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Stability Analysis of Yield and Its Components for Promising Barley Genotypes under Water Stress and Saline Affected Fields

EL-Shawy, E.E.; Sally E. El-wakeel and Ashgan M. Abd El-Azeem
Barley Research Dep., Field Crops Research Institute, ARC, Egypt
Corresponding author: sayedelshawy@gmail.com

Abstract

The objective of this investigation aim was to evaluate twenty barley genotypes under different environments for testing stability of their performance. Where, development of any crop genotypes with adaptation to changes is one of most important goal of breeding program. This study examined twenty barley genotypes over different three environments; normal, water stress and salt stress. The normal and water stress experiments were conducted at Sakha while salt stress experiment was conducted at the El-Hosinia station during two seasons (2014/2015 and 2015/2016). The combined analysis of variance for environments, genotypes and (Genotypes x Environments) interaction was highly significant for all studied genotypes, suggesting differential responses of the genotypes and the need to stability analysis. Results revealed that highly yielding genotypes can also be stable. Giza 133 and Line 7 had desired performance (grain yield) compared to the grand mean, regression coefficient (b_i) did not differ significantly from unity and had low deviation from regression (S^2d) values, indicating the role of linear portion of G x E interaction in the performance of these genotypes. Giza 130, Line 4, Line 5 and Line 8 had the lowest (b_i) values which were more adapted to unfavorable environments, whereas Giza 132, Line 3 and Line 6 were input sensitive and adapted to high potential environments.

Keywords: Barley, stability, grain yield, water stress, salt stress.

Introduction

Barley crop is growing in a large scale in the rainfed areas in North coastal region and in the newly reclaimed saline lands in Egypt. Most of these lands are suffering from water shortage, soil salinity and low soil fertility. Only about 2.5% of the total area of Egypt is cultivated, with about 30% of the cultivated lands affected by salinity. In addition, about (400 000 ha) suffer from waterlogging. Egypt has about 120 000 ha in the North West Coast (NWC) region and about 40000 ha in North Sinai. The annual precipitation is about 135 mm in NWC, and slightly higher in North Sinai (**Noaman 2008**).

Barley is recommended to grow under drought and saline soil conditions. Therefore, barley cultivars developed for these areas should be drought tolerant and stable under harsh conditions. **El-Sayed (2002), Ahmed *et al*., (2003) and Noaman *et al*., (2006),** reported that it is possible to identify high yield potential barley genotypes under sever stresses with high yield stability. Total harvested areas in Egypt season 2016/2017 amount to 175,270 feddan with an annual production of approximately 239,666.7 ton.

Therefore, the main objective of this study was to identify promising barley genotypes that are able to produce high yield and are more tolerant to water stress and salinity conditions.

Materials and Methods

Twenty barley six-row genotypes were used in the study, including 5 covered local varieties, 5 hulles local varieties and 10 promising Egyptian lines. The list of the twenty genotypes and pedigree are presented in **Table 1.**

The twenty barley genotypes were evaluated at different three environments; normal, water stress and salt stress. The normal and water stress experiments were conducted at Sakha Agricultural Research Station while salt stress experiment was conducted at the El-Hosinia Agricultural Research Station (salinity affected soils), during two seasons (2014/2015 and 2015/2016).

The normal experiment irrigated three times, while the second one included only the sowing irrigation (water stress). Grains were hand drilled at the recommended sowing rate of barley in the irrigated land in Egypt (50 kg fed^{-1}). Each genotype was sown in six rows of 3.5 m, spaced with 20 cm among rows (plot area 4.2 m^{2}). These experiments were laid out in a RCBD with three replications. Sowing was done in first of December in both seasons.

Data were collected from each plot on random sample for each genotype, days to maturity, plant height (cm), spike length (cm), No. of spikes m^{-2}, No. of grains spike^{-1}, biological yield (kg fed^{-1}), grain yield (kg fed^{-1}) and 1000-grain weight (g) were recorded.

Soil samples were randomly taken from the experimental area at a depth of 0 to 30 cm from soil surface before barley sowing. The soil properties are shown in **Table 2**. Monthly temperature and rainfed shown in **Table 3**. Water application was mentiored via a water meter as shown in **Table 4**.

Table 1. Name and pedigree of the studied barley genotypes.

No.	Genotype	Pedigree/Cross Name
1	Giza 123	Giza 117//FAO86
2	Giza 126	BaladiBahteem/SD729-por12762-Bc
3	Giza 132	Rihane-05//As46/Aths*2" Aths/ Lignee686
4	Giza 133	Carbo/Gustoe
5	Giza 134	Alanda-01/4/WI 2291/3/Api/CM67//L2966-69
6	Giza 129	Deir Alla 106/Cel//As46/Aths*2
7	Giza 130	"Comp.cross"229//Bco.Mr./ DZ0231 /3 /Deir Alla106
8	Giza 131	CM67-B/CENTENO//CAM- B /3/ ROW906.73 /4 / GLORIA-BAR / COME-B/5/ FALCON –BAR /6/ LINO
9	Giza 135	ZARZA/BERMEJO/4/DS4931//GLORIA-BAR/COPAL/3/SEN/5/AYAROS
10	Giza 136	PLAISANT/7/CLN-B/LIGEE640/3/S.P-B//GLORIA-BAR/COME-B/5/FALCON-BAR/6/LINO CLN-B/A/S.P-B/LIGNEE640/3/S.P-B//GLORIA- BAR/COME-B/5/FALCON-BAR/6/LINO
11	Line 1	Giza 117/4/4/Mr 25-84/Att/3/Mari/Aths//Bc
12	Line 2	Giza 117/4/API/CM67-B//ORE/3/LBIRAN/UNA80//….
13	Line 3	Giza 118/3/Aths/Lignee686//ACSAD618
14	Line 4	Giza 121/3/Alanda/Hamra-01//Gloria 'S'/Copal 's'
15	Line 5	Giza 121/3/Alanda/Hamra-01//Gloria 'S'/Copal 's'
16	Line 6	Giza 123/3/Alanda/Hamra-01//Alanda-01
17	Line 7	Giza125/5/ACSAD1182/4/Arr/ESP//Alger/Ceres362-1-1/3/WI
18	Line 8	Giza126/5/Apm/HC1905//Robur/3/Arr/4/Baca 'S'/3/AC253//CI08887/CI05761
19	Line 9	Giza 2000/3/Alanda/Hamra-01//Alanda-01
20	Line 10	C.C 89/Alanda/Zafraa//Gloeia'S'/Copal 's'

Table 2. Some mechanical and chemical analysis before sowing at 0-30 cm depth for Sakha and El-Hosinia Research stations during 2014/2015 and 2015/2016 seasons.

Soil Properties	Sakha		El-Hosinia	
	2014/2015	2015/2016	2014/2015	2015/2016
Sand	13.2	16.2	17.9	10.5
Silt	37.5	36.3	35.3	39.6
Clay	49.3	47.5	46.8	49.9
Chemical analysis				
pH	7.9	8.15	9.3	8. 5
EC dSm^{-1}	2.2	2.1	15.7	12.3
ESP	7.3	7.6	13.2	13.9

Table 3. Monthly mean of air temperature (At ^{O}C) and rainfed (mm/month) in winter seasons 2014/2015 and 2015/2016 at Sakha and El-Hosinia sites.

Month	At ^{O}C 2014/2015				At ^{O}C 2015/2016				Rainfed (mm)			
	Sakha		El-Hosinia		Sakha		El-Hosinia		Sakha		El-Hosinia	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	2014/2015	2015/2016	2014/2015	2015/2016
December	19	11	20	10	20	13	20	14	35	15	47	15
January	17	6	19	9	17	10	18	11	18	12	49	33
February	21	8	22	11	22	11	20	13	23	5	14	33
March	23	10	23	13	23	13	21	15	14	18	6	3
April	28	11	26	14	28	16	24	18	3	2	-	-
May	31	13	29	17	29	19	27	20	-	-	-	-

Table 4. Amount of supplied water in $m^3 fed^{-1}$ at different barley critical growth stages, rainfall amount and total water supplied at 2014/2015 and 2015/2016 Seasons.

Treatment	Growth Season	Growth Stages			Irrigation			
		Sowing irrigation	35 days after sowing	75 days after sowing	Water (m^3)	Rainfall		Total (m^3 fed^{-1})
						mm	m^3 fed^{-1}	
Sakha normal irrigation	2014/2015	500	350	400	1250	93	391	1641
	2015/2016	500	375	425	1275	52	218	1493
Sakha water stressed	2014/2015	500	-	-	550	93	391	941
	2015/2016	500	-	-	500	52	218	718
El-Hosinia	2014/2015	450	350	385	1185	116	487	1672
	2015/2016	450	340	370	1160	84	353	1513

Stability parameters were computed according to **Eberhart and Russell (1966).** If regression coefficient (b_i) is significantly larger or smaller than one, the genotype is considered more adapted to favorable and unfavorable environments, respectively with respect to the site mean yield. If (b_i) is not significantly different from one, the genotype is considered stable for all environments. The hypothesis that any regression coefficient does not differ from unity, it was tested by the t-test using its own standard error for regression. The second stability parameter was mean square of the deviation from regression for each genotype. For the regression analysis of variance, the residual from the combined analysis of variance were used as a pooled error to test the S^2d values. A significant F-value would indicate that the S^2d was significantly different from zero. The appropriate analysis of variance is given with this model, the sum of squares due to environments and genotype x environments (linear) and deviations from the regression model.

Results and Discussion

Interactions effect:

The differences among the environments and genotypes were significant for all studied traits, while differences between years were highly significant for all studied traits except for spike length and grain yield fed^{-1} were not significant. Also, the mean square of interaction between the years x environments, genotypes x years, genotypes x environments and genotypes x years x environments found to be significant and highly significant for all studied traits (**Table 5**). These results indicated that, the studied genotypes responded differently to the environmental conditions suggesting the importance of the assessment of genotypes under different environments in order to identify the best genotypes that more adapted for a particular environment.

Table 5. The combined analyses of variance over years (Y), environments (E) and genotypes (G) for all studied traits.

SOV	df	Days to maturity	Plant height	Spike length	No. of spikes m^{-2}	No. of grains $spike^{-1}$	Biological yield	Grain yield	1000 -grain weight
Years (Y)	1	829.6**	1806.8**	1.3ns	35760.4**	3490.7**	10443803.5**	128332.6ns	116.2**
Environments(E)	2	884.1**	10308.4**	337.4**	434033.7**	18447.6**	233293896.9**	17274610.5**	539.6**
Y*E	2	155.2**	173.1**	78.8**	10258.3*	3840.9**	54094895.7**	295903.0**	49.5*
Error (a)	9	4.4	3.5	1.4	1603.5	33.1	923590.5	28458.9	7.8
Genotypes G)	19	94.2**	589.1**	11.4**	9865.1**	161.9**	3637721.5**	172049.5**	137.9**
G*Y	19	8.0**	122.8**	1.6**	2838.8**	87.2**	2140282.4**	51897.0**	47.2**
G*E	38	8.7**	64.5**	0.9*	4060.9**	88.3**	1371868.7**	46697.9**	27.1**
G*Y*E	38	6.4**	45.9**	1.3**	2346.7**	66.1**	1111472.1**	18901.9**	16.1**
Error (b)	227	2.2	3.8	0.6	1621.3	21.1	446580.5	10010.3	4.1

The mean squares due to environments were the most important source of the total mean squares for all characteristics. Also, the variances due to environments were higher than those of interactions between genotypes and environments for all studied characters. Therefore, most of the differences in the performance of barley genotypes in these experiments were due to environment and not to genotype by environment interaction differences. These results are in agreement with those reported by **Mohamed, (2004); Farhat, (2005); El-Shawy, (2008); El-Seidy *et al.*, (2012); El-Seidy *et al.*, (2013); El-Denary and El-Shawy, (2014); Mansour *et al.*, (2016) and El-Shawy *et al.*, (2017).**

Environments effect:

The days required for maturity date were not similar *i.e.* due to the difference in water applied and/or weather conditions (rainfall and temperature) (**Table 3**). The average of number of maturity date under water stress condition was reduced by 2.5 days compared with normal growth condition (**Table 6**). Plant height, spike length, No. of spikes m^{-2}, No. of grains spike^{-1}, grain yield fed^{-1}, biological yield fed^{-1} and 1000-grain weight were reduced under stress treatments compared with normal condition. Results indicated that, the wide range of growth conditions resulted in a broad variation of mean yields, ranging from 7660.7 kg fed^{-1} in favorable normal condition to 4930.5 kg fed^{-1} in salinity stress (**Table 6**). Water stress and salinity stress were considered the major threat to agricultural production, whereas lack of soil moisture and soil salinity restricts plant growth. Limitation of growth resources by stresses, reduce the size of plant organs such as leaves, tillers, and spikes (**Fischer 1984**).

Table 6. Means of the twenty genotypes over years and environments.

Item	Days to maturity	Plant height (cm)	Spike length (cm)	No. of spikes m^{-2}	No. of grains spike^{-1}	Biological Yield (kg fed^{-1})	Grain yield (kg fed^{-1})	1000 -grain weight (g)
First year	127.0	92.7	8.0	332.9	63.1	6435.3	2517.3	50.9
Second year	130.1	97.2	8.2	352.8	56.9	6122.5	2596.6	49.8
Normal	128.4	104.7	9.7	402.0	73.1	7660.7	3233.7	52.2
Water stress	125.9	93.9	8.2	344.9	58.4	6245.6	2758.3	50.8
Salinity stress	131.3	86.2	6.4	281.8	48.5	4930.5	1678.8	48.0
Mean overall	128.54	94.9	8.1	342.9	60.0	6278.91	2556.94	50.33
LSD at 0.05	**3.86**	**3.5**	**2.2**	**74.0**	**10.6**	**1822.22**	**654.30**	**1.05**

Performance of genotypes:

The mean number of days to maturity for different genotypes ranged from 124.1 for Line 1 to 132 days for Line 6. The earliest genotypes were Line 1 and Line 2, whereas Giza 132, Line 5 and Line 6 were the latest genotypes (**Table 7**). The average of plant height ranged from 86.7 cm for Line 9 (the shortest genotype) to 106.3 cm for Line 7 (the tallest genotype) (**Table 8**). Giza 132, Line 3, Line 5 and Line 7 gave the highest values for plant height in both seasons. The tallest plant was achieved when plants were grown under the normal conditions compared with those plants grown under the stress treatments. The reduction in plant height could be attributed to lower crop growth rate and the decrease in relative water content. These results are in harmony with those of **Nabipour *et al.*, (2002), Bayoumi (2004), Mohamed (2004), Farhat (2005), Bagheri and abad (2007), Samarah *et al.*, (2009) and Vaezi *et al.*, (2010).**

Table 7. Means of days to maturity for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	2014/2015			2015/2016			Mean
	N	WS	Sal	N	WS	Sal	
Giza 123	124.7	121.0	129.0	128.0	125.3	129.3	126.2
Giza 126	126.0	125.3	133.7	131.0	129.0	133.3	129.7
Giza 132	128.3	127.3	135.3	133.3	129.7	133.7	131.3
Giza 133	123.7	121.0	133.3	128.0	126.0	130.0	127.0
Giza 134	126.0	124.3	131.3	132.0	128.7	133.7	129.3
Giza 129	127.0	120.7	126.3	126.3	127.0	128.7	126.0
Giza 130	127.0	127.0	127.3	133.3	129.3	133.7	129.6
Giza 131	125.7	127.3	133.3	132.7	129.7	132.0	130.1
Giza 135	127.3	126.7	131.7	132.0	129.0	129.0	129.3
Giza 136	130.0	126.7	135.3	132.0	129.0	133.3	131.1
Line 1	122.3	118.7	125.0	127.0	125.7	126.0	124.1
Line 2	122.7	120.0	126.0	127.0	125.3	125.3	124.4
Line 3	126.3	120.7	127.3	130.3	127.7	132.0	127.4
Line 4	125.7	122.7	129.0	132.0	127.7	129.0	127.7
Line 5	127.0	128.0	135.3	133.3	130.7	135.0	131.6
Line 6	128.0	128.7	135.7	134.3	129.7	135.7	132.0
Line 7	123.7	121.0	129.3	129.0	126.7	132.7	127.1
Line 8	129.0	126.0	132.7	131.3	128.7	133.3	130.2
Line 9	126.3	121.7	136.5	129.7	126.3	132.7	128.9
Line 10	125.0	122.7	129.0	130.7	128.3	132.7	128.1
LSD at 0.05	**2.1**	**1.9**	**4.0**	**2.0**	**1.6**	**2.3**	**2.4**

Table 8. Means of plant height (cm) for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	2014/2015			2015/2016			Mean
	N	WS	Sal	N	WS	Sal	
Giza 123	106.3	86.0	90.4	110.3	86.7	84.3	94.0
Giza 126	106.3	95.0	91.7	112.0	90.3	85.0	96.7
Giza 132	112.0	98.7	92.9	119.3	105.3	95.3	103.9
Giza 133	96.7	91.0	79.6	95.0	91.0	78.0	88.5
Giza 134	101.3	94.0	86.1	111.7	103.7	92.3	98.2
Giza 129	95.0	90.0	78.8	103.0	89.3	87.0	90.5
Giza 130	92.7	80.3	75.7	111.3	91.3	94.0	90.9
Giza 131	97.3	91.0	75.1	105.3	100.3	93.3	93.7
Giza 135	96.7	92.0	77.9	99.7	91.7	86.3	90.7
Giza 136	103.3	79.7	87.8	110.3	100.0	95.3	96.1
Line 1	92.7	90.3	78.8	102.3	89.3	87.3	90.1
Line 2	99.0	98.0	84.2	106.7	100.3	85.7	95.6
Line 3	113.7	98.0	96.6	103.3	99.3	90.7	100.3
Line 4	99.7	96.3	84.7	116.7	103.3	83.7	97.4
Line 5	112.0	106.7	95.2	118.0	109.0	94.0	105.8
Line 6	96.3	93.3	81.9	103.7	94.0	87.0	92.7
Line 7	115.0	112.0	95.2	115.7	105.0	95.0	106.3
Line 8	98.7	87.7	83.9	109.0	86.3	83.3	91.5
Line 9	93.7	75.3	79.6	110.3	88.3	72.7	86.7
Line 10	92.3	90.7	78.5	102.0	86.0	83.3	88.8
LSD at 0.05	**3.2**	**3.0**	**2.6**	**4.1**	**2.7**	**3.3**	**3.2**

For spike length means of the twenty barley genotypes, showed highly significant differences between barley genotypes (**Table 9**). Giza 131 and Line 6 gave the highest values for spike length, while the lowest value obtained from Giza 133 (compacted spike type).

Table 9. Means of spike length (cm) for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	2014/2015			2015/2016			Mean
	N	WS	Sal	N	WS	Sal	
Giza 123	8.3	8.0	5.7	10.0	7.3	7.3	7.8
Giza 126	7.7	8.3	4.3	8.7	7.0	6.0	7.0
Giza 132	11.7	10.0	6.0	10.0	7.7	7.3	8.8
Giza 133	7.7	7.7	3.7	7.7	5.0	4.7	6.1
Giza 134	8.7	9.0	5.0	9.3	6.0	7.3	7.6
Giza 129	9.7	9.7	7.0	11.0	8.0	8.3	8.9
Giza 130	9.7	9.0	5.3	11.0	8.7	7.7	8.6
Giza 131	10.3	10.7	7.0	11.3	8.7	8.7	9.4
Giza 135	9.7	7.7	5.7	9.3	7.3	6.7	7.7
Giza 136	10.3	9.3	7.7	10.3	7.7	7.3	8.8
Line 1	10.3	8.7	5.7	9.7	8.0	7.7	8.3
Line 2	11.0	8.3	5.7	10.7	7.7	7.0	8.4
Line 3	9.7	9.7	4.5	11.0	7.0	7.3	8.2
Line 4	10.0	9.3	6.5	9.0	7.3	7.7	8.3
Line 5	10.3	9.0	5.3	9.0	7.7	6.7	8.0
Line 6	11.0	9.7	6.3	11.0	8.3	7.7	9.0
Line 7	10.7	9.3	6.3	10.3	7.0	7.3	8.5
Line 8	8.7	7.3	4.7	8.3	7.7	6.0	7.1
Line 9	8.3	9.0	4.5	9.7	6.7	7.7	7.6
Line 10	8.3	9.0	4.5	10.7	7.0	7.3	7.8
LSD at 0.05	**1.1**	**1.2**	**1.5**	**1.6**	**1.0**	**0.8**	**1.2**

For mean number of spike m^{-2}, Giza 133, Giza 134, Line 5, Line 6 and Line 7 gave the highest values (389.1, 374.4, 385.7, 363.6 and 369.3 spikes), respectively. Whereas Giza 136 (314.6) and Line 2 (313.1) were the lowest genotypes (**Table 10**). Giza 133, Giza 134 and Line 7 were superiors under saline conditions in both growing seasons. The normal condition recorded the highest number of spike m^{-2}. The severe water stress and saline treatments decreased spike number in both growing seasons. Such response may be attributed to lack of water absorbed and reduction in photosynthetic efficiency under insufficient water condition. Moreover, the reduction in assimilates translocated to new developing tillers might owe much the death of the new tillers and depressed the number of spikes primordial. These results are confirmed by**Abd El-Wahab (2002), Bayoumi (2004), Mohamed (2004), Farhat (2005), Mahmoud (2006), Bagheri and abad (2007), Samarah *et al.*, (2009) and Vaezi *et al.*, (2010).**

Table 10. Means of no. of spikes m^{-2} for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	2014/2015			2015/2016			Mean
	N	WS	Sal	N	WS	Sal	
Giza 123	430.0	356.0	306.7	436.0	328.0	294.7	358.6
Giza 126	364.0	344.0	241.7	414.0	340.0	313.3	336.2
Giza 132	354.0	336.0	218.3	386.0	332.0	326.7	325.5
Giza 133	390.0	371.3	343.3	456.0	414.0	360.0	389.1
Giza 134	392.0	374.0	328.3	432.0	384.0	336.0	374.4
Giza 129	390.0	294.0	250.0	380.0	312.0	317.3	323.9
Giza 130	342.0	288.0	300.0	370.0	308.0	308.0	319.3
Giza 131	412.0	344.0	286.7	322.0	280.0	294.7	323.2
Giza 135	374.0	366.0	225.0	400.0	340.0	297.3	333.7
Giza 136	382.0	290.0	245.0	388.0	316.0	266.7	314.6
Line 1	374.0	392.0	231.7	454.0	354.0	282.7	348.1
Line 2	360.0	298.0	228.3	420.0	308.0	264.0	313.1
Line 3	444.0	432.0	166.7	446.0	370.0	254.3	352.2
Line 4	364.0	294.0	295.0	406.0	344.0	270.7	328.9
Line 5	424.0	424.0	288.3	450.0	416.0	312.0	385.7
Line 6	392.0	368.7	283.3	420.0	400.0	317.3	363.6
Line 7	450.0	404.0	293.3	426.0	308.0	334.7	369.3
Line 8	352.0	330.0	226.7	432.0	328.0	332.0	333.4
Line 9	384.0	282.0	265.0	416.0	374.0	248.0	328.2
Line 10	436.0	308.0	245.0	416.0	342.0	272.0	336.5
LSD at 0.05	**42.6**	**60.5**	**90.5**	**57.1**	**83.4**	**49.9**	**65.6**

Concerning response of grains number/spike, the differences among genotypes were highly significant in both growing seasons, indicating overall differences between growth conditions. Giza132 (64.4 grains), Giza 130 (64.0 grains), Giza 131 (64.7 grains) and Line 7 (63.3 grains) produced the highest mean number of grains/spike (**Table 11**). The reduction might be due to the reduction in photosynthetic efficiency and the lack of photosynthates translocated to the developing seeds by adding irrigation might owe much to these results. According to **Ceccarelli (1987),** water deficit during the early stage of plant development induces a reduction in spikelets primordia, while water deficit late in the plant development increases death of the flower and the entire spikelet. The number of grains spike^{-1} (fertility) depends on water availability during the early vegetative phase and during shooting stage. If water deficit occurs after the flowering stage, it induces a decrease of grain weight and thus its yield. The results are supported with obtained by **Mohamed (2004), Farhat (2005), Bagheri and abad (2007), Samarah *et al.*, (2009) and Vaezi *et al.*, (2010).**

Results in **Table 12** show that genotypes exhibited highly significant differences in biological yield fed^{-1}. Line 6 and Line 7 gave the highest mean values (6885.6 and 7178.9 kg), respectively. Whereas, Giza 129 (5093.1 kg) and Line 9 (5609 kg) were the lowest genotypes. Grain yield fed^{-1} mean of the genotypes ranged from 2128.8 to 2943.7 kg fed^{-1} for Giza 129 and Line 7, respectively, with an overall average of 2556.9 kg fed^{-1} (**Table 13**). The best genotype was Giza 133, Giza 134, Line 3, Line 6 and Line 7 under the normal condition, while Giza 134, Line 6 and Line 7 were superior under water stress conditions. Under saline condition Giza 133, Giza 134 and Line 7 had good performance in both growing seasons in addition to Giza 126 in the second season. For 1000-grain weight mean, Giza

123, Giza 136 Line 4, and Line 7 gave the highest mean values (54.2, 54.1, 54.0 and 54.3 g), respectively. Whereas, Giza 129 (44.9 g) and Giza 135 (45.0 g) had the lowest mean values **(Table 14)**.

Table 11. Means of no. of grains spike^{-1} for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	**2014/2015**			**2015/2016**			**Mean**
	N	**WS**	**Sal**	**N**	**WS**	**Sal**	
Giza 123	62.0	58.0	46.0	70.0	50.0	50.0	56.0
Giza 126	76.0	68.0	44.0	52.0	54.0	48.0	57.0
Giza 132	84.0	78.7	48.0	72.0	52.0	52.0	64.4
Giza 133	73.0	69.3	38.0	56.0	46.7	46.7	54.9
Giza 134	74.0	68.0	44.0	68.0	47.3	52.0	58.9
Giza 129	76.0	68.0	54.0	70.0	50.0	54.0	62.0
Giza 130	74.0	68.0	44.0	84.0	60.0	54.0	64.0
Giza 131	74.0	68.0	54.0	76.0	56.0	60.0	64.7
Giza 135	82.0	52.0	46.0	72.0	50.0	52.0	59.0
Giza 136	74.0	62.0	58.0	66.0	46.0	48.0	59.0
Line 1	84.0	70.0	44.0	76.0	48.0	52.0	62.3
Line 2	80.0	62.0	48.0	72.0	46.0	48.0	59.3
Line 3	76.0	72.0	42.0	80.0	42.0	52.0	60.7
Line 4	76.0	68.0	51.0	68.0	44.0	54.0	60.2
Line 5	74.0	68.0	44.0	60.0	46.0	46.0	56.3
Line 6	78.0	74.0	53.3	76.0	50.0	54.0	64.2
Line 7	76.0	72.0	54.0	76.0	52.0	58.0	64.7
Line 8	74.0	68.0	42.0	62.0	54.0	48.0	58.0
Line 9	74.0	66.0	42.0	78.0	44.0	42.7	57.8
Line 10	74.0	68.0	39.0	76.0	50.0	44.0	58.5
LSD at 0.05	6.7	5.6	9.3	9.6	5.8	6.6	7.38

Table 12. Means of biological yield (kg fed^{-1}) for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	**2014/2015**			**2015/2016**			**Mean**
	N	**WS**	**Sal**	**N**	**WS**	**Sal**	
Giza 123	8143.3	7002.9	3777.7	7024.7	5894.6	5618.5	6243.6
Giza 126	8400.0	7298.7	3698.3	7838.4	5736.3	5913.6	6480.9
Giza 132	8509.7	7099.0	3672.2	9152.0	6046.1	5457.5	6656.1
Giza 133	8474.7	7614.3	4055.3	5291.8	5138.4	6032.5	6156.7
Giza 134	8424.8	6641.3	5137.2	8118.3	5759.0	5899.9	6552.3
Giza 129	6517.2	4982.3	4063.5	5325.3	4574.2	5096.0	5093.1
Giza 130	7770.0	7612.5	4678.7	8414.1	4687.9	5292.0	6409.2
Giza 131	8572.3	7356.3	4018.0	7566.1	4770.3	4996.4	6213.2
Giza 135	7095.5	6715.2	3491.6	7557.7	4654.6	4754.2	5711.5
Giza 136	6958.0	6928.5	4092.0	7489.1	5805.5	5236.0	6084.9
Line 1	7096.9	6265.8	4198.3	7588.4	7290.5	6002.5	6407.1
Line 2	7540.3	7236.3	4922.4	6593.2	5978.9	4400.2	6111.9
Line 3	8591.7	6994.6	3128.4	8745.3	6072.7	5796.7	6554.9
Line 4	7202.5	6289.4	5578.7	6472.0	5328.0	5757.5	6104.7
Line 5	7918.7	6758.2	5023.0	7376.6	5061.8	5603.4	6290.3
Line 6	9037.7	7570.7	5426.4	7492.3	6459.3	5327.1	6885.6
Line 7	10042.7	8808.7	5047.0	6895.0	6163.5	6116.3	7178.9
Line 8	9229.2	6021.9	4557.0	7270.8	5250.0	5198.2	6254.5
Line 9	6760.0	6260.1	3513.3	6973.4	5040.0	5105.9	5608.8
Line 10	8222.7	7917.5	4160.1	6734.0	4739.0	5374.9	6191.4
LSD at 0.05	**1310.6**	**993.1**	**1409.9**	**1182.3**	**973.6**	**557.2**	**1089.1**

Table 13. Means of grain yield (kg fed^{-1}) for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	**2014/2015**			**2015/2016**			**Mean**
	N	**WS**	**Sal**	**N**	**WS**	**Sal**	
Giza 123	2998.3	2916.7	1448.0	3252.7	2695.6	1957.6	2544.8
Giza 126	3066.0	3009.1	1480.0	3128.6	2834.1	2066.4	2597.4
Giza 132	3054.3	2889.8	1225.0	3544.0	2804.7	1634.3	2525.4
Giza 133	3355.3	3166.9	1812.8	3383.0	2925.5	1939.4	2763.8
Giza 134	3474.2	3238.7	2081.5	3438.8	2942.5	1812.1	2831.3
Giza 129	2538.8	2168.3	1260.0	3115.9	2201.4	1488.4	2128.8
Giza 130	2858.3	2712.5	1763.3	3080.0	2379.3	1627.5	2403.5
Giza 131	3090.1	2889.2	1732.5	3319.3	2414.8	1743.5	2531.6
Giza 135	3053.0	2254.0	1259.0	3198.8	2192.0	1270.1	2204.5
Giza 136	3150.0	2667.0	1620.0	3303.1	2793.8	1832.9	2561.1
Line 1	3090.7	2959.9	1596.8	3435.3	3125.3	2009.0	2702.8
Line 2	3073.8	3080.7	1757.0	3133.3	2441.6	1498.9	2497.5
Line 3	3458.3	3069.3	892.5	3677.3	2938.7	1652.0	2614.7
Line 4	2932.9	2747.7	1754.7	2990.0	2686.6	1657.6	2461.6
Line 5	3153.1	2683.7	1488.0	2865.3	2559.3	2100.0	2474.9
Line 6	3937.3	3325.3	1670.7	3664.1	3185.3	1646.3	2904.8
Line 7	4006.3	3467.9	1820.0	3365.7	3031.0	1971.2	2943.7
Line 8	3251.2	2346.3	1610.0	3316.9	2681.0	2324.0	2588.2
Line 9	2873.1	2350.0	1300.0	3353.0	2625.0	2126.1	2437.9
Line 10	3077.5	2683.3	1347.0	3290.0	2249.6	1876.0	2420.6
LSD at 0.05	**402.6**	**344.0**	**337.6**	**283.8**	**376.6**	**318.4**	**342.4**

Table 14. Means of 1000-grain weight (g) for the 20 studied genotypes under normal (N), water stress (WS) and saline soil (Sal) during 2014/2015 and 2015/2016 seasons.

Genotype	**2014/2015**			**2015/2016**			**Mean**
	N	**WS**	**Sal**	**N**	**WS**	**Sal**	
Giza 123	53.1	53.4	49.7	57.7	55.1	56.0	54.2
Giza 126	50.2	55.1	45.1	51.4	50.5	49.0	50.2
Giza 132	51.7	46.5	44.3	57.3	52.6	42.4	49.1
Giza 133	53.7	54.0	52.0	53.6	51.6	52.5	52.9
Giza 134	54.0	54.9	49.1	54.6	53.1	46.2	52.0
Giza 129	49.7	44.8	43.7	47.5	42.4	41.2	44.9
Giza 130	53.2	51.3	46.2	45.4	47.8	49.0	48.8
Giza 131	50.0	49.9	49.5	46.3	53.0	46.0	49.1
Giza 135	49.9	44.3	43.9	45.8	43.8	42.2	45.0
Giza 136	56.4	55.2	52.4	55.5	54.9	50.0	54.1
Line 1	56.5	52.7	47.6	50.7	52.3	52.0	52.0
Line 2	50.7	47.1	49.6	56.8	55.9	56.6	52.8
Line 3	53.7	52.2	49.8	50.4	54.4	43.1	50.6
Line 4	56.8	54.9	45.5	59.9	56.0	50.8	54.0
Line 5	51.5	49.1	47.6	52.7	49.8	51.4	50.4
Line 6	51.6	50.1	50.0	53.6	54.0	43.0	50.4
Line 7	57.7	56.2	49.9	57.3	56.8	47.9	54.3
Line 8	50.1	46.1	46.0	55.8	54.1	56.9	51.5
Line 9	58.9	56.1	51.7	58.1	51.0	44.9	53.5
Line 10	55.8	54.4	43.1	52.2	50.8	42.6	49.8
LSD at 0.05	**5.4**	**3.8**	**8.4**	**3.0**	**3.4**	**4.1**	**5.0**

The stability regression coefficient (b_i) and deviation from regression (S^2d) for the studied genotypes are presented in **Table 15**. A stable genotype is one with a high mean performance, unit regression coefficient ($b_i = 1$) and deviation from regression equal to zero **(Awad, 1997).** The predictability of genotypes for the yield ranged from 0.79 for Line 5, to 1.52 for Line 3 (**Table 15**). Based on regression coefficient (bi) values the tested genotypes divided into three groups. The first group included the most stable genotypes, Giza 123, Giza 126, Giza 133, Giza 134, Giza 129, Giza 131, Giza 135, Giza 136, Line 1, Line 2, Line 7, Line 9 and Line 10 with coefficient of regression b_i values equal to 1. The second group included the more adapted genotypes to unfavorable environments, Giza 130, Line 4, Line 5 and Line 8 (had the lowest b_i values), whereas genotypes Giza 132, Line 3 and Line 6 were input sensitive and adapted to high potential environments. This is similar to the report of **Gebremedhin (2015), Elakhdar *et al*., (2017) and Mansour *et al*., (2018).**

Table 15. Means of 20 studied genotypes and stability parameters, coefficient of regression (b_i) and deviation from regression (S^2d) for grain yield.

Genotype	Mean (Kg fed^{-1})	b_i	S^2d
Giza 123	2544.8	0.95	322.91
Giza 126	2597.4	0.91	3998.22
Giza 132	2525.4	1.23**	1532.73
Giza 133	2763.8	0.98	-1037.50
Giza 134	2831.3	0.96	6536.83
Giza 129	2128.8	0.91	6551.20
Giza 130	2403.5	0.80	2009.71
Giza 131	2531.6	0.93	2692.39
Giza 135	2204.5	1.13	7413.42
Giza 136	2561.1	0.95	-1122.93
Line 1	2702.8	0.98	5169.68
Line 2	2497.5	0.95	12134.35
Line 3	2614.7	1.52**	1980.60
Line 4	2461.6	0.81	1018.88
Line 5	2474.9	0.79	5425.42
Line 6	2904.8	1.36**	7391.54
Line 7	2943.7	1.05	1441.25
Line 8	2588.2	0.80	19352.82
Line 9	2437.9	0.90	17998.43
Line 10	2420.6	0.99	5372.13

Giza 133 and Line 7 had desired performance (grain yield) compared to the grand mean, regression coefficient (bi) did not differ significantly from unity and had low deviation from regression (S^2d) values, indicating the role of linear portion of G x E interaction in the performance of this genotype.

Cluster analysis based on environments mean yield during 2014/2015 and 2015/2016 seasons were performed (**Fig. 1**). In this analysis two main clusters were appeared. The first main cluster contained Line 6, Line 7, Giza 133 and Giza134 the most desired grain yield fed^{-1} performance. The rest genotypes were found in the second main cluster. Giza 129 and Giza 135 the lowest mean grain yield fed^{-1} genotypes were found together in the same sub-cluster. Cluster analysis has been used for description of the diversity based on similar characteristics **Subhani *et al*., (2015) and Mariey and Khedr (2017).**

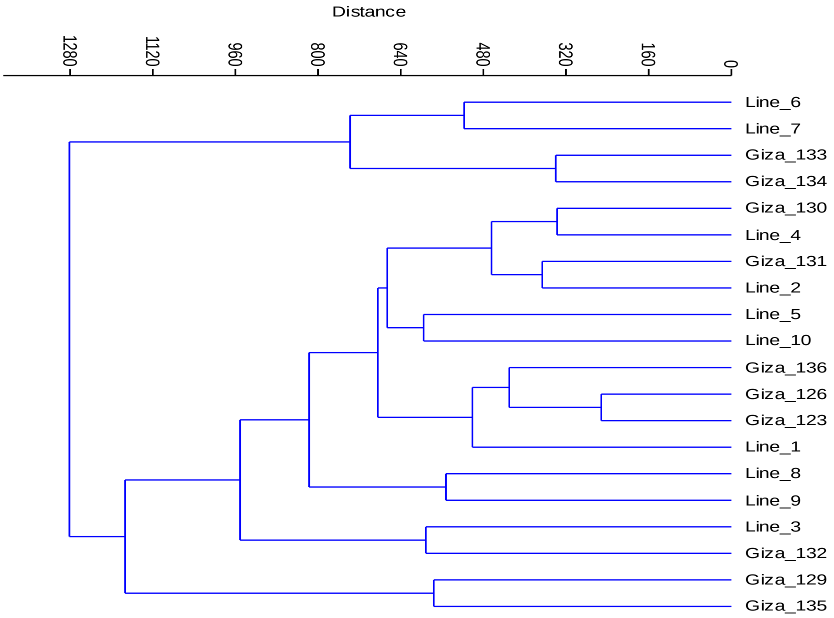

Fig. 1: Dendrogram presenting the classification of 20 barley genotypes tested at three environments (normal, water stress and saline soil) based on environments mean yield during 2014/2015 and 2015/2016 seasons.

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تحليل الثبات للمحصول ومكوناتة لتراكيب وراثية مبشرة من الشعير تحت ظروف الاجهاد المائى والاراضى المتأثرة بالاملاح

السيد السيد الشاوى – سالى المرسى على الوكيل – اشجان محمد عبدالعظيم
قسم بحوث الشعير. معهد بحوث المحاصيل الحقلية . مركز البحوث الزراعية . مصر
Corresponding author: sayedelshawy@gmail.com

يهدف هذا البحث إلى تقييم عشرين تراكيب وراثي من الشعير لتقييم أداءها في بيئات مختلفة. حيث يعتبر إنتاج تراكيب وراثية جديدة متأقلمة تحت الظروف البيئية المختلفة هو واحد من أهم أهداف برنامج التربية. تم دراسة هذة التراكيب الوراثية فى ثلاث بيئات مختلفة. ري طبيعي والإجهاد المائي والإجهاد الملحى. وقد أجريت تجارب الرى الطبيعى والاجهاد المائى فى محطة البحوث الزراعية بسخا، في حين أجريت تجربة الإجهاد الملحي بمحطة البحوث الزراعية بالحسينية خلال موسمي (2015/2014 و 2016/2015). اظهر تحليل التباين معنوية عالية لكل من البيئات والتراكيب الوراثية والتفاعل بين التراكيب الوراثية والبيئة لكل التراكيب الوراثية المدروسة، وهذا مؤشر لضرورة تحليل الثبات المحصولى. وقد أظهرت النتائج ان أفضل التراكيب الوراثية هى جيزة 133 والسلالة 7 بالنسبة لمحصول الحبوب/فدان وكانت الأكثر ثباتاً، ولم يختلف معامل الانحدار (b_i) بشكل معنوى عن الواحد الصحيح مع قيم منخفضة للانحراف القياسى (S^2d)، مما يشير إلى دور التفاعل بين التراكيب الوراثية والبيئة وتأثيره فى أداء التراكيب الوراثية تحت الدراسة. وأظهرت النتائج أن كل من التراكيب الوراثية جيزة 130 والسلالات 4 و5 و 8 كانت اقل القيم لمعامل الانحدار (b_i) وبالتالي فهى أكثر اداءاً تحت الظروف البيئية الغير ملائمة، بينما اظهرت التراكيب الوراثية جيزة 132 والسلالتان 3 و 6 اداءاً أفضل تحت الظروف الطبيعية وحساسية للاجهادات البيئية المختلفة.