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Stability Analysis Of Some Genotypes In Flax (Linum Usitatissimum L.)

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Abstract

The research was conducted to evaluate stability of eight genotypes of Flax (Linum usitatissimum L.) (Sakha 1, Sakha 2, Sakha 3, Sakha 5, Sakha 6, Giza 8, Syrian and Poloni) which was cultivated in the research station of the Field Crops Department of the College of Agriculture - Tikrit University during the season (2019/2020) in six agricultural environments, which is the combination of two agricultural distances (5 and 10 cm) and three planting dates, it was applied according to the split-plot system in the Randomized Complete Block Design (RCBD). With three replicated, the plants were divided into separate plot by four lines for each genotype in each environment, where the line length (2 m) and the distance between the lines was (0.40 m), The main plots contained agricultural environments and subplot of genotypes, and the study included thirteen traits , which are duration to 50% flowering, plant height, number of vegetative branches, number of capsules per plants, number of seeds per capsule, yield of seeds per plant, weight of 1000 seeds, average leaf weight, biological yield, leaf percentage, seed yield, and harvest index. The results of the analysis of variance of Genotype x environment interaction showed that the mean of the environments squares (E) were significant at the level of probability (1%) for the duration to 50% flowering, plant height, duration to maturity, number of vegetative branches, number of capsules, biological yield and seed yield, and the statistical significance limit was not reached for the rest of the traits. As for the squares mean of genotypes (G), it was significant about the level of probability (1%) for most of the traits under study and at (5%) for the average trait of leaf weight except for the trait of percentage of leaves was not significant, As for that due to the interaction of genotypes x environments (G × E) was significant at the level of probability (1%) for the recipe, the seed yield by the plant, the weight of 1000 seeds, and the seed yield and the evidence of harvesting did not reach the limit of significance for the rest of the traits studied, and the results showed that the squares mean of the environments (linear) was significant at a 1% probability level for all traits and at 5% for the average leaf weight trait, it is not significant for the number of seeds per capsule, and that the mean of the linear component squares of interaction genotypes x environments when tested against pooled deviation was significant for all traits and was non-significant for the number of capsules per plant, number of seeds per capsule and average leaf weight, The results of the stability parameters showed that some genotypes were suitable and stable for some approved agricultural environments, for the duration traits to 50% flowering, plant height, number of vegetative branches, number of capsules per plant, number of seeds per capsule, and biological yield.

Keywords: flax, genetic stability, genotypes x environments (G × E), genotypes.

Introduction

Flax or Linseed is one of the oldest plant crops known to Human and has been cultivated since ancient times to take advantage of oil or fiber or both. Which consists of 13 genera and 300 species (Raddy et al., 2013), its scientific name is (Linum usitatissimum L.). Flaxseeds are classified among the important functional foods for their abundance of many nutrients compared to other vegetable oils, such as unsaturated fatty acids, protein and lignans. Therefore, it is unique among oilseeds due to its high content of fixed oils for the fatty acid (Alpha-Linolenic Acid ALA) and its percentage ranges from (30 45)% of the oil, which makes up about 57% of the total fatty acids, The area cultivated of flax in the world for the year (2017) amounted to about (2,486) million hectares only, and it produced about (20.55) million tons of seeds, total annual production. Canada leads the world, followed by China, India, America, Ethiopia and Egypt, and there are other countries whose production is less than It (FAO STATA, 2018). That the ability to develop stable, high-yield cultivars is the primary focus of most breeding programs and determine their stability for different environments, and that understanding the environmental responses of flax lines is essential to improving the efficiency of flax production and achieving this by working on developing cultivars that are characterized by high productivity, The only method to increase production is to expand the area unit through improving and developing various production resources, which requires the development of stable and high-yield cultivars, knowledge of genetic fluctuations, depend on modern technology in cultivation and crop management, Determining of optimal methods for breeding programs, and the development of cultivars that are advanced in quantity and quality of production and adapted to local conditions and tolerant of disparate environmental conditions, Since it is important for plant breeders to introduce genotypes that have good performance under different environmental conditions, but the response of genotypes to changes in environmental conditions and the consequent instability of their traits under different environmental conditions causes difficulties for the breeder in identifying the excelled ones, Accordingly, the assessment of stability is an important criterion that plant breeders must take into account. In this regard, Yadav et al. (2000) investigated the phenotypic stability of the yield traits of ten genotypes of flax seed in three locations and determine the stability, T397, Garima, and ES44 showed stability of seed yield by the plant and the stability in yield was related to stability in the crop components such as early growth trait, days to 50% of flowering, vegetative branches of the plant, days to maturity, number of seeds per capsule, and Alem and Dessalegn (2014) showed when they used nine cultivars of flaxseed at six locations to identify the most stable genotypes. The results of the analysis of variance showed that the mean of the squares of both genotypes and environments was highly significant for all traits under study. E2 was the most suitable for seed yield, oil percentage and oil yield. Also, the genotype of the interaction (GEI) is statistically significant only for flowering days, days to maturity and number of seeds per capsule indicating the importance of stability analysis. In this study, El Mohsen and Amein (2016) confirmed their analysis to estimate the interaction between the genotype and environmental , and determine the stability of genotypes. It was found that the cultivar Sakha 1, Sakha 3 and Giza 9 was stable for all the studied traits. The aim of the current study is to know the stability of eight genotypes of Flax and determine the best genotypes and their stability through six agricultural environments that included (two planting distances of 5 and 10 cm and three planting dates)by Eberhart and Russel (1966) method and estimation of stability parameters for these genotypes.

Materials and methods:

In this study, 8 Flax genotypes were used, six genotypes of which were introduced and sourced from the Arab Republic of Egypt, Cairo University, College of Agriculture, Department of Field Crops, and two cultivars from Iraqi Kurdistan, College of Agriculture, Salah al-Din University. The details are shown in Table (1),It was planted in six environments, which is the combination between three planting dates (November 10, November 25 and

December 10) and two planting distances (5 and 10) cm. The experiment was conducted according to the arrangement of split plots with a randomized complete block design (R.C.B.D.).The main plots included the agricultural environments and the subplots of genotypes and with three replicates after preparing the experiment land by plowing it perpendicularly tillage , smoothing , leveling and dividing it into replicates by four lines in each experimental unit, where the length of the line was (2 m) and the distance between the lines was (0.40 m),The experiment land was fertilized with phosphate fertilizer at an average of (80 P_2O_5 kg.ha^{-1}) with a form of triple superphosphate (P_2O_5% 45) at a level of 80 kg.ha^{-1} (Grant et al., 2010), It was added in one batch with tillage , and nitrogen fertilizer was added at an average of (200 N kg.ha^{-1}) using urea fertilizer (with nitrogen content of N46%) and in two batches (Hassan and Shaker, 2013),and Table (1) shows the eight genotypes. The study was conducted on (10). Plants were taken randomly from the two middle lines for each experimental unit and the study included the following traits:

1- Plant height (cm.Plant^{-1}): The height was measured in centimeters from the base to the end of the main stem (the plant top) in the stage of maturity and its average was recorded.

2- Duration to 50% flowering (day): The number of days was recorded from the date of the first irrigation until 50% of the plants of the experimental unit flowered.

3- Duration to maturity (day): The number of days was recorded from the first irrigation until the physiological maturity of the plants of the experimental unit.

4- Number of vegetative branches (branch. plant^{-1}): The number of branches was counted from the base of the main stem of each plant and their average was recorded.

5- Number of capsules (capsule.plant^{-1}): The total number of capsules was calculated from ten randomly selected plants for each experimental unit and the average value was obtained.

6- The number of seeds (seed.Capsule $^{-1}$): The total number of seeds was calculated in ten randomly selected capsules for each of the ten plants that were randomly assigned from each experimental unit and their average was calculated.

7- Seed yield (g.Plant^{-1}): The individual plant yield was recorded by weighing the seeds of each plant from ten randomly selected plants after the lesson and calculating their average.

8- Weight 1000 seeds (g): 1000 seeds were weighed in grams using a sensitive scale after seeds were taken randomly from each plant.

9- Average leaf weight (g): The weight of the dry leaves, after sun drying, was recorded for ten plants that were randomly taken in the stage of physiological maturity, and then the average value was calculated.

10- Biological yield (g): represents (weight of dry matter). Ten dried plants were weighed randomly on the sun, and then the average weight of each plant was calculated (g).

11- Leaf percentage (%): It was measured from the dry leaf weight / dry matter weight at harvest to obtain the average value as a percentage.

12-Seed yield (kg.ha^{-1}): The yield per hectare of seeds was estimated according to the following equation:

$$\textbf{Seed yield (Kg.ha}^{-1}\textbf{)}=\frac{\textit{Individual plant yield} * 100}{\textit{The area occupied by the plant}}$$

13-Harvest index = seed yield per plant (g) / biological yield (g) x 100

Table (1): The items used in the study have their source and lineages

lineages	source	Origin	Cultivars Name	Cultivars number
I.1485 x Bombay	College of Agriculture - Cairo University	Egyptian	Sakha 1	1
Hera × 1.123	College of Agriculture - Cairo University	Egyptian	Sakha 2	2
(Belinka (2E) × 1.2096)	College of Agriculture - Cairo University	Egyptian	Sakha 3	3
Belinka (R3) ×1.2569)	College of Agriculture - Cairo University	Egyptian	Sakha 5	4
S.420 x bombay (I. USA)	College of Agriculture - Cairo University	Egyptian	Sakha 6	5
Giza6 × Senta Catalina)	College of Agriculture - Cairo University	Egyptian	Giza 8	6
Imported	College of Agriculture - University of Salahaddin	Syrian	Syrian local	7
Imported	College of Agriculture - University of Salahaddin	Poloni	Thorshansity72	8

Genetic Analysis Stability

Eberhart and Russel (1966) and Tai (1971) method were used to study stability with the aim of knowing the predictability of the cultivar suitable for all surrounding environmental conditions . In the first method, the stability parameters of genotypes in different environments were assessed (as reported by Al-Jubouri 1991 and in detail), which are:

The average effectiveness of the cultivar for the studied trait. = Y

The regression coefficient is used to assess the response of cultivars to surrounding agricultural environments. = Bi

Nonlinear variance (deviation from regression) and assessment of the stability of cultivars according to it. = S^2di

and when the values are:

1- S^2di = 0 (cultivars respond to good environments).

Bi> 1

2- S^2di = zero (cultivars are less responsive to environmental changes and have high stability).

= Bi1

3- S^2di = zero (cultivars grow well in unsuitable environments).

Bi <1

4- S^2di> zero (weakens linear prediction).

Results and discussion

Table (2) shows the results of the analysis of the variation of environmental genetic interference for the studied traits, and it is noticed that the squares mean of the environments (E) were significant at the level of probability (1%) for the duration to 50% flowering, plant height, duration to maturity, number of vegetative branches, number of capsules, biological yield, seed yield and that these high significant differences indicate the existence of differences in Combination between dates and distances. The significant limit did not reach the rest of the traits. The squares mean of genotypes (G) was significant about the level of probability (1%) for most of the traits under study, and at (5%) for the average traits of leaf weight except for the percentage of leaves trait , it was not significant. That these high significant differences of combinations in rest of traits, and it is evident from the significant differences between cultivars and their influence on agricultural environments and distances that there is a clear contrast between them, which encourages continuing to study their stability and Genetic behavior and may be due to their genetic differences and the nature of their differences in their origins, As for that due to the interaction of genotypes × environments (G × E), it is significant at the level of probability (1%) for the trait, the seed yield by the plant, the weight of 1000 seeds, the seed yield and the harvest index and the level of significance is not reached for the rest of the studied traits. This requires a stability analysis to determine the stability of the genotypes according to the criteria and stability parameters. As for those traits in which the genotype x environment interaction was not significant, this means that these genotypes behave similarly in different environments. The stability analysis was also done to ensure the stability parameters corresponds to the non-significance of the interaction between different genotypes and environments, It is noticed that the environments and genotypes ,and the interaction between them differed from each other in their relative importance towards the traits under study, as it became clear that the differences due to the genotypes were much greater than those of each of the environments and the interaction of all traits, and those related to the environments came more than it is almost because of the genotype x environment interaction, which indicates the differential response of those genotype that were significant across the test environments even though we worked the stability for everyone to make sure that there is a need for it or not,These findings are agree with Alem and Dessalegn (2014), Vishnuvardhan and Rao, (2014), Abd El-Haleem et al. (2016), Yadav et al. (2017), and partly inconsistent with Abo-Kaied et al. (2015) and El-Hosary et al (2016).The results of the Analysis of the collective variation for stability of the traits under study by Eberhart and Russell (1966) in Table (3) showed that the squares mean of genotypes ((G) was highly significant for all the studied traits except for the trait of the percentage of leaves that did not reach the level of significance, which indicates that Genotypes vary widely across different environments ,From this it becomes clear that the effect of mean linear variation of environments was significant at a probability level (1%) for all traits except for the trait of average leaf weight, which was significant at a probability level (5%), and with the except of the trait of the number of seeds in the capsule, which did not reach the statistical significance limit, this is an indication that the response to different environments is under genetic control, and these results agrees with (Adugna and Labuschagne, 2003), It is also noticed that the mean variance of the linear component of the interaction of genotypes x environment G × E (Linear) against pooled deviation was highly significant for most of the traits except for biological yield, leaf percentage and harvest index. The mean-variance was significant at a probability level (5%).For the traits of the number of capsules, the number of seeds and the average weight of the leaves, the mean of its squares did not reach the significant limit. The significance of the linear component of the interaction of cultivars with environments G × E (Linear) for most of the studied traits and the non-significance of the pooled deviation indicates that the main components of the differences in the stability of the genotypes of these traits are due to linear regression. Predictability of the behavior of these genotype is possible with high accuracy across environments. This result is consistent with what was indicated by (Vishnuvardhan and Rao, 2014).

Table (2): Results of the interaction of genotypes x environments variance analysis

Square mean (M.S.)							Degrees of freedom d.f.	Source of Variance S.O.V
The seed yield per plant (g.plant^{-1})	Number of seeds(seeds. capsules^{-1})	Number of capsules(capsules.plant^{-1})	the number of vegetative branches (Branch. Plant^{-1})	duration to maturity(day)	plant height(cm)	duration to 50% flowering(day)		
2.18	35.24	6240.40	1.03	22.03	52.30	187.52	2	Replication
*2.40	4.56	**1103.86	**1.93	**1932.04	**461.24	**529.73	5	Eenvironments (E)
**3.25	**105.73	**458.89	**1.01	**56.34	**387.57	**354.56	7	Genotype (G)
**0.69	7.63	155.58	0.21	8.43	22.75	18.35	35	G×E
0.28	7.00	190.71	0.51	6.54	24.44	18.18	94	Error
	harvest index (%)	seed yield(Kg.ha^{-1})	Percentage of leaves(%)	Biological yield (g)	Average leaf weight (g)	The 1000seeds weight (g)	Degrees of freedom d.f.	s.o.v
	1.42	436703.68	12.28	89.60	2.65	14.75	2	Replication
	25.52	**1704432.04	55.61	**70.23	0.12	4.55	5	Eenvironments (E)
	**65.23	**447474.50	30.73	**57.70	*0.43	**14.86	7	Genotype (G)
	16.28	**91164.72	23.06	22.85	0.14	**1.84	35	G×E
	10.87	42575.40	17.50	17.30	0.11	0.93	94	Error

(**) and (*) were significant at 1% and 5% probability levels, respectively.

Table (3): the collective variation analysis, Genetic Stability, and the studied trait

Square mean (M.S.)												Degrees of freedom d.f.	S V
seed yield(Kg.ha^{-1})	Percentage of leaves (%)	Biological yield (g)	Average leaf weight (g)	The 1000 seeds weight (g)	The seed yield per plant (g.plant^{-1})	Number of seeds(seeds. capsules^{-1})	Number of capsules(capsules.plant^{-1})	the number of vegetative branches (Branch. Plant^{-1})	duration to maturity(day)	plant height(cm)	duration to 50% flowering(day)		
**447474.50	30.73	**57.70	**0.43	**14.86	**3.25	**105.73	*458.89	**1.01	**56.34	**387.57	**354.56	7	G
**292823.14	*27.13	*28.78	0.14	**2.18	**0.90	7.24	274.11	**0.35	**248.88	**77.56	**82.27	40	En
**8522160.24	**278.09	**351.19	*0.62	**22.76	**12.01	22.82	**5519.31	**9.69	**9660.20	**2306.22	**2648.66	1	En
**130312.05	12.86	31.11	0.10	1.61	*0.61	8.90	66.95	0.15	8.91	29.74	38.08	7	G×
*71205.65	22.41	18.19	0.13	*1.66	**0.62	6.40	155.52	0.10	7.27	18.37	11.74	32	Pool
80977.56	9.49	16.62	0.02	1.32	0.34	1.32	170.76	0.08	3.31	9.09	4.00	4	
*105230.28	14.70	8.73	0.03	0.58	**1.42	10.01	152.75	0.14	*18.16	43.56	7.44	4	
36528.60	26.41	10.26	0.21	1.90	0.23	7.24	137.11	0.02	13.79	21.27	4.65	4	
84782.37	30.04	35.57	0.02	2.007	**1.35	10.76	296.03	0.06	5.98	14.25	29.13	4	
*120443.86	6.48	11.05	0.09	*2.70	*0.81	2.31	19.65	0.08	6.24	6.73	1.81	4	
78848.90	13.45	7.82	0.01	0.54	0.42	10.77	62.41	0.06	6.81	14.29	12.71	4	
24728.94	*45.56	32.47	0.17	*2.45	0.06	6.37	322.93	0.21	0.48	32.34	2.62	4	
38106.73	33.15	23.00	**0.50	1.69	0.31	2.40	82.51	0.12	3.34	5.45	31.57	4	Pol
42575.40	17.50	17.30	0.11	0.93	0.28	7.00	190.71	0.15	6.54	24.44	18.18	94	Po

(**)and (*) were significant at 1% and 5% probability levels, respectively.

The pooled error test was not significant in duration to 50% flowering, plant height, duration to maturity, number of vegetative branches, number of capsules, number of seeds, average leaf weight, biological yield, leaf percentage and harvest index, and the significance of the seed yield in kg was high for the seed yield in kg.ha^{-1}, and for the 1000 seed yield and seed yield per plant, the weight of 1000 seeds. That these traits have the linear component of the non-significant Genotype x environment interaction and the pooled deviation is significant, this indicates that the deviation from the linear function actually contributes to the deviation in the validity of these genotypes and that the deviation is one of the most important supporting parameters and this is consistent with (Berti et al., 2010), As for the two traits of the seed yield in g and the seed yield in kg. He noted that both the two components, which are the linear component of the Genotype x environment interaction and the combined deviation, were significant, and this indicates that the difference between the determinant parameters of the genotypes (regression and deviation from regression).It is also noticed in Table (3) that the (Syrian) genotype was significant for the two traits of seed yield and harvest index at a probability level (1%) and at a probability level (5%) for the two cultivars of duration to maturity and seed yield in kg.ha^{-1}, while the rest of the traits did not reach a statistical significance limit, As for the genotype (Sakha 3), it was significant for the seed yield at the probability level (1%), while the rest of the traits did not reach the statistical significance limit, and the genotype (Sakha 6) was significant at the probability level (5%) for the seed yield, the weight of 1000 seeds, and the seed yield in kg. The rest of the traits did not reach the statistical significance ,As for the genotype (Giza 8), it was significant at a probability level (5%) for the 1000-seed weight and leaf percentage traits, while the rest of the traits did not show significant differences, and for the (Poloni) genotype, it showed a significant probability level (1%) for the average leaf weight and No significant differences were found for the rest of the traits. The indicative parameters are shown in Table (4) were estimated, which are the average effectiveness of cultivars for different traits in different agricultural environments and the values of the regression coefficient (Bi), which determines the response of genotypes, which are measured by the linear regression of the mean of the genotype on the average of the phenotypes in each environment and the average deviation from the regression for genotype (S^2di), and the (t) test is used to test the significance of each regression coefficient from the integer one, As for the S^2di test, the square mean error of each cultivar is used on the Cumulative error and it is noted from the results of the variance analysis of the Genotype x environment interaction in Table (3) and (4) that the regression coefficient did not differ significantly from the correct one for all genotypes in the traits under study, This indicates that the genotypes did not differ in their response to environmental conditions in the traits. The result did not agree with (Sharma and Paul, 2016) and (Abo El-Komsan et al., 2017). It is also noted that there are no significant differences for the square mean deviation from the regression for each cultivar (S^2di) from zero for all genotypes in the traits, duration to 50% flowers, plant height, number of vegetative branches, number of capsules per plant, number of seeds per capsule, and biological yield, This means that all of these genotypes in these traits under study have stability for different agricultural environments and this is consistent with what was found (Yadav et al., 2017), It is noted that the regression coefficient was equal to one for the genotype (Syrian) in the traits, plant height, plant seed yield, seed yield, and genotype (Sakha 5) for all traits except for average leaf weight and genotype (Sakha 3) for all traits except for the number of capsules per plant, yield of seeds per plant, weight of 1000 seeds, biological yield, percentage of leaves, harvest index and genotype (Sakha 6) for all traits except for the number of seeds per capsule, weight of 1000 seeds, average leaf weight, seed yield and harvest index, It is also noticed that the regression coefficient was equal to one in the genotype (Sakha 1) in the traits, average leaf weight and biological yield, and for the genotype (Giza 8) in the traits, duration to maturity, number of vegetative branches, and number of capsules per plant. The seed yield by the plant, the percentage of leaves, the seed yield, the harvest index, and finally the genotype (Poloni) in the traits, duration to 50% flowering, duration to maturity, number of vegetative branches, average leaf weight, seed yield, and harvest index, Therefore, these genotypes have a good response to the different environments and are highly Stability in the above traits, and it is noticed from Table (4) that each of the genotypes are Syrian, Sakha 3, Sakha 6, Giza 8 and Poloni have values of deviation from the significant regression in the traits, duration to maturity, individual plant yield, 1000 seed weight and average Leaf weight, leaf percentage, and seed yield, accordingly, their rate of effectiveness for these traits and the regression coefficient are sufficient to selection the appropriate genotypes. These results agree with (El-Hosary et al., 2016). The results in Table (4) showed that most of the genotypes were suitable and stable for some approved agricultural environments for traits duration to 50% flowering, plant height, number of vegetative branches, number of capsules, number of seeds and biological yield. From the above, it becomes clear that there are high significant differences between all genotypes for all traits except for the percentage of leaves understudy, which allows selection to be conducted between these genotypes, where the Syrian genotype outperformed in the traits of duration to maturity, seed yield, plant seed yield, total seed yield and harvest index. The genotype of Sakha 6 excelled in the seed yield of the plant, the weight of 1000 seeds, the seed yield, and the genotype of Giza 8 in the traits, the weight of 1000 seeds and the percentage of leaves, while the Poloni genotype was higher in the average leaf weight. and all the genotypes were distinguished by being suitable and stable for all approved agricultural environments under study, traits duration to 50% flowering, plant height, number of vegetative branches, number of capsules, number of seeds and biological yield, This information about the set of genotypes that was adopted in the study can be used in breeding programs to improve crop traits and develop new cultivars with distinguished performance in a wide range of environmental conditions in Iraq.

Table (4) Genetic parameters and average of the studied traits

duration to maturity(day)				plant height(cm)				duration to 50% flowering(day)				Cultivars
R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	
99.13	-1.07	1.12	148.83	88.80	-5.11	1.00	68.66	96.47	-4.72	1.15	104.55	1-Sakha 2
95.04	*3.87	1.07	148.66	46.58	6.37	0.72	68.43	95.50	-3.58	1.38	103.33	2-Syrian
94.32	2.41	0.87	153.38	61.35	-1.05	0.68	58.03	75.91	-4.51	0.42	118	3-Sakha 5
98.30	-0.18	1.07	149	81.85	-3.39	0.94	70.52	59.78	3.64	0.72	109.77	4-Sakha 3
97.82	-0.09	0.96	149.66	82.14	-5.90	0.65	66.89	96.84	-5.45	0.81	109	5-Sakha 6
97.88	0.89	1.02	184.11	85.93	-3.38	1.10	67.45	91.78	-1.82	1.31	108.22	6-Sakha 6
99.81	-2.01	0.94	151.22	84.25	2.63	1.54	72.18	98.13	-5.18	1.29	110.77	7-Giza 8
98.74	-1.06	0.93	151.05	95.93	-6.32	1.33	61.85	67.99	4.46	0.90	110	8-Poloni
		0.073				0.291				0.234		SE = (Bi)

Number of seeds(seeds. capsules^{-1})				Number of capsules(capsules.plant^{-1})				the number of vegetative branches (Branch. Plant^{-1})				Cultivars
R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	
37.55	-18.94	1.05	7.49	61.12	-6.65	1.24	39.77	90.58	-0.02	1.61	2.18	1-Sakha 2
12.08	10.04	-1.38	7.67	57.85	-12.65	1.10	37.45	68.94	-0.002	1.03	2.14	2-Syrian
8.44	0.78	0.96	5.39	38.03	-17.86	0.69	31.16	81.71	-0.04	0.62	1.52	3-Sakha 5
1.70	12.52	0.51	7.78	39.69	35.10	1.06	44.74	81.93	-0.02	0.99	2.1	4-Sakha 3
8.31	-15.63	-0.54	7.37	63.15	-57.02	0.44	34.22	66.25	-0.02	0.73	2.1	5-Sakha 6
14.89	12.56	1.62	7.24	83.66	-42.76	1.36	38.18	90.99	-0.30	1.46	2.15	6-Sakha 6
12.97	-2.10	1.15	7.58	28.30	44.07	0.85	46.27	43.77	-0.01	0.73	1.78	7-Giza 8
86.37	-15.33	4.61	7.08	75.83	-36.06	1.22	41.16	59.83	-0.008	0.79	1.82	8-Poloni
		1.566				0.526				0.357		SE = (Bi)

Average leaf weight (g)				The 1000seeds weight (g)				seed yield(Kg.ha^{-1})				Cultivrs
R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	

74.83	-0.03	1.79	3.77	46.99	0.13	1.28	6.40	78.19	0.01	1.81	2.64	1-Sakha 2
78.80	-0.02	2.43	3.64	73.84	-0.11	1.52	5.32	1.55	**0.38	0.24	2.03	2-Syrian
1.46	0.03	-0.40	3.47	15.58	0.32	0.70	4.26	14.91	-0.01	0.32	1.19	3-Sakha 5
15.51	-0.03	0.43	3.86	0.03	0.38	0.02	6.72	30.39	**0.35	1.25	2.17	4-Sakha 3
49.98	-0.007	2.20	3.90	43.63	*0.59	1.71	6.58	26.80	*0.17	0.89	2.19	5-Sakha 6
51.36	-0.03	1	3.82	5.55	-0.12	-0.21	6.25	70.64	0.04	1.64	2.29	6-Sakha 6
15.22	0.01	1.25	3.91	29.18	*0.50	1.19	5.22	39.21	-0.07	0.33	1.88	7-Giza 8
1.94	**0.13	-0.72	3.63	56.34	0.25	1.75	4.85	72.45	0.008	1.48	1.80	8-Poloni
		1.231				0.572				0.438		SE = (Bi)

harvest index ((%)				seed yield(Kg.ha^{-1})				Percentage of leaves(%)				Biological yield (g)				Cultivrs
R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	R^2	S^2di	Bi	Average of trait	
42.76	1.58	1.71	13.700	88.56	12800.71	1.53	983.88	75.48	-2.67	1.83	20.22	73.40	0.22-	2.04	19.45	1-Sakha 2
24.01	*14.06*	2.05	12.73	63.21	20884.95*	0.82	742.77	0.11	-0.93	0.04	21.77	0.39	2.85-	0.05	17.25	2-Syrian
34.4	-1.15	0.98	8.10	80.57	-2015.60	0.75	452.63	20.20	2.97	0.87	23.49	17.79	2.34-	0.45	15.50	3-Sakha 5
0.24	-0.06	-0.08	10.38	51.54	14068.32	0.58	771.52	26.55	4.17	1.11	19.46	47.12	6.08	1.69	20.83	4-Sakha 3
1.06	1.46	-0.20	11.24	80.54	25956.15*	1.36	837.36	34.65	-3.67	0.62	20.40	38.68	2.08-	0.79	19.62	5-Sakha 6
57.3	0.29	1.99	12.67	85.3	12091.16	1.3	849.30	42.1	-1.35	1.06	21.74	43.7	3.16	0.74	18.14	6-

4				**1**		**1**		**4**				**3**	**-**			Sakha 6
26.42	**-2.25**	**0.60**	**9.18**	**88.47**	**-5948.82**	**0.84**	**700.13**	**6.81**	**9.35***	**0.61**	**19.87**	**0.26**	**5.05**	**0.08**	**20.67**	7-Giza 8
52.31	**-2.56**	**0.93**	**9.86**	**81.02**	**-1489.55**	**0.78**	**647.91**	**46.37**	**5.21**	**1.81**	**20.94**	**68.16**	**1.89**	**2.11**	**18.85**	8-Poloni
		0.825				**0.2**				**0.7096**				**0.628**		**SE = (Bi)**

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