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Article

Performance Evaluation and Estimation of Stability Parameters of Maize Genotypes *Zea mays L.* in Different Environments

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ABSTRACT

An experiment was conducted to study five hybrids, four of them introduced (Zwin, Zp, Syngenta, and Kws) and the local hybrid Baghdad in the spring lug and with three planting dates (5/3, 15/3, and 25/3) and in the two seasons 2019-2020 and 2020-2021 in the design of randomized complete sectors to study the performance of the Genotype stability in three planting dates and two seasons. Thus, we have six environments, Where the highest genetic variation coefficient in the first and second environments was in the number of grains per ear, which amounted to 11.84 and 12.37, respectively. In the third environment, the weight of the ear reached 25.08, and in the fourth, fifth and sixth environment, the number of grains per ear reached 15.14, 24.93 and 13.39, respectively. The results were different genotypes and genetic parameters in their performance in different environments. The two genotypes (Zwin and Kws) showed significance in the highest number of traits, in contrast to the rest. The superiority of the Syngenta genotype was shown in leaf area, leaf area index, plant height, ear diameter, number of rows per ear, the weight of 300 grains, grain yield, and protein percentage, which were 4027, 3.29, 162.8, 51.03, 17.16, 60.09, 3.99, and 11.22 on the respectively, then the Zp genotype in tasselling and silking, ear length and number of grains per ear, as their average values were 54.12, 59.09, 17.92 and 466.8, respectively.

Keywords: Maize; Stability; Environmental; Genetic Parameter; Stability Triangle.

INTRODUCTION

Maize (*Zea mays L.*) is one of the most important cereal crops in the world after wheat and rice, has great production potential, and has achieved a leading position among cereals based on yield and yield [1]. Moreover, progress in maize genomics, breeding, and production has a major role in the lives of many of the world's population [2]. Environmental, genetic interaction is important to identify distinct genotypes with good behavior across a wide range of environmental changes and to reveal how specific genotypes are adapted to suitable or unsuitable environments. The stability of seed yield specifications and other traits of genotypes over a wide range of environmental changes is a source of great concern for plant breeders, and the genotype optimum generally shows a low variance of environmental and genetic interaction [3]. The optimum variety is the one that gives the highest return in a wide range of environments. They defined the stable variety as that in which the value of the regression coefficient is equal to one, with the mean squares of deviation from the regression equal to zero. Therefore, the variety not characterized by this is classified as unstable [4]. Any genotype may be considered stable if: its variance is small between environments, if its response to environments is parallel to the average response of all genotypes or if the mean of the remaining squares of the regression model on environmental evidence is small [17].

MATERIALS AND METHOD

An experiment was carried out in the fields of a farmer in Hawija district to study five crosses, four of which are introduced (Zwin, Zp, Syngenta, and Kws) and a local hybrid Baghdad in the spring season and with three planting dates (5/3, 15/3 and 25/3) and in the two seasons 2019-2020 and 2020-2021 in the design of RCBD, which included four lines, the distance between the 0.7 m and between one plant and another 0.15 m. 120 kg P_2O_5 was added in the form of triple superphosphate when planting and 160 kg N and two once, half of them immediately after germination and the other half in the stage of six leaves. The following characteristics were studied. The broad sense of heritability was estimated based on the indicated ranges: less than 40% are low, 40-60% are medium, and more than 60% are high, and as follows: H2B.S= $\sigma^2 G/\sigma^2 p$, estimating the expected genetic improvement G.A. and adopting the limits of the expected genetic advance is less than (10) low, between (30-10) medium and more than (30) high, according to what was mentioned by [5] from the following equation: G.A=K.H2B.s.σP, The expected genetic advance was estimated as a percentage G.A% of the mean of the trait, according to the [6] method.

$$G.A\% = (G.A/\bar{Y})*100 \tag{1}$$

To test the genetic stability of the five genotypes in the different environments adopted in the study, the linear regression model proposed by [4] was used: $yij = \mu + biIj + {}^{\delta}ij + eij$, where yij means the mean of the genotype i in the environment j and bi is the regression coefficient of the structure genotype i at the given environmental index, which means the response of the genotype to environmental change, Ij it is the environmental index, which is defined as the deviation of the mean of all genotypes in a specific environment from the general mean, $^{\delta}j$ is the deviation from the regression for genotype i at the environment j and eij is the mean experimental error. Two parameters of stability were estimated according to the steps explained by [7], which are (1) the regression coefficient, which is the regressive behavior of each genotype in different environments, from the equation $bi = \sum yij\ Ij / \sum Ij2$, knowing that $\sum yij\ Ij$ is the sum of the quotients the product and $\sum Ij2$ are sums of squares and (2) the mean deviation from the linear regression (S2di) is equal to: $[\sum {}^{\delta}ij2 / (s-2)] - Se2/r$, where $\sum {}^{\delta}ij2 = [\sum yij2 - Yi2/t] - (\sum yij\ Ij)2 / \sum Ii2$ and Se2 is an estimate of the pooled error. The varieties were also distributed according to the values of the regression coefficient and the means of each trait in the triangle of environments in the way explained by [8], in which the varieties located near the end of the vertex of the triangle are adapted to all environments. Those located at the top of the base angle are adapted to the preferred environments, which fall to The extreme left of the average stability line, which is poorly adapted to all environments. In contrast, those below and to the left of the triangle are considered poorly adapted to unfavorable environments, as explained by [9].

RESULT

Table (1) shows the analysis of variance for the studied traits, and it shows that the genotypes were significant for all traits except the ear weight. The results are in agreement with [10, 11, 12].

S.O.V.	**d.f**	**MS**						
		Tasseling	date to silking	leaf area	leaf area index	plant height	ear length	ear diameter
Rep.	2	50.92	50.19	25645.73	1.62	1227.20	71.53	285.09
Geno.	4	8.54**	9.29**	3107.70*	0.32**	607.90**	35.34**	44.32**
Env.	5	23.64**	60.48**	1570310.34**	2.64**	3883.20**	6.47	1548.39**
Geno. ×Env.	20	1.38*	1.32	717.77	0.03	121.69**	3.41**	5.66
Error	58	0.74	0.87	549.42	0.04	54.97	0.99	3.51
S.O.V.	d.f	M.S.						
		No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
Rep.	2	15.34	550.05	384042.42	1059.02	1664.04	0.98	3.77
Geno.	4	2.36**	251.67**	161353.68**	192.22*	1247.00	2.63**	0.27*
Env.	5	78.86**	112.75**	17022.61	111.60	11348.35**	7.84**	46.62**
Geno. ×Env.	20	0.29	26.72**	13909.73**	47.78**	688.48	0.42**	0.08
Error	58	0.21	9.61	4214.81	14.76	822.75	0.01	0.11

Table 1. Analysis of variance for the yield and some of its components.[1](*) (**) significant and highly significant at 0.05 and 0.0l level, respectively;

They found significant differences between the genotypes of most of the studied traits, while environments were significant in all traits except ear length, the number of grains per ear, and the weight of 300 grains. As for the interaction between the genotypes and environments, it was significant in tasseling, date to silking, plant height, ear length, number of grains per ear, number of grains per row, the weight of 300 grains, and grain yield. It is also noted that the environments, genotypes, and interactions between them have differed in their relative importance towards traits under study. Table (2) Variation components and some genetic parameters, it is noted in the first environment that genetic variance was higher than the environmental variance for tasseling, silking, ear length, number of rows per ear, number of grains per ear, the weight of 300 grains, the ear weight and grain yield, which indicates the importance of genetic variation in improving these traits. In comparison, environmental variance was higher than the genetic variance in traits of leaf area, leaf area index, ear diameter, number of grains per row and protein%, which confirms the importance of the environmental factor in inheriting these traits. The value of heritability was high in ear length, number of rows per ear, number of grains per ear, ear weight, and grain yield, which amounted to 0.94, 0.80, 0.89, 0.86, and 0.91, respectively, so these traits can be improved by selection. It is medium and low in rest traits other. As for expected genetic advance as a percentage, it was high in the number of grains per ear, reaching 33.18, and average in ear length and grain yield, which amounted to 15.64 and 11.47, respectively, and rest traits were low. The coefficient of variation shows the possibility of selection is higher in the trait of the leaf area index and the number of grains per ear, in contrast, to rest traits in which the selection process is less than it is. These results are in agreement with [12] found differences in the genetic parameters between the genotypes.

Genetic parameter	**Tasseling**	**Date to silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	0.69	0.65	12.26	0.02	-2.98	2.60	0.54
σ^2e	0.53	0.53	120.73	0.02	16.04	0.15	0.97
σ^2ph	1.23	1.18	136.22	0.05	13.55	2.77	1.54
H.b.s	0.56	0.55	0.09	0.43	-0.22	0.94	0.35
GΔ	1.09	1.05	1.84	0.16	-1.42	2.74	0.76
G%Δ	1.93	1.67	0.05	6.39	-1.02	15.64	1.98
C.V.	2.24	2.01	0.51	11.50	4.99	3.92	4.45
Means	56.47	62.48	3690.0	2.54	139.02	17.49	38.49
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	Grain yield ton. h-1	protein %
σ^2g	0.33	1.00	5588.82	7.84	3.65	0.03	0.005
σ^2e	0.08	1.50	647.16	5.82	0.55	0.002	0.03
σ^2ph	0.41	2.56	6279.57	13.75	4.24	0.03	0.05
H.b.s	0.80	0.39	0.89	0.57	0.86	0.91	0.11
GΔ	0.90	1.09	123.42	3.70	3.10	0.29	0.04
G%Δ	6.22	3.43	33.18	7.00	1.19	11.47	0.46
C.V.	3.42	6.66	11.84	7.91	0.49	3.65	3.86
Means	14.46	31.86	371.94	52.83	259.73	2.52	8.84

Table 2. Genetic parameter, heritability, and expected genetic advance at the first environment for all studied traits [1]Negative variances indicate that there is an error

Table (3) shows the components of variance and genetic parameters of traits studied in the second environment It is noted the importance of the genetic factor in tasselling, silking, leaf area, plant height, ear length, ear diameter, number of rows per ear, number of grains per row, number of grains per row, the weight of 300 grains, ear weight, grain yield, and protein % on the contrary, in silking, and leaf area index, which shows the importance of the environmental factor in these two traits. Heritability was high in leaf area index, plant height, ear length, number of rows per ear, number of grains per row, number of grains per row, the weight of 300 grains, the ear weight, grain yield, and protein %, which were 0.68, 0.68, 0.96, 0.72, 0.93, 0.94, 0.89, 0.62, 0.92, and 0.83, respectively, and average in the rest traits. The expected genetic advance, as a percentage, is high in the number of grains per ear, reaching 51.68, medium ear length, number of grains per row, and the weight of 300 grains, reaching 18.18, 24.00, and 19.89, and low in the rest of traits. The highest coefficient of variation was in the number of grains per ear, reaching 12.73, which allows it to be selected in contrast to the rest of the traits. Results are in agreement with [12] found differences in the genetic parameters between the genotypes.

Genetic parameter	**Tasseling**	**Silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	0.26	0.29	125.43	0.02	9.48	3.43	1.44
σ^2e	0.21	0.32	101.82	0.01	4.43	0.12	0.96
σ^2ph	0.47	0.60	228.05	0.03	13.94	3.57	2.44
H.b.s	0.55	0.48	0.55	0.68	0.68	0.96	0.59
GΔ	0.66	0.65	14.54	0.20	4.44	3.18	1.61
G%Δ	1.19	1.06	0.39	7.62	3.15	18.18	3.96
C.V.	1.43	1.59	0.47	7.10	2.58	3.56	4.17
Means	55.77	61.70	3715.8	2.68	141.14	17.47	40.75
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
σ^2g	0.19	18.16	11368.78	44.76	4.11	0.02	0.10
σ^2e	0.07	1.28	662.99	5.20	2.49	0.002	0.02
σ^2ph	0.26	19.53	12094.45	50.29	6.63	0.02	0.12
H.b.s	0.72	0.93	0.94	0.89	0.62	0.92	0.83
GΔ	0.65	7.19	180.91	11.05	2.79	0.24	0.50
G%Δ	4.14	24.00	51.68	19.89	1.07	10.10	5.46
C.V.	3.10	6.55	12.73	7.11	1.04	3.53	2.80
Means	15.62	29.97	350.06	55.54	261.52	2.35	9.24

Table 3. Genetic parameter, heritability, and expected genetic advance at the second environment for all studied traits
[1]Negative variances indicate that there is an error

Table (4) shows the genetic parameters of the trait's third environment. It is noted that the importance of the genetic factor in plant height, ear length, ear diameter, number of grains per row, number of grains per row, weight of 300 grains, and grain yield is the opposite in the rest of the traits, which shows the importance of the environmental factor.

As for heritability, it was high in plant height, ear length, ear diameter, number of grains per row, number of grains per ear, weight of 300 grains, and grain yield, which amounted to 0.84, 0.83, 0.83, 0.88, 0.91, 0.71, and 0.99, respectively, and it was medium in silking. The number of rows per ear and the protein % amounted to 0.48, 0.47, and 0.41, respectively, and it was low in rest traits. As the expected genetic advance as a percentage, it is high in the number of grains per row and the number of grains per ear, as it reached 31.44 and 61.32, and medium ear length and the grain yield, which reached 19.67 and 25.97, were low in the rest traits, highest coefficient of variation, it was in the number of grains per row, the number of grains per ear, and ear weight, as it reached 11.83, 20.03, and 25.08, which allows it to be selected more than rest traits, the results are in agreement with [12] They found differences in the genetic parameters between genotypes.

Genetic parameter	**Tasseling**	**Silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	0.09	0.13	71.55	0.003	18.58	3.98	6.06
σ^2e	0.16	0.14	150.42	0.006	3.47	0.76	0.45
σ^2ph	0.25	0.27	223.59	0.01	22.12	4.80	7.05
H.b.s	0.36	0.48	0.32	0.29	0.84	0.83	0.86
G∆	0.32	0.44	8.37	0.05	6.91	3.18	4.00
G%∆	0.56	0.71	0.21	1.71	4.63	19.67	9.26
C.V.	1.23	1.06	0.54	5.45	2.16	9.38	3.91
Means	56.19	61.21	3897.86	3.02	149.34	16.17	43.16
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
σ^2g	0.06	39.25	20960.94	10.57	-203.10	0.29	0.006
σ^2e	0.07	4.99	1974.77	4.18	1570.47	0.002	0.006
σ^2ph	0.13	44.60	23034.00	14.89	1450.71	0.29	0.01
H.b.s	0.47	0.88	0.91	0.71	-0.14	0.99	0.41
G∆	0.29	10.28	241.69	4.79	-9.33	0.94	0.09
G%∆	1.98	31.44	61.32	8.68	-3.41	25.97	0.79
C.V.	3.17	11.83	20.03	6.41	25.08	2.51	1.50
Means	14.86	32.71	394.18	55.24	273.64	3.61	10.95

Table 4. Genetic parameter, heritability, and expected genetic advance at the third environment for all studied traits [1]Negative variances indicate that there is an error

Table (5) shows the genetic parameters of the traits studied in the fourth environment, and it is noted that the importance of the genetic factor in all traits indicates the importance of the genetic factor in these traits except for leaf area index and protein%, which shows the importance of the environmental factor. The heritability was high in tasseling, silking, leaf area, plant height, ear length, ear diameter, number of rows per ear, number of grains per row, weight of 300 grains, ear weight, and grain yield, which amounted to 0.85, 0.82, 0.80, 0.96, 0.96, 0.71, 0.91, 0.93, 0.97, 0.64, and 0.99, respectively, and medium in leaf area index, ear diameter, and protein %, which were 0.55, 0.57 and 0.42 respectively.

The expected genetic advance, as a percentage, is high in the number of grains per ear and grain yield, which reached 54.02 and 30.03, and medium to ear length, grain yield, number of grains per row, and weight of 300 grains, reaching 20.45, 27.14 and 24.80, and low in rest traits. The highest coefficient of variation was in the number of grains per ear, reaching 11.83 and 15.14, which allows it to be more selective than the rest of the traits. The results are in agreement with [12] found differences in the genetic parameters between the genotypes.

Genetic parameter	**Tasseling**	**Silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	2.16	2.06	244.95	0.01	19.53	4.13	3.59
σ^2e	0.36	0.42	57.60	0.01	0.75	0.13	2.70
σ^2ph	2.54	2.51	306.19	0.02	20.34	4.30	6.30
H.b.s	0.85	0.82	0.80	0.55	0.96	0.96	0.57
GΔ	2.37	2.27	24.50	0.13	7.58	3.48	2.50
G%Δ	4.37	3.84	0.63	4.03	4.90	20.45	5.51
C.V.	1.92	1.91	0.33	5.62	0.97	3.80	6.27
Means	54.21	59.22	3914.66	3.22	154.80	17.04	45.40
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
σ^2g	0.25	31.37	15919.59	45.06	45.78	0.35	0.01
σ^2e	0.1	2.73	1188.57	1.10	25.00	0.001	0.01
σ^2ph	0.35	34.47	17117.84	46.45	71.53	0.35	0.02
H.b.s	0.71	0.91	0.93	0.97	0.64	0.99	0.42
GΔ	0.74	9.35	212.93	11.57	9.47	1.03	0.11
G%Δ	4.69	27.14	54.02	24.80	3.22	30.03	1.02
C.V.	3.52	8.32	15.14	3.20	2.94	1.69	2.03
Means	15.71	34.45	394.17	46.66	294.12	3.43	11.11

Table 5. Genetic parameter, heritability, and expected genetic advance at the fourth environment for all studied traits. [1]Negative variances indicate that there is an error

Table (6) shows the components of variance and genetic parameters of the traits studied in the fifth environment. It is noted that the importance of genetic factors in tasseling, silking, leaf area, plant height, ear length, ear diameter, number of grains per row, the weight of 300 grains, ear weight, and grain yield, and unlike rest traits, which shows the importance of the factor environmental. As for the heritability, it was high in tasseling, silking, leaf area index, plant height, ear length, ear diameter, number of grains per row, ear weight, and grain yield, which amounted to 0.68, 0.64, 0.75, 0.81, 0.86, 0.84, 0.87 and 0.96, respectively, and medium in leaf area, and weight of 300 grains, which amounted to 0.55 and 0.56, respectively, and low in the number of rows per ear, and number of grains per ear, which amounted to 0.15 and 0.16, respectively. The expected genetic advance is medium in plant height, the number of grains per row, and grain yield, as it reached 10.11, 12.86, and 24.14, and low in the rest of the traits. As for the highest coefficient of variation, it was in the number of grains per ear, which amounted to 24.93, which allows for this trait more than the rest of the traits. The results are in agreement with [12]. They found differences in the genetic parameters between the genotypes.

Genetic parameter	**Tasseling**	**Silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	0.28	-0.07	349.20	0.01	132.64	0.74	4.66
σ^2e	0.12	0.37	284.65	0.01	43.78	0.16	0.72
σ^2ph	0.41	0.32	634.91	0.02	176.85	0.91	5.42
H.b.s	0.68	-0.22	0.55	0.64	0.75	0.81	0.86
GΔ	0.76	-0.22	24.25	0.14	17.45	1.35	3.50
G%Δ	1.40	-0.38	1.81	4.05	10.11	8.45	5.86
C.V.	1.14	1.84	0.66	5.22	6.64	4.40	2.46
Means	54.38	57.45	1339.06	3.46	172.56	16.04	59.80
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
σ^2g	0.005	8.54	636.32	9.22	61.05	0.33	-0.02
σ^2e	0.02	1.58	3329.95	7.03	8.84	0.01	0.02
σ^2ph	0.03	10.17	3977.00	16.46	70.17	0.34	0.00
H.b.s	0.15	0.84	0.16	0.56	0.87	0.96	-23.76
GΔ	0.05	4.69	17.66	3.98	12.75	0.98	-1.21
G%Δ	0.25	12.86	4.40	6.98	4.01	24.14	-9.42
C.V.	1.56	5.97	24.93	8.06	1.61	4.46	2.09
Means	19.08	36.46	400.90	57.01	318.22	4.08	12.80

Table 6. Genetic parameter, heritability, and expected genetic advance at the fifth environment for all studied traits [1]Negative variances indicate that there is an error

Table (7) shows the genetic parameters of traits studied in the sixth environment. It is noted that genetic variance is higher than the environment in silking, leaf area, plant height, length ear, diameter ear, number of grains per row, number of grains per ear, ear weight, and grain yield, which indicates the important the of genetic factor in these traits and the opposite of this in rest traits, which shows the importance of the environmental factor. As for the heritability, it was high in silking, leaf area, plant height, ear length, number of grains per ear, ear weight, and grain yield, which were 0.71, 0.63, 0.75, 0.76, 0.95, 0.75, and 0.97, respectively, and medium in the ear diameter, number of grains per row. It was 0.57 and 0.54, respectively, the expected genetic advance. It is high in the number of grains per ear and grain yield, which reached 44.90 and 31.09, medium in the number of grains per row, which reached 10.85 and low in rest traits. As for the highest coefficient of variation, it was in the number of grains per row, which amounted to 13.39, which allows it to be selected for this trait more than the rest of the traits. The results are in agreement with [12] found differences in the genetic parameters between the genotypes.

Genetic parameter	**Tasseling**	**silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
σ^2g	-0.01	0.31	454.21	0.0003	120.42	0.92	0.91
σ^2e	0.26	0.12	259.33	0.01	39.27	0.29	0.67
σ^2ph	0.20	0.44	720.97	0.02	160.56	1.21	1.60
H.b.s	-0.05	0.71	0.63	0.02	0.75	0.76	0.57
GΔ	-0.04	0.82	29.60	0.00	16.63	1.46	1.26
G%Δ	-0.07	1.41	0.67	0.12	9.37	8.96	2.02
C.V.	1.67	1.03	0.63	5.63	6.11	5.70	2.28
Means	53.35	58.40	4412.0	3.59	177.58	16.34	62.30
Genetic parameter	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	grain yield ton. h-1	protein %
σ^2g	-0.06	9.77	14033.78	-3.81	33.31	0.50	-0.09
σ^2e	0.12	8.20	655.73	6.70	10.94	0.01	0.10
σ^2ph	0.06	18.09	14772.40	2.89	44.41	0.52	0.01
H.b.s	-1.07	0.54	0.95	-1.32	0.75	0.97	-7.35
GΔ	-0.44	4.02	202.06	-3.92	8.75	1.22	-1.42
G%Δ	-2.24	10.85	44.90	-6.53	2.72	31.09	-10.84
C.V.	3.12	13.39	9.85	7.34	1.78	4.75	4.26
Means	19.76	37.04	450.04	60.08	321.54	3.92	13.13

Table 7. Genetic parameter, heritability, and expected genetic advance at the sixth environment for all studied traits. [1]Negative variances indicate that there is an error

Table (8) shows the results of the genetic environmental interaction variance analysis for the studied traits, and it is noted that the mean of the environments squares and the genotypes were significant for all studied traits except protein. The genotype's significant traits indicate a clear discrepancy between them, which encourages the continuation of the study of their stability and genetic behavior and may be due to their genotype and the nature of their differences. As for the return of the interaction of genotypes x environments (G x E) significantly, this requires conducting a stability analysis to determine the stability of genotypes according to criteria and parameters of stability different, but those traits in which the environmental, genetic interaction was not significant, this means that these genotypes behave similarly in different environments as well. The results of the cumulative analysis of variance for the stability of traits under study according to the method of [4] in to (8) Showed that mean squares of genotypes (G) were highly significant for all studied traits except for ear weight and protein, which did not significant, it is also noted that the mean-variance the linear component of the interaction of genotypes × environment (Linear) against pooled deviation was highly significant for most traits. The insignificance of the aggregate deviation indicates that the main components of the differences in the stability of genotypes, the genetics of these traits, are due to linear regression and that predictability of the behavior of these genotypes is possible and with high accuracy across environments. As for the cumulative deviation test against experimental error, it was not significant, and these traits have the linear component of insignificant environmental genetic interference. The aggregate deviation is significant, indicating that the deviation from linear function contributes to deviation in the reliability of these genotypes and that the deviation is one of the most important confirmatory parameters, which fits with [13]. It was noted that both components, which are the linear component of genetic-environmental interference and the aggregate deviation, were significant, and this indicates the difference between the confirmatory parameters of the genotypes (regression and deviation from the regression). The results of the cumulative variance analysis for stability by ^{4} methods for studied traits were obtained. It is noted that mean squares of the linear environments were highly significant for all traits, indicating that the response to different environments is under genetic control [14, 15]. The mean of the squares of the linear component of the interference of genotypes x environments when tested against significant aggregate error in leaf area, leaf area index, plant height, ear length, and grain yield, while the traits for which the mean of aggregate error squares was not significant indicates that main component of differences in the reliability of genotypes this trait is due to linear regression and the possibility of predicting it is possible. As for the mean of the squares of the linear component of the interference of genotypes x environments in the traits in which it was not significant and due to aggregate error significantly, this means that the deviation from the linear function contributes to deviation in the reliability of genotypes of these traits and that the deviation is one of the most important parameters of confirmation [16].

Source of variation	**d.f**	**Tasseling**	**silking**	**leaf area**	**leaf area index**	**plant height**	**ear length**	**ear diameter**
Environmental	5	23.64**	60.48**	157310.34**	2.64**	3883.20**	6.47**	1548.3**
Genotypes	4	8.54**	9.29**	3107.70**	0.32**	607.90**	35.34**	44.32**
Ent. G×E	20	1.38*	1.32	717.77	0.03	121.69**	3.41**	5.66
Env. / Gen.	25	5.83**	13.15**	314636.29**	0.55**	873.99**	4.02**	314.21**
Env. Linear	1	118.23**	302.42**	7851551.7**	13.20**	19416.0**	32.37**	7741.9**
G×E Linear	4	1.24	1.00	1447.69*	0.12*	436.76**	5.90**	2.00
Deviation	20	1.13	1.12	428.24	0.01	34.34	2.23**	5.26
Zwin	4	0.51	0.59	1064.20	0.00	28.12	3.58*	7.72
Zp	4	1.58	1.48	168.48	0.03	45.17	0.40	4.33
Syngenta	4	1.76	1.60	25.05	0.00	8.85	1.75	2.67
Kws	4	0.82	0.82	36.45	0.00	44.77	1.62	0.11
Baghdad	4	0.96	1.10	846.99	0.01	44.77	3.79**	11.49*
Pool Error	58	0.74	0.87	549.42	0.04	54.97	0.99	3.51
Source of variation	d.f	No. of row per ear	No. of grains per row	No. of grains per ear	weight of 300 grains	ear weight	Grain yield ton. h-1	protein %
Environmental	5	78.86**	112.75**	17022.61**	111.60**	11348.3**	7.84**	46.62**
Genotypes	4	2.36**	251.67**	161353.68**	192.22**	1247.00	2.63**	0.27
Ent. G×E	20	0.29	26.72**	13909.73**	47.78**	688.48	0.42**	0.08
Env. / Gen.	25	16.00**	43.93**	14532.31**	60.54**	2820.45**	1.90**	9.39**
Env. Linear	1	394.34**	563.77**	85113.08**	558.00**	56741.7**	39.23**	233.14**
G×E Linear	4	0.40	19.76	7222.32	2.25	287.77	1.79**	0.14
Deviation	20	0.21	22.77**	12465.26**	47.33**	630.93	0.06**	0.05
Zwin	4	0.15	34.35*	13287.45*	54.07*	141.78	0.11**	0.09
Zp	4	0.300	12.87	3071.09	18.74	108.46	0.00	0.00
Syngenta	4	0.21	9.75	11067.35*	48.19*	242.41	0.14**	0.04
Kws	4	0.28	27.41*	24984.39**	90.87**	2463.75*	0.01	0.09
Baghdad	4	0.10	29.46*	9916.05	24.77	198.23	0.03	0.04
Pool Error	58	0.21	9.61	4214.81	14.76	822.75	0.01	0.11

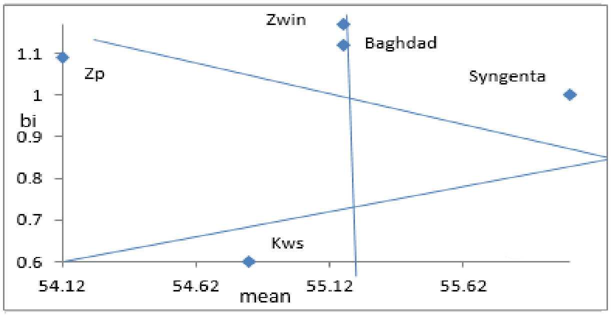
Table 8. Analysis variance for the stability of the seed yield and some of its components in traits of student

As for the traits, both components were significant, and this means that the differences in the reliability of genotypes are due to the linear regression and the deviation from the linear function. The Zwin genotype was significant in ear length, number of grains per row, number of grains per ear, and the weight of 300 grains, the Syngenta genotype in number of grains per ear and the weight of 300 grains, grain yield, and Kws genotype in number of grains per row and Baghdad in ear length, ear diameter, and number of grains per row. [4] indicated that two components, linear (the regression coefficient Bi) and non-linear (the deviation from the regression S2di), are both important in judging the stability of genotypes.

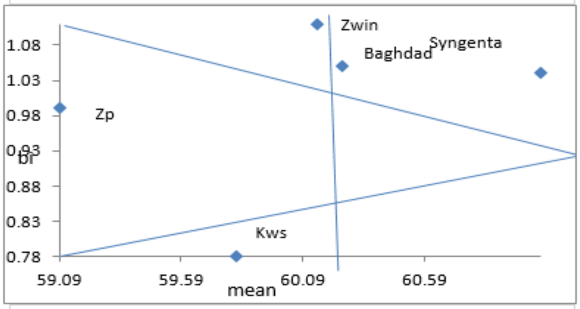
Geno.	**Tasseling**				**Silking**				**leaf area**			
	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ
Zwin	-0.07	1.17	94.02	55.17	-0.09	1.11	96.96	60.15	171.59	1.03	99.74	4003
Zp	0.28	1.09	81.72	54.12	0.20	0.99	90.96	59.09	-126.97	0.95	99.96	3995
Syngenta	0.34	1.00	77.03	56.02	0.24	1.04	91.16	61.07	-174.79	1.02	99.99	4027
Kws	0.02	0.60	72.44	54.82	-0.01	0.78	91.81	59.82	-170.98	0.99	99.99	4002
Baghdad	0.07	1.12	88.57	55.17	0.07	1.05	93.82	60.25	99.19	0.98	99.77	3995
SE(Bi)	0.177				0.120				0.017			
Geno.	leaf area index				plant height				ear length			
	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ
Zwin	-0.01	1.08	99.10	3.12	-8.94	0.89	96.48	150.0	0.86*	1.46	49.22	17.96
Zp	-0.00	0.69	89.54	3.07	-3.26	0.45	81.77	149.3	-0.19	0.79	71.51	17.92
Syngenta	-0.01	0.86	99.48	3.29	-15.37	1.18	99.35	162.8	0.25	2.22*	81.98	17.42
Kws	-0.01	1.12	99.24	3.00	-3.39	1.24	97.10	157.9	0.21	-0.37	12.07	15.37
Baghdad	-0.01	1.23	99.02	2.94	-3.39	1.22	97.01	158.5	0.93**	0.88	25.08	15.12
SE(Bi)	0.128				0.119				0.391			
Geno.	ear diameter				No. of row per ear				No. of grains per row			
	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ
Zwin	1.40	1.02	98.14	46.95	-0.02	1.06	99.32	16.30	8.24*	1.56	66.87	36.74
Zp	0.27	0.96	98.81	47.88	0.02	0.96	98.33	16.40	1.08	0.63	47.12	36.58
Syngenta	-0.27	1.04	99.36	51.03	-0.00	0.89	98.67	17.16	0.04	1.23	81.52	35.97
Kws	-1.13	1.00	99.97	47.75	0.02	1.00	98.62	16.45	5.93*	0.56	24.57	30.60
Baghdad	2.65*	0.95	96.87	47.95	-0.03	1.06	99.51	16.30	6.61*	0.99	48.60	28.84
SE(Bi)	0.047				0.052				0.292			
Geno.	No. of grains per ear				weight of 300 grains				ear weight			
	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ
Zwin	3024.21*	1.48	41.36	449.7	13.10**	1.18	41.96	56.42	-226.99	0.87	93.92	285.9
Zp	-381.23	0.92	54.37	466.8	1.32	0.98	59.31	55.61	-238.09	0.82	94.63	288.0
Syngenta	2284.17*	1.32	40.35	463.0	11.14*	0.96	35.12	60.09	-193.44	1.07	93.14	299.3
Kws	6923.19**	-0.10	0.18	312.5	25.36**	1.06	25.77	51.45	546.99*	1.22	63.18	276.3
Baghdad	1900.41	1.36	44.44	267.2	3.33	0.79	41.63	58.40	-208.17	1.00	93.49	291.0
SE(Bi)	0.497				0.363				0.269			
Geno.	Grain yield ton. h^{-1}				protein %							
	S2di	Bi	R2 %	ȳ	S2di	Bi	R2 %	ȳ				
Zwin	1.18	1.18	96.05	3.24	-0.00	0.94	99.08	10.99				
Zp	0.95	0.95	99.79	3.13	-0.03	1.00	99.94	11.00				
Syngenta	1.71	1.71	97.49	3.99	-0.02	0.93	99.57	11.22				
Kws	0.58	0.58	98.28	3.17	-0.00	1.05	99.30	10.90				
Baghdad	0.55	0.55	95.24	3.05	-0.02	1.04	99.61	10.95				
SE(Bi)	0.048				0.048							

Table 9. Stability parameters for the traits of the seed yield and some of its components for all studied traits

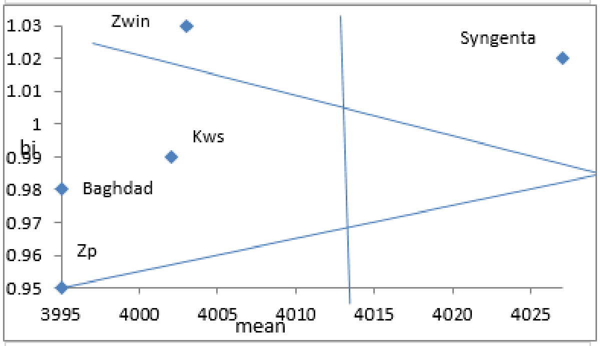
The genotypes are moderately responsive to environmental changes. They are moderately stable, and if the regression coefficient is greater than one, the genotypes are described as being highly sensitive to environmental changes and adapting to high-productivity (good) environments. As for the regression coefficient of less than one, it is evidence of high resistance to environmental changes (higher medium stability), and this further determines adaptation to environments of low yield [3] and [9]. Table (9) estimates the average effectiveness of genotypes for different traits in different environments and the values of the regression coefficient (Bi) that determines the response of the genotypes, which is measured by linear regression of mean genotype over the mean of genotypes in each environment. The mean deviation from the regression, for each genotype (S²di), the (t) test is used to test the significance of each regression coefficient from the correct one.



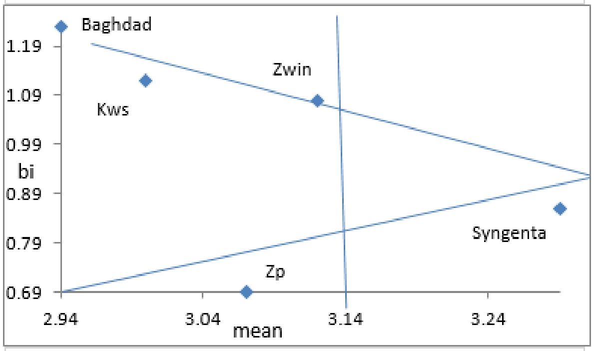
(1) Tasseling



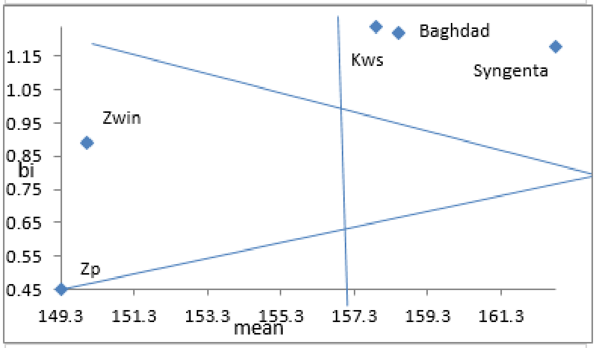
(2) Flowering



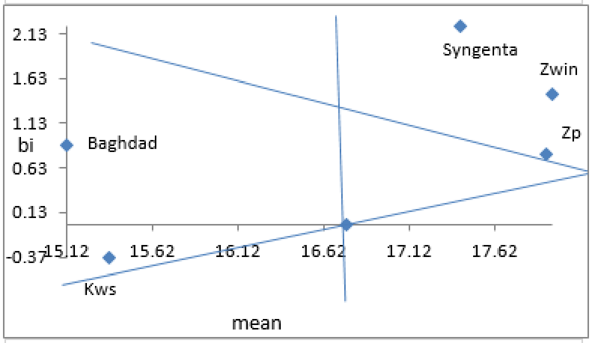
(3) leaf area



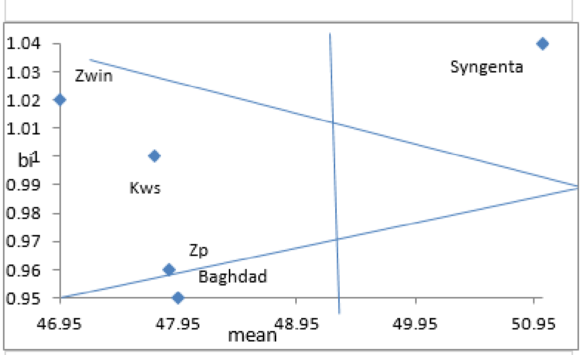
(4) leaf area index



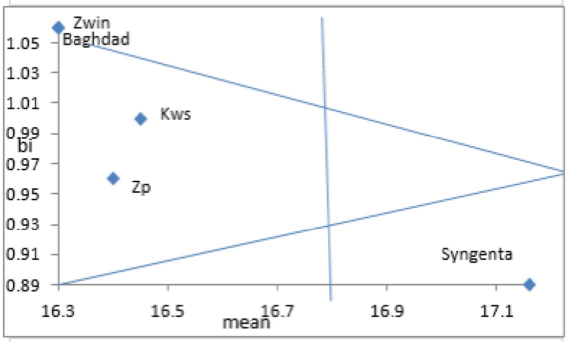
(5) plant height



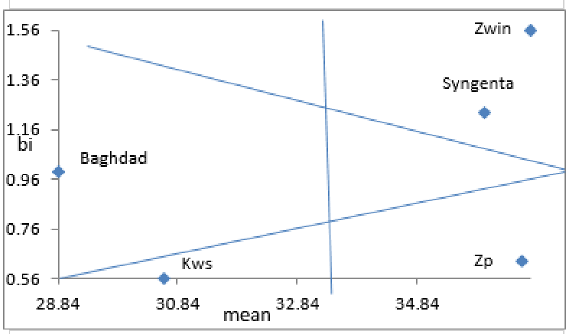
(6) ear length



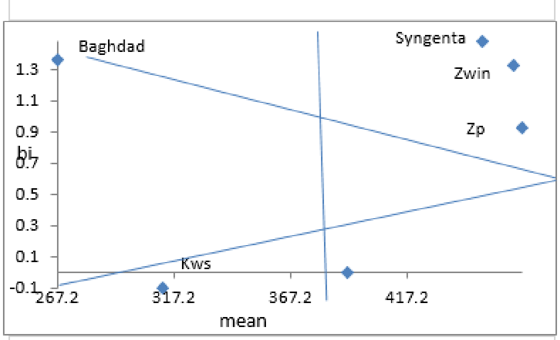
(7) ear dimeter



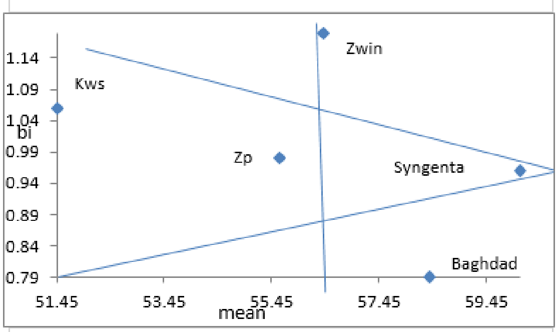
(8) No. of row per ear



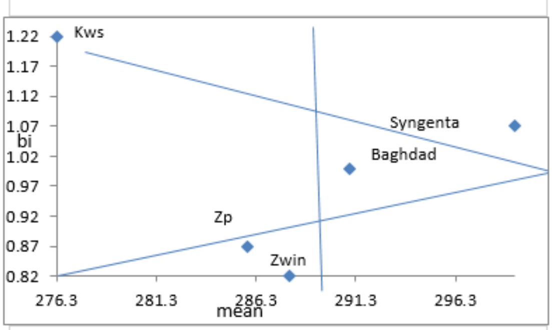
(9) No. of grains per row



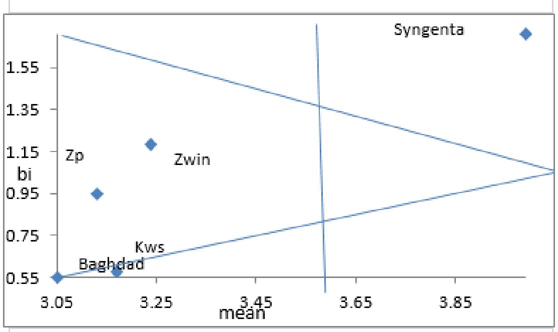
(10) No. of grains per ear



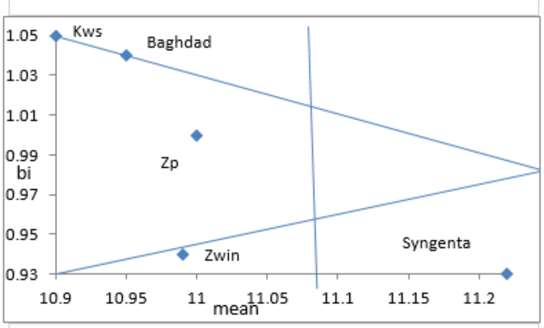
(11) weight of 300 grains



(12) ear weight



(13) Grain yield ton. h-1



(14) protein %

DISCUSSION

As for the S^2di test, the mean squared error of each category is used on aggregate error. There are no significant differences in mean square deviation from the regression for each composition (S^2di). From zero for all genotypes in tasseling, silking, leaf area, leaf area index, plant height, number of rows per ear, grain yield, and protein, this means that all these genotypes in these traits under study have stability for different environments. It is noted that the regression coefficient was equal to one for Zwin genotype in plant height, ear weight, protein, genotype Zp in silking, leaf area, leaf area index, plant height, ear length, ear diameter, number of rows per ear, number of grains per row, number of grains per row, the weight of 300 grains, the ear weight, and the grain yield and Syngenta genotype in leaf area index, number of rows per ear, the weight of 300 grains, protein, Kws genotype in tasseling, silking, leaf area, number of grains per row, and grain yield, Baghdad genotypes in leaf area, ear length, ear diameter, number of grains per row, the weight of 300 grains and grain yield. Figures (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (12), (13), and (14) The environments triangle in the method explained by (Ellis et al., 1997), and it is noted in Figure (1) and (2) that the tasselling and silking traits appear, the zp genotype is adapted to preferred environments, while Kws genotype is considered adaptive to environments not preferred for rest of genotypes Zwin, Syngenta and Baghdad, they were outside stability triangle, they are considered unstable. Figures (3) and (4) show traits of leaf area and leaf area index. It is noted that the Kws genotype is adapted to preferred environments.

In contrast, the Zp genotype is adapted to unfavorable environments, followed by the Baghdad genotype, while the rest of the Zwin and Syngenta genotypes were outside a triangle Stability. Figure (5) shows the plant height. The Zwin genotype is adapted to the preferred environments, while the Zp genotype is adapted to unfavorable environments. The rest of the genotypes Kws, Syngenta, and Baghdad, were outside the stability triangle. The Baghdad genotype is adapted to the preferred environments, the Kws genotype is adapted to the unfavorable environments, and the rest are outside the stability triangle. Figure (7) shows traits of ear length. It is noted the Zwin and Kws genotype is adapted to the preferred environments, in contrast to the Zp genotype, which is within the stability triangle and near the regression line and the left of a general average of the trait. In Figure (8) for the character of a number of rows per ear, which shows the superiority of the composition between Kws and Zp, they were within the stability triangle and were located to the left of the general average of trait, in contrast to the Zwin and Baghdad genotype adapted to unfavorable environments, while Syngenta genotype, which occurred outside the stability triangle and to right of the general average line of the trait. Figure (9), the number of grains per row, shows that the Baghdad genotype is more stable as it is located within the stability triangle and to the right of the general average line of the trait average.

In contrast, the Kws genotype is considered adaptive to unfavorable environments, while the rest of the genotypes were outside the stability triangle. As for Figure (10), the number of grains per ear, it is noted that the Kws genotype is close to the regression line, in contrast to the Baghdad genotype, which was adapted to unfavorable environments, and the rest of the genotypes were outside the stability triangle. Figures (11) and (12) for the traits of the weight of 300 grains and ear weight show the highest stability of the Zp genotype as it fell within the stability triangle and was on the right of the median line of Kws genotypes. Its stability for the preferred environments and the two genotypes Syngenta and Baghdad were closer to the tip of the triangle, indicating their stability for most of the environments, and the rest of the genotypes were outside the stability triangle. Figure (13) shows the trait of grain yield and that genotypes Zp and Zwin were within the stability triangle and located to the left of the median line of the trait, indicating their high stability.

Conclusions

The stability triangle is located to the left of the median line of the trait, indicating its high stability compared to the rest of the genotype, while the Zwin genotype is adapted to unfavorable environments, unlike the genotypes Baghdad and Kws are considered adapted to the preferred environments.

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