P_g	-0.079	0.091	0.070	-0.094	0.002	-0.028	-0.039
	P_{ph}	-0.032	0.048	0.073	-0.026	0.001	-0.016	0.048
Days to 50% maturity	P_g	-0.051	0.140	0.040	0.048	0.115	0.012	0.304
	P_{ph}	-0.017	0.091	0.046	0.019	0.044	-0.001	0.183
Plant height (cm)	P_g	-0.025	0.025	0.225	0.354	-0.117	0.062	0.525
	P_{ph}	-0.009	0.016	0.262	0.087	-0.047	0.019	0.328
Number of spikes/plant	P_g	0.008	0.008	0.090	0.886	-0.405	0.077	0.663
	P_{ph}	0.003	0.006	0.082	0.279	-0.139	0.013	0.244
Number of grains/spike	P_g	-0.0001	0.018	-0.029	-0.394	0.912	-0.048	0.458
	P_{ph}	-0.00004	0.009	-0.028	-0.089	0.438	-0.015	0.315
1000- grain weight (g)	P_g	0.005	0.004	0.031	0.153	-0.098	0.446	0.541
	P_{ph}	0.003	-0.0004	0.029	0.022	-0.038	0.169	0.185

P_g and P_{ph} refer to path coefficients relative to genotypic and phenotypic correlations, respectively.

Table 7. Direct (Diagonal) and indirect effect of various metric traits of 35 wheat landraces and cultivars on grain yield/plant during the 2nd season (2016/2017)

Trait	Path coefficient	Days to 50% heading	Days to 50% maturity	Plant height (cm)	Number of spikes/ plant	Number of grains/ spike	1000-grain weight (g)	Correlation with grain weight/plant (g)
Days to 50% heading	P_g	0.008	-0.079	-0.058	0.165	-0.076	-0.040	-0.079
	P_{ph}	-0.019	-0.030	-0.005	0.063	-0.036	-0.024	-0.051
Days to 50% maturity	P_g	0.004	-0.158	-0.007	0.122	0.037	-0.031	-0.034
	P_{ph}	-0.007	-0.078	-0.001	0.059	-0.001	-0.007	-0.036
Plant height (cm)	P_g	0.002	-0.005	-0.242	0.517	-0.138	-0.032	0.102
	P_{ph}	-0.004	-0.002	-0.020	0.207	-0.073	-0.015	0.091
Number of spikes/plant	P_g	0.001	-0.017	-0.114	0.997	-0.303	-0.131	0.532
	P_{ph}	-0.002	-0.008	-0.007	0.601	-0.125	-0.056	0.404
Number of grains/spike	P_g	-0.001	-0.008	0.047	-0.464	0.717	0.002	0.293
	P_{ph}	0.002	0.0003	0.004	-0.184	0.411	-0.004	0.229
1000- grain weight (g)	P_g	-0.001	0.010	0.015	-0.282	0.003	0.510	0.255
	P_{ph}	0.001	0.002	0.001	-0.105	-0.005	0.319	0.214

P_g and P_{ph} refer to path coefficients relative to genotypic and phenotypic correlations, respectively.

and number of grains/spikes *via* days to maturity. Also, number of spikes/plant *via* plant height, as well as, plant height *via* 1000-grain weight, relative both genotypic and phenotypic correlations.

Generally, the aforementioned results exposed that number of spikes/plant, number of grains/ spike and 1000-grain weight were considered the major yield components, indicated that the wheat breeder should take into account as the most selection criteria for developing high yielding genotypes at early generations. The results of path analysis are in consonance with **Anand *et al*. (2016), Meles *et al*. (2017), Jassim (2019) and Rajput (2019).**

REFERENCES

Abdul Hamid, M.I.E., N. Qabil and F.M.A. El-Saadony (2017). Genetic variability, correlation and path analysis for yield and yield components of some bread wheat genotypes. J. Plant Prod., Mansoura Univ., 8 (8): 345-352.

Ahmadi, M., E. Farshadfar and S. Veisi (2012). Evaluation of genetic diversity in landraces of bread wheat under irrigated and rainfed conditions. Int. J. Agri. Crop Sci., 4 (21): 1627- 1636.

Ali, M.M.A. (2017). Stability analysis of bread wheat genotypes under different nitrogen fertilizer levels. J. Plant Prod., Mansoura Univ., 8 (2): 261-275.

Ali, M.M.A. and M.I.E. Abdulhamid (2017). Yield stability of wheat under some drought and sowing dates environments in different irrigation systems. Zagazig J. Agric. Res., 44 (3): 865 – 886.

Anand, G., K. Anandhi and V. Paulpandi (2016). Genetic variability, correlation and path analysis for yield and yield components in F6 families of Greengram (*Vigna radiata* L. Wilczek) under rainfed condition. Omics, 3 (1): 1-6.

Anil, S., K. Sanjiv, K. Shashi, P. Krishan, K. Anil and S. Manender (2012). Genetic improvement through variability, heritability and genetic advance in barley crop (*Hordeum vulgare* L.). Environ. Ecol., 30 (4): 1343-1345.

Burton, G.W. and E. Devane (1953). Estimating heritability in tall fescue (*Festuca arundinacea* L.) from replicated clonal material. Agron. J., 45 (10): 478-481.

Cobb, J.N., R.U. Juma, P.S. Biswas, J.D. Arbelaez, J. Rutkoski, G. Atlin, T. Hagen, M. Quinn and E.H. Ng (2019). Enhancing the rate of genetic gain in public-sector plant breeding programs: lessons from the breeder's equation. Theor. Appl. Genet., 132 (3): 627-645.

Deshmukh, S.N., M.S. Basu and P.S. Reddy (1986). Genetic variability, character association and path coefficient of quantitative traits in Virginia bunch varieties of groundnut. Indian J. Agric. Sci., 56 : 816-821.

Desiderio, F., L. Zarei, S. Licciardello, K. Cheghamirza, E. Farshadfar, N. Virzi, F. Sciacca, P. Bagnaresi, R. Battaglia and D. Guerra (2019). Genomic regions from an Iranian landrace increase kernel size in durum wheat. Front. Plant Sci., 10: 448.

Dewey, D.R. and K.H. Lu (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J., 51: 515-518.

FAOSTAT (2019). Food and Agriculture Organization of the United Nations. Statistical Database. (Accessed 28 July 2019).

Fu, Y.B. (2015). Understanding crop genetic diversity under modern plant breeding. Theor. Appl. Genet., 128(11): 2131-2142.

Ghallab, K.H., A. N. Sharran and N. A. Al-Sayed Shalby (2016). Genetic parameters for yield and yield components traits of some wheat genotypes grown in newly reclaimed soils. Int. J. Agr. Agri. R., 9 (4): 1-8.

Ghuttai, G., F. Mohammad, F.U. Khan, W.U. Khan and F.Z. Zafar (2015). Genotypic differences and heritability for various polygenic traits in F5 wheat populations. Ame. Eurasian J. Agric. Environ. Sci., 15 (10): 2039-2044.

Hanson, C.H., H.F. Robinson and R.E. Comstock (1956). Biometrical studies of yield in segregating populations of Korean Lespedeza. Agron. J., 48: 268-272.

Hassan, M.I., E.A. Mohamed, M.A. El-Rawy and K.A. Amein (2016). Evaluating interspecific wheat hybrids based on heat and drought stress tolerance. J. Crop Sci. Biotechnol., 19(1): 85-98.

Jassim, W.M. (2019). Correlations and path analysis for agronomic and productivity in bread wheat (*Triticum aestivum* L.) by effect of seeding rates. Tikrit J. Agric. Sci., 15(4): 32-41.

Kwon, S.H. and J.H. Torrie (1964). Heritability and interrelationship among traits of two soybean populations. Crop Sci., 4: 196-198.

Lone, R.A., T. Dey, B.C. Sharma, G.K. Rai, S.H. Wani and J.A. Lone (2017). Genetic variability and correlation studies in winter wheat (*Triticum aestivum* L.) germplasm for morphological and biochemical characters. Int. J. Pure App. Biosci., 5 (1): 82-91.

Lopes, M.S., I. El-Basyoni, P.S. Baenziger, S. Singh, C. Royo, K. Ozbek, H. Aktas, E. Ozer, F. Ozdemir and A. Manickavelu (2015). Exploiting genetic diversity from landraces in wheat breeding for adaptation to climate change. J. Exp. Bot., 66(12): 3477-3486.

Mathew, I., H. Shimelis, L. Mwadzingeni, R. Zengeni, M. Mutema and V. Chaplot (2018). Variance components and heritability of traits related to root: shoot biomass allocation and drought tolerance in wheat. Euphytica., 214(12): 1-12.

Meles, B., W. Mohammed and Y. Tsehaye (2017). Genetic variability, correlation and path analysis of yield and grain quality traits in bread wheat (*Triticum aestivum* L.) genotypes at Axum, Northern Ethiopia. J. Plant Breed. Crop Sci., 9(10): 175-185.

Naik, V.R., S.S. Biradar, A. Yadawad, S. Desai and B. Veeresha (2015). Study of genetic variability parameters in bread wheat (*Triticum aestivum* L.) genotypes. Res. J. Agric. Sci. 6(1): 123-125.

Najaphy, A., R.A. Parchin and E. Farshadfar (2012). Comparison of phenotypic and molecular characterizations of some important wheat cultivars and advanced breeding lines. Aust. J. Crop Sci., 6(2): 326-332.

Rahman, M., M. Kabir, M. Hasanuzzaman, R. Rumi, and M. Afrose (2016). Study of variability in bread wheat (*Triticum aestivum* L.). Int. J. Agric. Res., 8: 66-76.

Rajput, R.S. (2019). Path analysis and genetic parameters for grain yield in bread wheat (*Triticum aestivum* L.). Ann. Res. Rev. Biol., 31: 1-8.

Rangare N.R, A. Krupakar, A. Kumar and S. Singh (2010). Character association and component analysis in wheat (*Triticum aestivum* L.). Electron. J. Plant Breed., 1(3): 231-238.

Rufo, R., F. Alvaro, C. Royo and J.M. Soriano (2019). From landraces to improved cultivars: Assessment of genetic diversity and population structure of Mediterranean wheat using SNP markers. PloS one., 14(7): 1-19.

Sajjad, M., S.H. Khan, and M. Shahzad (2018). Patterns of allelic diversity in spring wheat populations by SSR-markers. Cytol. Genet., 52(2): 155-160.

Shamuyarira, K.W., H. Shimelis, T. Tapera and T.J. Tsilo (2019). Genetic advancement of newly developed wheat populations under drought-stressed and non-stressed conditions. J. Crop Sci. Biotechnol., 22(2): 169-176.

Sharaan, A.N., K.H. Gallab and M.A.S.M. Eid (2017). Estimation of genetic parameters for yield and its components in bread wheat (*Triticum aestivum* L.) genotypes under pedigree selection. Int. J. Agron. Agric. Res., 10 (2): 22-30.

Sheoran, S., S. Jaiswal, D. Kumar, N. Raghav, R. Sharma, S. Pawar, S. Paul, M.A. Iquebal, A. Rai and D. Kumar (2019). Uncovering genomic regions associated with 36 agro-morphological traits in Indian spring wheat using GWAS. Front. Plant Sci., 10: 1-20.

Shoeva, O.Y., E. Gordeeva, V. Arbuzova and E. Khlestkina (2017). Anthocyanins participate in protection of wheat seedlings from osmotic stress. Cereal Res. Commun., 45 (1): 47-56.

Steel, R.G.D., J.H. Torrie and D.A. Diekey (1997). Principles and Procedures of Statistics. A Biometrical Approach 3rd Ed. McGraw-Hill Book Co. New York.

Tripathi, G.P., N.S. Parde, D.K. Zate and G.M. Lal (2015). Genetic variability and heritability studies on bread wheat (*Triticum aestivum* L.). Int. J. Plant Sci., 10(1):57-59.

Zhao, J., Z. Wang, H. Liu, J. Zhao, T. Li, J. Hou, X. Zhang and C. Hao (2019). Global status of 47 major wheat loci controlling yield, quality, adaptation and stress resistance selected over the last century. BMC Plant Boil., 19(1): 1-14.

التباين الوراثي والعلاقات المتبادلة بين الصفات المحصولية في أصناف مصرية قديمة وحديثة من قمح الخبز

محمد عبدالعزيز حسين غريب[١] - عبد الحميد حســن ســالم[٢]
محمد محمد عبدالحميد على[٢]- السيد منصور[٢]- نجلاء قبيل[٢]

١- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية - الجيزة - مصر

٢- قسم المحاصيل - كلية الزراعة - جامعة الزقازيق - مصر

الهدف من هذا البحث هو دراسة التباين الوراثي فى خمسة وثلاثين تركيباً وراثياً من قمح الخبز وكذلك توضيح العلاقة بين صفة محصول الحبوب والصفات المحصولية المهمة الأخرى وتحديد العلاقات المتبادلة بين هذه الصفات، لذلك تم إجراء تجربتين حقليتين في المزرعة التجريبية بقسم الأصول الوراثية، محطة بهتيم للبحوث الزراعية، مصر خلال الموسمين الشتويين ٢٠١٥-٢٠١٦ و ٢٠١٦-٢٠١٧ بهدف تقييم اثني وثلاثين صنف قمح قديم تم جمعها من أحدى عشر محافظة في مصر، بالإضافة إلى ثلاثة أصناف محلية وتم دراسة صفات التبكير، ارتفاع النبات، المحصول ومكوناته، أشارت النتائج إلى وجود فروق معنوية بين التراكيب الوراثية تحت الدراسة لجميع الصفات التي تم تقييمها خلال الموسمين، وتم تسجيل أعلى كمية محصول للنبات والصفات المساهمة للتراكيب الوراثية؛ ٣ و ٨ و ١٨ و ٢٧ و ٢٩ و ٣٣ و ٣٥ في الموسمين، وأظهرت النتائج أن التباين المظهري كان أعلى قليلاً من التباين الوراثي لجميع الصفات تحت الدراسة في الموسمين، وبالتالي كانت قيم معامل الإختلاف المظهرى أكبر نسبيًا من قيم معامل الإختلاف الوراثي لجميع الصفات، وكانت قيم كفاءة التوريث فى المعنى الواسع عالية لارتفاع النبات (٩٠.٦٣ و ٩٧.٨١ %) ، عدد حبوب السنبلة (٩٥.٣٣ و ٨٤.٦٦%) ، وزن الألف حبة (٧٦.٤٢ و ٨٤.٠٣ %)، عدد الأيام حتى الطرد (٧٧.٤ و ٨٧.٠٦ %) وعدد الأيام حتى النضج (٨٦.١٨ و ٦٦.٥٦%) في الموسم الأول والثاني على التوالي، بينما كانت كفاءة التوريث منخفضة في الموسم الأول (٤٣.٣٨ %) وعالية في الموسم الثاني (٧١.٩١%) لوزن حبوب النبات، في حين كانت متوسطة لعدد السنابل على النبات (٥٢.٨٧ و ٥٨.٠٩%) في الموسمين الأول والثاني، على التوالي، ووجد أن معامل الارتباط الوراثي والمظهري كان إيجابياً بين الصفات المدروسة وصفة وزن حبوب النبات خلال الموسمين ماعدا عدد الأيام حتى ٥٠% من طرد السنابل، هذا وقد أظهرت تقديرات معامل المرور أهمية التأثير المباشر على محصول الحبوب من جميع الصفات المدروسة في كلا الموسمين ماعدا عدد الأيام حتى الطرد في الموسمين وعدد الأيام حتى النضج وارتفاع النبات في الموسم الثاني.

المحكمـــــون:

١- أ.د. السيد السيد حسن	أستاذ المحاصيل المتفرغ - كلية التكنولوجيا والتنمية – جامعة الزقازيق.
٢- أ.د. حسن عوده عواد	أستاذ ورئيس قسم المحاصيل – كلية الزراعة - جامعة الزقازيق.