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Genotype by environment interaction and stability for grain yield in corn (*Zea mays* L)

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Abstract

This study was carried out with the aim of identifying eight inbreed line of maize through season 2016 in three different environmental location (Wasit, Diwaniyah and Nasiriyah) to determine the most stable inbreed. The study involved planting this breeds (Inp-6, Pio-17, Syn-9, Zm-17, Pio-3, S-10, MGW-1 and Ast-B). Using RCBD design to three replicate. The results showed significant differences between each of the inbreeds and location approved for the studied traits (ear length and number of rows in ear and the number of grains in the row and the grain yield of the plant). The result of the stability analysis, four of them (Inp-6, Pio-17, S-10, and Ast-B) showed high averages relative to the general average and the slope coefficients were to one within the two confidence intervals. It is the best in adapting to all environmental conditions. Inp-6 inbreed is superior to the ear length, which is 19.19cm in length, while the Ast-B is superior in both rows of ear and plant yield, with 23.35 rows and 322.83g respectively. While inbreedInp-6 and Pio-17 in the number of grains per row were 15.41 seed per row and some inbreed showed that It is adapted to the new environmental conditions as in the inbreed (Ast-B, S-10 of Australian origin and Pio-17 Yugoslav origin, which exceeded the individual grain yield of the localin breeds at 322.83, 312.87 and 284.57g / plant). The ast–B inbreed highest components and adapted to the conditions of the studied environments.

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Introduction

Planting Crop varieties are grown under a wide range of environmental conditions such as different types of soils, soil fertility levels, different levels of moisture, temperatures and agricultural processes. All of these variables can be encountered during the production of different crop varieties, which refers to the so-called environment.

The goal of most breeding programs is to select genetic makeup that characterizes new specifications and produce high and stable in a wide range of different environmental conditions. This selection is often inefficient because of the environmental impact on genetics, which leads to failure in genetics in having similar relative behavior in different environments (knight, 1970).

As a result of this variation in performance across environments, gaining excellence in one category is difficult if it is impossible. The main causes of environmental genetic interference are thought to be chemical pathways to some physiological processes that occur in plants. Although plants are similar in appearance, they remain different in some nucleotide chains. These lead to changes in the genes in the different environment. Environmental genetic interference is an ongoing challenge for plant breeders to complicate the selection of genotype that are evaluated in different environments by reducing the association between phenotypic and genetic values (Comstock and Moll, 1963). When there is an inherited genetic interference, one of the options that opens the plant breeder's front is to use stability analysis and to distinguish the most productive and consistent genotypes in their behavior. For this reason, several statistical methods have been proposed and adopted to study the adaptation and stability of varieties to different environmental conditions (Lin *et al.*, 1986).

On the other hand, Francis and Kannenderg (1978) used the coefficient of variation as a measure of stability, and considered the high-yielding genetic structure and the low variation coefficient to be stable. Other evidence of stability includes the variance of Shukla (1972) and regression coefficients (perkins and jinks, 1968) and finlay&. wilkinsons (1963) and Eberhart and Russel (1966). The regression coefficient and deviation from the regression are useful in describing behavior across a series of environmental conditions. The regression coefficient measures the increase in variety behavior for each unit of the environmental index. The deviation from the regression measures the compatibility of expected and observed responses. Genetic genomic sequencing and one or more regression factors are highly stable for all environments. This most stable category is characterized by a total of low deflection squares and a high determination coefficient. The aim of the study is to identify the stability of eight inbreed of maize in three different environmental location in their climatic conditions and soil properties to identify the best and stability.

Materials and methods

Methods of Experiments

Eight inbreed maze were used in the experiment (inb-6, pio-17, syn-9, zm-17, pio-3, s-10, mgw-1 ast-b 1). The seeds of the inbreed were planting on 15/7 season 2016. The distance between the plants within the 25cm line and the 75cm lines was by using the design of the complete random block with three replicates (r) in three locations (the first in Diwaniya 200 km southwest of Baghdad) and the second in Nasiriyah South of Baghdad 380km and (third in Al-Kut, 180km south of Baghdad), the single experimental unit contains 5m long lines, using p205 superphosphate as a source of phosphorus at 200kg per hectare, all added to the culture, and urea fertilizer (46% n) by 200kg / hectare was added, the first at planting and the second after one month from the planting and irrigation service operations were carried out according to recommendations and need. At maturity, data were recorded on the characteristics ofear length (cm), number of rows in ear , number of grains per row,

Analysis of Experiments

The analysis of the aggregate variance was carried out across the tested environments and the Russel and Eberhart (1966) method was used to study the stability to determine the predictability of the appropriate category.

The environmental conditions surrounding all three sites (the inbreedand location). The parameters of genetic stability were estimated at different location (Jubouri 1991):

y-= Average variety effectiveness of the studied.

Bi = Regression coefficient is evaluated based on the response of varieties to surrounding agricultural environments.

S2 di = The non-linear variance (deviation from regression) evaluates the characteristics of the items depending on it.

When the values are

1- S2di is insignificant and Bi <1 (varieties respond to ideal environments).

2- S2di is insignificant and Bi = 1 (species that are not responsive to environmental changes and are highly stable)

3- S2di is insignificant and Bi <1 (varieties grow well in unsuitable environments).

4- S2di morally regardless of B_i value (weakens linear prediction).

Table 1. Inbreed names andsources.

Nabber	Inbreed	Sources
1	Inp-6	Local
2	Pio-17	Yogslafy
3	Syn-9	France
4	Zm-17	Yogslafy
5	Pio-3	Yogslafy
6	S-10	Australia
7	MGW-1	Yogslafy
8	Ast-B	Australia

Results and discussion

The table (2), the results of the analysis of the aggregate variance are shown. It is noted that the average squares of the location and the inbreeds and the interaction were highly significant for most of the traits. The yield grains, ear length. significant number of rows per ear and the number of row grains and plant yield.

This indicates that the respective in breeds have different performance of these traits in different locations and the overlap between (location X inbreeds) is highly significant for all traits, different in their origin and their inbreeds are also the case for the various sites of the environment and therefore the genotype or in breed shows the maximum genetic ability to express the grade (Badu, ets 2003).

Table (3) shows the results of the average characteristics of the inbreeds and location for the ear length. There are significant differences between the location and between the inbreeds and the overlap between them as the superiority of the (lnp-6) gave the highest rate of 19.1cm, which did not differ significantly with thein breeds (2, 3, 5, 6 and 8) while the MGW-1 gave less average (17.23cm). The locations differed between them. The first location gave the highest rate of 19.362cm while the third location gave the lowest rate of 17.31cm which did not differ significantly with the second location. While the first location andinbreed (pio-3) gave the highest rate of 20.86cm.

Table 2. Analysis of the cumulative variation of the studied traits.

S.o.v	Char / df	Ear lenght	Number of row pr ear	Number of grain per ear	grain Yield per plant
Location	2	**25.33	*5.97	0.97	**21139.31
rep/location	6	1.76	0.95	0.81	1316.24
inbreed	7	*4.02	**64.10	**3.87	**13924.12
inbreedXlocation	14	**9.02	**70.41	**3.50	**9076.46
error	42	1.38	0.61	0.42	1357.29

*and * significant at a probability level of 1 and 5%, respectively.

The combination of the third location and inbreed (zm-17) recorded the lowest mean rate of 15.20cm. This is due to the difference in genetic origin and inbred as well as the situation of the various environmental and therefore the strain shows the maximum genetic ability to express the character (Surma *et al*, 2015). Table (4) shows the results of the average characteristics of location andinbreeds and interaction them for the number of rows per ear.

There are significant differences between location and between the inbreeds and overlap between them.

Table 3. Calculations of the sites and genotypes and the overlap between them for the length ear.

Location / inbreed	L1	L2	L3	mean
1	21.67a	15.48jk	20.42abc	19.19a
2	18.64b-h	19.81a-e	17.65d-j	18.70ab
3	19.92abcd	17.43f-i	19.15b-g	18.83a
4	18.89b-h	18.53c-h	15.20k	17.54bc
5	20.86ab	17.52e-j	15.59jk	17.99abc
6	18.26c-h	17.77b-h	17.91d-h	18.31abc
7	17.25g-k	18.61b-h	15.85jk	17.23c
8	19.39b-g	19.65a-f	16.70hijk	18.58ab
Mean location	19.362a	18.22b	17.31b	

The superiority of the inbreed (ASt -B) gave the highest rate of 32.35 which did not differ significantly with the INBREED (Pio-17). The lowest mean was 24.93 and the locations differed between them. The third location gave the highest mean of 29.51 while the second location gave the lowest mean of 28.53 which did not differ significantly with the first location. While the first location gave the number of rows (pio-3) the highest mean of 36.60.

The combination of the second location of the inbreed (Syn-9) recorded the lowest average of 21.66 rows per ear. The reason for the genetic differences in their origin and genetic structure is also the case of the various sites, His genetic abilities to express his cultivars (Badu *et al*, 2003).

Table 4. The statistical averages of the sites and the genetic structures and the overlap between them for the number of rows per ear.

location / inbreed	L1	L2	L3	mean
1	29.42gh	23.32jk	35.74ab	29.49c
2	31.09ef	32.33d	31.41de	31.61a
3	24.42j	21.66L	34.22c	26.76d
4	23.21jk	29.33gh	22.25kl	24.93e
5	36.60a	27.81i	24.51j	29.64c
6	30.61efg	31.37de	30.08efg	30.69b
7	22.11kl	27.25i	29.82fg	26.39d
8	33.80c	35.15bc	28.08hi	32.35a
Mean	28.91ab	28.53b	29.51a	

Table (5) shows the results of the average characteristics of location and inbreeds and interaction between them for the number of row grains. There are significant differences between location and between the inbreeds and interaction .inbreed (Inp-6, Pio-1 7) highest mean 15.41 is not significant with inbreed (Pio-3, Ast-B) Whil (MGW-1) was less than 13.50 and did not differ between location, giving the first location the highest rate of 14.84.

While the third location and (pio-17) inbreed gave the highest mean of 17.28 grain per row. The combination of the third location of the (MGW-1), the lowest mean of the value of 13.06 grains per row.

Table 5. The statistical averages of the sites and the genetic structures and the overlap between them for the number of grain grade.

location / inbreed	L1	L2	L3	mean
1	16.39ab	13.74efg	16.11b	15.41a
2	13.62efg	15.32bcd	17.28a	15.41a
3	16.05b	13.65efg	14.33def	14.68bcd
4	14.53de	14.50de	13.75efg	14.26d
5	15.34bcd	15.77bc	14.25defg	15.12ab
6	14.40def	14.09defg	14.60cde	14.36cd
7	13.17fg	14.28defg	13.06g	13.50e
8	15.22bcd	14.52de	15.22bcd	14.98abc
Mean	14.84a	14.48a	14.82a	

Table (6) shows the results of the average characteristics of the locations of the inbreeds interaction between them for the yield grain. There are significant differences between the locations and between theinbreeds .the (Ast–B) inbreed gave the highest rate of 322.83g which did not differ significantly with the (S-10).

The (Zm -17) lowest rate was 214.95g and the locations differed between them. The third location gave the highest rate of 282.92g which did not differ significantly with the second location while the first site gave the lowest rate of 231.16g and the combination of the third site and (inp-6) recorded the highest rate of 381.24g. inbreed (Zm-17) lowest rate 155.84g in first location.

The reason for the different genetic strains in their origin and genetic structure as well as the case of different sites environmentally and thus the genetic structure shows the maximum genetic abilities to express trait (Badu *et al.*, 2003).

Table 6. Calculations of the location and inbreed and the overlap between them for the grain Yield per plant.

location / inbreed	L1	L2	L3	mean
1	214.78ghij	209.65g-h	381.24a	268.56cd
2	289.19cdef	254.30c-g	310.23bcd	284.57bc
3	249.70c-h	182.72hij	287.05cdef	239.82def
4	155.84j	307.60bcd	181.41hij	214.95f
5	219.72f-j	297.87bcde	244.44d-i	254.01cde
6	272.85c-g	358.66ab	307.10bcd	312.87ab
7	174.97ij	269.65c-g	232.69e-h	225.77ef
8	272.21c-g	377.14a	319.16abc	322.83a.
Mean	231.16b	282.20a	282.92a	

Table (7) showed the results of the analysis of the aggregate variance of the stability. It is clear that there are clear evidence of significant differences between all the inbreed and environments (location).

The average of the two source is highly significant for all the character. doesn't investigate Quantity variable in location also find genetic variable between the inbreed and show the mean of the squares of the environmental genetic (linear) interaction showed a high significance for the same characteristics, indicating differences between the regression coefficients of the eight genotypes and each of the studied characteristics associated (Kang 1988).

The descriptive parameters shown in Table (8) are the average of the effectiveness of varieties for the different traits in the different agricultural environments and the regression coefficient (Bi).

Which means the response of varieties to the different environments and measured by the linear regression of the average of the species on the average of the species in each environment. (T) is used to test the morale of each regression factor from the correct one, and the S2di test uses the average error total for each installation for the aggregate error (Elsahookie, 1996).

Table 7. Analysis of the cumulative variance of the genetic stability of the traits under study.

S.O.V.	df.Cha.	Ear lenght	Number of row pr ear	Number of grain per ear	grain Yield per plant
Geno	7	4.02	**64.11	*3.87	13924.18
Einvr	2	*25.33	5.98	0.97	*21138.72
G*E	14	9.02	**70.41	3.50	9076.59
E+G*E	16	1.41	12.19	0.42	865.97
E Li	1	6.33	1.49	0.24	5284.68
G*E Li	7	2.33	27.66	0.92	1224.40
Pool Div	8	3.39	9.80	1.13	4064.37
1	1	**20.05	**1.13	0.01	**14526.59
2	1	**1.96	*0.51	*6.71	**1569.21
3	1	**2.84	**2.82	*1.36	**5463.55
4	1	**1.87	**7.55	0.32	**8117.46
5	1	0.11	**66.38	*0.65	**1465.82
6	1	0.32	0.05	0.02	**1372.30
7	1	**3.03	**24.66	0.01	722.82
8	1	**2.02	**1.24	0.00	**1742.44
Pool Erro	48	1.43	0.660	0.469	1352.141

**and* significant at a probability level of 1 and 5%respectively.

The ear length was less than one and the mean of the regression (S-10 inbreed) and the values of the square deviation from the high slope of the (inp-6 inbreed) and the moral (syn-9 and MGW-1). This suitable for poor locations so (s-10 inbreed) Greater than one and the significance and values of a square deviation from the regression are not significant from zero, so they are responsive to ideal environments. Characterization of the number of rows in per ear.

The values of the regression coefficient indicated that the number (inp-6) is greater than one and the significance and square values of the deviation from the regression are less than one.

Therefore, it responds to the ideal environments, as well as to the number of grains in the row.the (inp-6) inbreed has high values of the square deviation from the regression are less than zero. Therefore, the response to it in ideal environments and other genotypes is to respond to poor environments based on the values of the regression coefficient and the square values of the deviation from the regression.

The yield grain , the regression coefficient values were less than one. Therefore, the inbreeds respond to growth in different environments, indicating that the values of the square deviation from the regression are high.

Table 8. Stability parameters and average environments as the average of the varieties of the qualities under study.

Genotype	Ear lenght			Number of row pr ear			Number of grain per ear			grain Yield per plant		
	mean	Bi	$S^{2}di$	mean	Bi	$S^{2}di$	mean	Bi	$S^{2}di$	mean	Bi	$S^{2}di$
1	19.19	-0.07	**19.57	29.50	**7.55	0.91	15.42	**15.93	-0.14	268.56	0.21	**14075.87
2	18.71	-0.60	1.48	31.61	-1.76	0.29	15.41	-0.11	**6.55	284.58	-1.19	**1118.50
3	18.84	-0.48	*2.36	26.77	**5.04	*2.60	14.68	0.87	1.20	239.82	-0.72	**5012.83
4	17.54	0.79	1.40	24.93	-1.96	**7.33	14.26	-0.99	0.16	214.95	0.33	**7666.75
5	17.99	**6.66	-0.36	29.64	-0.51	**66.16	15.12	-1.30	0.50	254.01	-0.01	**1015.11
6	18.31	-2.16	-0.15	30.69	**-7.51	-0.17	14.37	0.31	-0.13	312.87	0.18	**921.58
7	17.24	-0.33	*2.55	26.40	0.36	**24.44	13.51	**-10.42	-0.14	225.77	0.74	**272.10
8	18.58	0.26	1.54	32.35	**-5.30	1.02	14.99	11.81**	-0.16	322.83	0.47	**1291.73

**and * significant at a probability level of 1 and 5% respectively.

References

Badu-Apraku B, Abamu FJ, Menkir A, Fakorade MAB, Obeng-Antwi K. 2003. Genotype by environment interactions in the regional early maize variety trials in West and Central Africa. Maydica **48,** 93-104.

Comstock RE, Moll RH. 1963. Genotype-Environment Interactions, Symposium on Statistical Genetics and Plant Breeding, NASNRC Publication **982,** pp. 164-196.

Demisie D. 2016. Genotype by Environment Interaction and Yield Stability Analysis of Ethiopian Bread Wheat Using Mixed Model. Haramaya University, Haramaya. pp. 78.

Eberhart SA, Russel WA. 1966. Stability parameters for comparing varieties. Crop Sci **6,** 36-40.

Elsahookie MM. 1996. Applications on stability analysis of genotypes.The Iraqi Jour. for Agri. Sci **27,** 11-20.

Finlay KW, Wilkinson GN. 1963. The analysis of adaptation in a plant breeding programme Australian. J. Agric. Res **14,** 742-754.

Francis TR, Kannenberg LW. 1978. Genotype grouping and stability measurement. Can. J. Plant Sci **58,** 1029-1034.

Kang MS. 1988. A rank – Sum Method For Selecting high yielding Stable Corn n.genotypes Cereal Res. Comm **16,** 113-115.

Knight R. 1970. The measurement and interpretation of genotype environment interactions. Euphytica **19,** 225-35.

Lin CS. Binns MR, Lefkovitch L. 1986. Stability analysis: Where do weStand Crop Sci **26,** 894-900.

Perkins JM, Jinks JL. 1968. Environmental and genotype environmental components of variability. III. Multiple lines and crosses. Heredity **23,** 339-356.

Shukla GK. 1972. Some statistical aspects of partitioning genotype-environmentcomponents of variability. Heredity **29,** 237-45.

Surma M, Adamski T, Banaszak Z, Kaczmarek Z, Kuczyńska H, Tugowska MB, Obuchowskił W, Salmanowicz B, Krystkowiak K. 2015. Effect of genotype, environment and their interaction on quality parameters of wheat breeding lines of diverse grain hardness.Plant Prod. Sci. **15(3),** 192-203.