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Stability Evaluation of Barley Genotypes grown in gypsum soil for Environmental variations

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ABSTRACT

A field experiment was carried out at the research station of field crops department at College of Agriculture at Tikrit University, which is about 12 km from center of Tikrit city, during two winter agricultural seasons 2021-2022 AD and 2022-2023 AD. Experiment included tow factor the first ten genotypes of six-row barley were Warka Aswad, Shuaea Al Khair, Hadar Aswad, Amal, Buraq, Samir, Rayhana, Arifat, and Ibaa 99, and the seconed three spray concentrations of zinc (0.60, 120) mg. liter, and experiment was implemented according to Randomized Complete Block Design (R.C.B.D), with three replications and a split-plot arrangement. Traits of number of spikes per m^2, number of grains per spike, weight of a thousand grains, grain yield, total biological yield, and harvest index were studied. Stability was estimated according to method of Eberhart and Russell (1966) and genetic, environmental, and phenotypic correlations. The following results were reached: Linear effect of environments and environments was highly significant for all traits studied and was effect of genotypes was highly significant for all traits except grain yield, and the joint interaction between genotypes and environments was highly significant for all of studied traits except for biological yield trait. Effect of linear component of joint interaction between genotypes, environment, and clustering deviation with experimental error were highly significant for all traits except for traits of grain yield and biological yield, and it was Genetic and phenotypic correlation is positive and highly significant for traits of number of spikes per m^2, number of grains per spike, weight of a 1000 grains and grain yield, and that genotypes Amal, Rayhana, Shuaa and Ibaa 99 were genetically stable of grain yield.

تقييم إستقرارية تراكيب وراثية من الشعير المزروعة في التربة الجبسية للتغيرات البيئية

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المستخلص

نفذت تجربة حقلية في محطة أبحاث قسم المحاصيل الحقلية في كلية الزراعة في جامعة تكريت والتي تبعد حوالي (١٢) كم عن مركز مدينة تكريت خلال الموسمين الزراعيين ٢٠٢١-٢٠٢٢ م و٢٠٢٢ -٢٠٢٣ م . وتضمنت التجربة عشرة أصناف من الشعير السداسي الصفوف وهي وركاء أسود وشعاع والخير وحضر أسود وأمل وبراق وسمير وريحانة وأريفات وإباء ٩٩ والعامل الثاني كان تراكيز الرش بالزنك (٠ و ٦٠ و١٢٠) ملغم.لتر وطبقت التجربة وفق تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات وبترتيب الألواح المنشقة. ودرست صفات عدد السنابل بـ م^{2}وعدد الحبوب بالسنبلة ووزن ألف حبة وحاصل الحبوب في وحدة المساحة والحاصل البايلوجي الكلي ودليل الحصاد وتم تقدير الإستقرارية وفق طريقة Eberhart وRussell (١٩٦٦) والإرتباطات الوراثية والبيئية والمظهرية وتم التوصل الى النتائج الى ما يلي : كان الإرتباط الوراثي والمظهري موجب وعالي المعنوية لصفات عدد السنابل بالمتر مربع وعدد الحبوب بالسنبلة ووزن ألف حبة مع حاصل الحبوب وأن الأصناف أمل وريحانة وشعاع وإباء ٩٩ كانت مستقرة وراثياً في صفات حاصل الحبوب الكلي في وحدة المساحة وجودته.

الكلمات المفتاحية : الشعير ، الإستقرارية ، الإرتباط الوراثي ، الإرتباط المظهري .

INTRODUCTION

Barley is one of most important grain crops in world (*Hordeum vulgare* L.). It is used in most countries of world as a grain and fodder crop. It still represents an alternative to bread wheat in many countries of world, especially poor ones, or as a mixture with concentrated rations. It ranks fourth after Wheat, Rice, and Maize . In terms of cultivated area and amount of world production, barley is characterized by characteristics of high resistance to salinity, drought tolerance, low nutritional requirements, and rapid growth. Most regions of Iraq are suitable for its cultivation, especially northern areas, which are one of areas where double-row barley grows. Its nutritional value lies in its grains, which contain on mean78 %, carbohydrates, 10 %, protein, 10% water, 1%, and fats Al-Baldawi et al (2014).

The importance of barley in Iraq in developing livestock comes from fact that its grains are used in good concentrated fodder for feeding animals and birds, mixed with leguminous fodder crops such as clover and jet to improve the green fodder material. It is also used in production of malt and yeast and for various medical uses, including food for diabetics. The reasons for low productivity of barley production rate per unit area of Iraq are attributed to many factors, most prominent of which is deterioration of cultivated genotypes as a result of their cultivation for long years and failure to maintain their purity along with their sensitivity to diseases and stagnation. One of most important methods that help in increasing productivity rate is use of improved and newly developed genotypes in agriculture that are suitable for environment. Region in which it is cultivated. Geneticists and barley plant breeders have been interested in studying continuous variation of quantitative traits such as grain yield and its components. Phenotypic variation of these traits represents the result of interaction between genetic and environmental factors. Knowing inherited and non-inherited components of phenotypic variation is necessary to find strong foundations for selecting quantitative traits as well as analyzing Stability according to method Eberhart and Russell (1966) is one of methods used that gives indications of behavior of genotypes in different environments and determines which of them is more stable in its production characteristics. This enables barley breeders to determine variety that gives highest grain yield in different environments and gives an estimate of genetic and environmental correlations. The Phenotypic importance of contribution of yield components to grain yield gives preliminary indicators for their adoption as selection evidence for improving grain yield traits.

The Research aims to estimate stability of varieties in three environments, namely concentrations of zinc spraying (0, 60, 120) mg. L^{-1} to determine its stability in grain yield traits, as well as to estimate genetic, environmental and phenotypic correlations of studied traits.

MATERIALS AND METHODS

Experiment was carried out at the research station of Filed Crops Department at College of Agriculture at Tikrit University, which is located 12 km away from center of Tikrit city in Salah al-Din Governorate and located below longitude (43.6) east and latitude (34.6) north during two winter agricultural seasons (2021_2022) and (2022_2023) AD Experiment included ten genotypes of barley obtained from seed Inspection and Certification department in Salah al-Din Governorate that is the first environment , details of which are shown in table (1) and three concentrations of zinc spraying (0, 60 and 120) mg.L^{-1} which is the seconed environment in the two seasons , second concentration was prepared as 60 mg.L^{-1}. We weighed (1) gram of zinc and added it to a liter of distilled water, so solution became diluted. Then we took 6 cc of diluted solution and added it to every liter of distilled water. Third concentration was 120. mg.L^{-1}, as 12 cc of same diluted solution was taken with t use of a spreading material to increase surface area. Spraying process was carried out in three stages of plant’s life cycle, which are branching, elongation, and expulsion, according to the Zadock scale for every liter of distilled water. As for the first concentration (comparison) spraying process was carried out with distilled water only until complete wetness for all treatments under study. A 15 liter backpack sprayer was used to carry out spraying process. Spraying process was carried out in the early morning and in a sunny, windless atmosphere , and the experiment design was according to Randomized Complete Block design (R.C.B.D), with three replications and a split-plot arrangement estimated Stability according to method of Eberhart and Russell (1966) to finding the most staibilty genotypes

Table (1): Names, proportions, sources, color, and number of rows of barley varieties used in study:

No.	Genotypes	Breeding methods	Source	color of the grain	Number of rows
١	waraka aswad	Radiation	Atomic Energy organization	Black	Hexa
٢	Shaeae	Radiation Arevat	Atomic Energy organization	White	Hexa
٣	Al-Khair	Radiation local Black x seed Iraq	Atomic Energy organization	White	Hexa
٤	Hadar aswad	Radiation local Black	Atomic Energy organization	Black	Hexa
٥	Amal	Irradiation of the nomar variety with gamma rays in 1994	Atomic Energy organization	White	Hexa
٦	Buraq	Selection between new mutations of the cultivar Arifat	Atomic Energy organization	White	Hexa
٧	Samir	Radiation local Black barley	Atomic Energy organization	White	Hexa
٨	Rayhana	As46/Avt/Aths Sel.02L-IAP-OAP	Abaa center for agricultural research	White	Hexa
٩	Arifat	Atlas x Vaughn	Atomic Energy organization	White	Hexa
١٠	Ibaa 99	OAP-4AP-7L,sel/ICARDA	Abaa center for agricultural research	White	Hexa

A cumulative sample of field soil was taken at a depth of (0.3) m after scraping surface of ground to a depth of 5 cm to estimate its physical and chemical traits before planting and in both planting seasons, as shown in Table (2):

Table (2) Physical and chemical traits of soil in two growing seasons and at a depth of (0.3) m.

Season	PH Soil		E.C Soil		Ready nitrogen		Ready phosphorus	
	first season	Seconed Season	first season	Seconed Season	first season	Seconed Season	first season	Seconed Season
Measruing unit	–	–	Desmenz. m^{-1}	Desmenz .m-^{1}	Mg.Kg-^{1}	Mg.Kg-^{1}	Mg.Kg-^{1}	Mg.Kg-1
Measruing unit	٧.٤	٧.٨	٢.٣٩	٢.٧٧	١٨	١٨	٥.٢٥	٥.٩٥

Season	Ready potassium		Organic matter		Histology			
	first season	Seconed Season	first season	Seconed Season	-	-		
Measruing unit	Mg.Kg^{-1}	Mg.Kg-^{1}	g.kg	g.kg	loamy sandy	loamy sandy		
Measruing unit	٨٠.٢٦	٩.١٠	١٠	١١				

Experimental land was plowed using a drill plow, since the soil was gypsum. It was smoothed with available smoothing machines, and nitrogen fertilizer was added to it in an amount of 200 kg.ha^{-1} In form of urea (46% N) as a source of nitrogen, in two batches, first at planting and second at tillering stage. Also, phosphate and potassium fertilizer were added in an amount of 200 kg.ha Both in form of triple superphosphate for first fertilizer and in form of (48% P2O5) as a source of phosphorus. Second was in form of potassium sulfate as a source of potassium in one batch Sibahi (2011) Planting took place in 2021-2022 and 2022-2023 growing seasons on 15 th Nov 11/15

Area of each experimental unit was 4 m^2, and the distance between line was 0.2 m. Ten lines were planted in each experimental unit.Barley genotypes were harvested took place in 25 th May 2023 AD, Studied traits were number of ears per m^2, number of grains per spike, weight of 1000 grains, the grain yield, biological yield, and harvest index.

Genetic correlation $\quad r G xy = \frac{\mathbf{cov}}{\sqrt{\sigma^2\ \mathrm{Gg}\sigma^2\mathrm{Gy}..}}$

Environmental correlation $\quad \mathrm{rExy} = \frac{\mathbf{cov}}{\sqrt{\sigma^2\ \mathrm{GE}\sigma^2\ \mathrm{Ey}..}}$

Phenotypic correlation $\quad rpxy = \frac{cov}{\sqrt{\sigma^2\ Gp\sigma^2\ py..}}$

As: X and Y are the two traits under the study .

The components of genetic stability in six studied environments were estimated according to method of Eberhart and Russell (1966) through linear and non-linear components, as follows:

bi=(∑yij * lj) / ∑lj2

$Lj = (\sum yij/V) – (\sum\sum yij / VSJ)$

$S2\ di=[\sum 2\ ij/(S-2)]-(S2\ e/r)$

$\sum \sigma 2\ ij=[(\sum yij2 -(yi.2 /V)]-[(\sum yij*Ij)2 /\sum Ij2[$

(g) refers to the genotypes and (S) refers to environments studied and yij represents total

number of items in environment.

Yij∑ represents the general sum, and (S2e) represents the sum of the squares of clustered error.

X = average performance of genotype for studied trait over General mean for trait.

bi: Regression coefficient, which measures the genotypes response to different environments.

S2di = mean square deviation of regression that measures variety in agricultural environments studied

When the regression coefficient values are:

١ = variety has a moderate response to change in agricultural environments.bi

bi < 1 variety responds well in poor environments.

bi > 1 variety responds well in appropriate and highly productive environments.

For regression coefficient when values are:

S2di = 0 variety is stable and stable in different agricultural environments.

S2di > 0 weakens prediction of item behavior.

The significance of regression coefficients for items and each trait was tested through the t-test and according to following equation:

$T=b – 1 / Sbi$

The linear regression coefficient (bi) shows relationship between mean trait of variety and environment studied, and it is a measure of linear response to environmental changes.

RESULT AND DISCUSSION

1. Genetic stability of genotypes :

It is necessary to point out the significance of the interaction of varieties (genetic factor) and the effect of zinc three spray concentrations 0 -60-120 mg. L (environmental factor), which reflects behavior of genotypes differently from one environment to another, which makes it difficult to predict stable variety, so it requires studying it and choosing appropriate stabilization methods. Among these methods is method Eberhart and Russell (1966) Methods used to estimate stability of varieties in different environments.

Presence of these high differences in all traits of genotypes and their influence on plant breeders to extrapolate in studying stability of these genotypes and diagnosing their genetic behavior. This is an ongoing challenge in complexity of selection for genotypes that are divided in different environments by reducing correlation between phenotypic and genetic values that Mean of the last square is used to determine and test significance (G × E Liner), and if it is significantly different from zero, it is tested using pooled error , Results of table (3) show that effects of environments were highly significant for all of the studied traits. As for the effects of genotypes , they were highly significant for all of studied traits except for grain yield trait, which was significant at 0.05 probability level. As for effects of interaction between (genotypes x environments), it was high.

Significant for all of studied traits except for total biological yield trait, which did not reach limits of statistical significance. As for environments (linear), it was highly significant at probability level of 0.01. For all of studied traits, test of linear component of interaction of environment (G X E Liner) against pooled deviation was significant. At probability level of 0.01, for all of studied traits except for two traits of grain yield and total biological yield, which did not reach limits of statistical significance. This is evidence of the difference between proven parameters of genotypes regression coefficient (bi) and deviation from regression (S^2di). As for aggregate deviation test against experimental error, Pooled Error, it was highly significant for all of the studied traits except for two traits. Grain yield and total vitality, significant for all of the studied traits except for two traits. grain yield and total vitality, did not reach limits of statistical significance.

Table (3): Combined analysis of variance if stability according to Eberhart and Russell (1966) for studied traits of barley

S.O.V	d.f	number of spikes per m^2	number of grains spike	weight of a 1000 grains (g)	grain yield ($tons.ha^{-1}$)	biological yield ($tons.ha^{-1}$)	harvest index (%)
Environments	٥	47352.08 **	476.254 **	179.178 **	32.988 **	27.425 **	1734.892 **
Genotypes	٩	١١٧١.٠٨ **	20.595 **	13.030 **	1.555 *	1.197 **	65.566 **
In + GxE	٤٥	441.16 **	3.966 **	5.892 **	0.225 N.S	0.428	12.482 **
Env / Gen	٥٠	5132.253 **	51.195 **	23.221 **	3.501 **	3.127 **	184.723 **
Env.linear	١	136760.444 **	2381.266 **	895.894 **	164.943 **	137.125 **	8674.462 **
GxE linear	٩	82.631 **	3.576 **	13.140 **	0.228 N.S	0.507 N.S	18.580 **
Deviation	٤٠	713 **	3.658 **	3.672 **	0.201 N.S	0.367 N.S	9.862 **
DESV G-1	٤	202.354 **	5.717 **	3.705 **	0.242	0.225	22.049 **
DESV G-2	٤	497.412 **	2.100 **	10.862 **	0.291	0.380	2.704 **
DESV G-3	٤	508.744 **	4.148 **	2.347 N.S	0.212	0.489	19.772 **
DESV G-4	٤	908.91 **	4.623 **	4.767 **	0.407	0.480	17.574 **
DESV G-5	٤	199.450 **	2.2649 N.S	0.754 N.S	0.044	0.927	8.335 **
DESV G-6	٤	729.929 **	0.91 N.S	3.268 **	0.231	0.161	3.652 **
DESV G-7	٤	136.164 **	1.654 N.S	2.244 N.S	0.127	0.219	11.123 **
DESV G-8	٤	224.537 **	4.314 **	2.987 **	0.079	0.214	1.928 *
DESV G-9	٤	994.929 **	4.764 **	2.79 **	0.284	0.388	5.295 **
DESV G-10	٤	374.701 **	6.080 **	3.086 **	0.096	0.186	6.186 **
Pooled Error	١١٨	21.122	3.513	2.520	0.044	0.342	5.360

2. Genetic stability parameters **:**

Stability analysis, which they referred to Eberhart and Russell (1966) includes two components, linear regression coefficient (bi) and non-linear deviation from regression (S^2di), which are important parameters in how to judge stability of genotypes across different environments and predict appropriate genotype for all environmental conditions surrounding it, as parameters were estimated. reliability shown in table (4) is average effectiveness of genotypes and different traits in agricultural environments and values of regression coefficient bi, which determines the genotypes response and is measured by a linear regression of average of the variety on the mean of genotypes in each environment and mean deviation from regression for each genotype S^2di. test is used to test the significance of each of coefficients. regression from correct one, while S^2di test uses mean square error for each class over clustering error and calculated (R^2) the coefficient of determination that mean proportion of variance in the dependent variable that can be predicted by independent variable it is useful in explaining which on of genotypes is more stable. We note from results of table (4) regarding results of reliability analysis that for trait of number of spikes per m^2, ten genotypes were not stable for trait despite superiority of genotype Hadhar Aswad with highest mean for trait reaching (245.222) spikes .m^2, and for trait of number of grains per spike, genotypes were Warka Aswad ,Shaeae, Hadar aswad,Amal,Buraq,Samir,Arifat and Ibaa 99 is genetically stable in trait, and for 1000-grain weight trait, genotypes Warka Aswad ,Al-Khair, Amal, Samir, Rayhana and Ibaa 99 were most stable in character, and the genotype Amal was most dual because it gave highest coefficient of determination (96.427) and its mean trait was (38.777) g. And for grain yield characteristic, genotypes Amal, Rayhana and Ibaa 99 were the most genotyps are stable in character, and most stable genotype is Amal because it recorded highest coefficient of determination (98.796) and an arithmetic mean for trait reached (3.450) tons.ha .

As for total biological yield trait, genotypes Warka Aswad,Shaeae,AL-Khair,Hadar Aswad , Buraq, Samir , Rayhana, Arifat, and Ibaa 99 were most stable in trait, despite superiority of Hadar Aswad genotypes, with highest a mean for trait reaching (11,892) tons. ha, and for harvest index trait, genotypes Shaeae, Amal,Buraq, Samir, Rayhana, Arifat and Ibaa 99 were genetically stable in trait, and best genotypes was Amal because it gave highest coefficient of determination of (96.830) and an mean for trait of (31.319)%. These results were in line with results of Khanzadeh et al. (2018) and Al Myaliy et al .(2020) Who obtained genetic stability for grain yield trait for some genotypes and in different environments they studied.

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Table (4): Stability parameters and environment averages for number of spikes per m^2 and number of grains per spike of the ten barley genotypes :

Traits	number of spikes per (m^2)				number of grains per spike				Weight of a 1000 grain (g)			
Genotypes	$\bar{x}$	bi	S^2 di	R^2	$\bar{x}$	Bi	S^2 di	R^2	$\bar{x}$	bi	S^2 di	R^2
1	229.111	0.983 n.s	60.410**	96.586	40.944	0.919 n.s	0.734 n.s	89.803	38.722	1.259 n.s	0.395 n.s	90.555
2	222.666	1.151*	158.763**	94.038	39.277	1.085 n.s	0.471 n.s	97.092	37.888	0.328 *	2.780**	18.193
3	223.555	1.011 n.s	162.540**	92.248	38.777	0.812 *	0.211 n.s	90.450	39.111	0.802 n.s	0.057 n.s	86.008
4	245.222	1.002 n.s	295.929**	86.742	40.888	1.085 n.s	0.369 n.s	93.816	40.555	1.404*	0.748 n.s	90.259
5	228.055	0.979 n.s	59.442**	96.606	39.222	1.066 n.s	0.416 n.s	96.761	38.777	0.953 n.s	0.588 n.s	96.427
6	237.055	0.973 n.s	236.268**	97.793	39.833	0.945 n.s	0.867 n.s	98.313	39.166	1.412*	0.249 n.s	93.184
7	228.611	1.009 n.s	38.347**	97.793	40.277	0.794 n.s	0.619n.s	95.783	39.222	1.322 n.s	0.091 n.s	94.583
8	226.222	0.950 *	67.804**	95.965	39.333	1.076*	0.266 n.s	94.116	39.500	1.168 n.s	0.125 n.s	91.339
9	241.388	1.004 n.s	324.602**	85.721	42.111	1.123 n.s	0.416 n.s	94.040	40.777	0.471 *	0.898 n.s	64.128
10	222.222	0.933 *	117.859**	93.232	39.000	1.090 n.s	0.855 n.s	92.085	39.555	0.876 n.s	0.188 n.s	84.77
	230.411				39.966				39.327			
Traits	Grain yield ($tons.ha^{-1}$)				biological yield ($tons.ha^{-1}$)				Harvest index (%)			
genotypes	$\bar{x}$	bi	S^2 di	R^2	$\bar{x}$	bi	S2 di	R^2	$\bar{x}$	Bi	S2 di	R^2
1	3.634	1.026 n.s	1.066**	94.713	11.760	0.912 n.s	0.039 n.s	92.698	30.560	0.927 n.s	5.562**	89.493
2	3.377	0.951 n.s	1.082**	92.753	11.300	1.260 n.s	0.012 n.s	93.467	30.607	1.005 n.s	0.885 n.s	98.782
3	3.405	0.812 *	1.561**	92.750	11.268	1.063 n.s	0.049 n.s	88.784	30.031	0.735 *	4.803**	85.580
4	4.187	1.239*	1.121 **	93.957	11.892	1.240 n.s	0.045 n.s	91.664	35.085	1.239*	4.071*	94.987
5	3.540	0.941 n.s	0.000 n.s	98.796	11.257	0.922 n.s	0.195 *	75.852	31.319	0.990 n.s	0.991n.s	96.230
6	3.756	1.102 n.s	1.062**	95.587	11.650	0.812 n.s	0.060 n.s	93.344	32.005	1.177 n.s	0.569 n.s	98.799
7	3.731	0.994 n.s	1.027*	96.981	11.393	1.239 n.s	0.040 n.s	95.992	32.520	0.013 n.s	1.920 n.s	95.242
8	3.594	0.960 n.s	0.011 n.s	97.963	11.280	0.848 n.s	0.042 n.s	91.995	31.821	1.000 n.s	1.144 n.s	99.120
9	4.227	1.066 n.s	1.079**	94.291	11.864	0.729 n.s	0.015 n.s	82.430	35.355	1.065 n.s	0.021 n.s	97.894
10	3.535	0.904 n.s	0.017 n.s	97.219	11.635	0.971 n.s	0.051 n.s	94.548	30.161	0.843 n.s	0.275 n.s	96.147
	3.699				11.530				31.946			

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Genetic correlation coefficients between studies :

Results of table (5) of genetic correlation for studied traits show that grain yield trait has a positive and highly significant genetic correlation with two traits: number of spikes per m^2 and number of grains per spike and a positive and significant positive correlation with weight of a thousand grains, and trait of number of spikes per m^2 has a positive and highly significant genetic correlation with two traits. weight of a thousand grains and number of grains per spike. Trait of number of grains per spike was highly genetically linked to weight of a thousand grains. This means that trait of grain yield ($ton.ha^{-1}$) was significantly correlated with its main components, even if it is polygenic (pleiotrop) and its isolation leads to changes in traits that affect them, and this is main reason for correlation, and that positive correlation results from increasing number of genes for both traits Sherwan et al (2016) and Akalu et al (2021) and Nekov et al (2022) all obtained a genetic and positive significant correlation for yield components with grain yield trait in barley.

Table (5) Genetic correlation of studied traits :

Traits	grain yield ($tons.ha^{-1}$)	weight of a thousand grain (g)	number of grains per spike	number of spikes per m^2
number of spikes per m^2	0.054**	0.239**	0.081**	1
number of grains per spike	0.041**	0.965**	1	
weight of a thousand grain (g)	0.085*	1		
grain yield ($tons.ha^{-1}$)	1			

3. **Phenotypic correlation coefficients between studies :**

Results of table (6) for phenotypic correlation and for studied traits show that grain yield trait was positively and highly significantly phenotypically associated with traits of a number of spikes m^2, number of grains per spike, and weight of a thousand grains. Trait of the number of spikes per m^2 had a positive and highly significant phenotypic correlation with traits of the weight of a thousand grains and number of grains per spike and trait of number of grains per spike was phenotypically highly correlated with weight of a thousand grains. We conclude from this that the trait of grain yield was phenotypically linked to its main components and increasing one of these traits in a positive direction leads to an increase in grain yield, and both occurred. There is a high phenotypic correlation between yield components and grain yield in barley.

Table (6) Phenotypic correlation of studied traits :

Traits	grain yield (tons.ha^{-1})	weight of a thousand grain (g)	number of grains per spike	number of spikes per (m^2)
number of spikes per (m^2)	**0.940****	**0.733****	**0.766****	**1**
number of grains per spike	**0.637****	**٠.٦٤٤****	**1**	
weight of a thousand grain (g)	**0.866****	**1**		
grain yield (tons.ha^{-1})	**1**			

4. **Environmental correlation coefficients between studies :**

Results of table (7) for environmental correlation indicate that trait of grain yield per unit area was positively and highly environmentally correlated with traits of a number of grains per spike and weight of a thousand grains, and trait of number of spikes per m^2 was negatively and highly environmentally correlated with number of grains per spike and traits of number of grains was associated spike has a negative and highly significant correlation with weight of a thousand grains. We conclude from this those environmental factors effect traits associated with it in a positive direction, and that its suitability to a trait leads to an increase in trait associated with it, and that grain yield trait per unit area has a highly significant correlation with two traits of number of grains per spike and weight of a thousand grains Woede et al (2016) Fadel et al (2022)

Table (7) Environmental correlation of studied traits :

Traits	grain yield (tons. ha^{-1})	weight of a thousand grain (g)	number of grains per spike	number of spikes per m^2
number of spikes per m^2	0.105 N.S	0.026 N.S	-0.315**	1
number of grains per spike	0.374**	-0.282**	1	
weight of a thousand grain (g)	0.315**	1		
grain yield (tons.ha^{-1})	1			

Based on finding of current study , it can be concluded that varieties Amal, Rayhana, Shuaa and Ibaa 99 were genetically stable in terms of grain yield in six environments studied and that genetic and phenotypic correlation of traits of a number of spikes per m^2, number of grains per spike, and weight of a thousand grains was highly significant with grain yield. It is possible to benefit from traits of genetically stable genotypes in different environments, as well as possibility of using traits of the number of spikes per m^2 and weight of a thousand grains as primary indicators for selecting genotypes that excel in trait of grain yield.

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