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ANALYSIS OF PHENOTYPIC STABILITY FOR GRAIN YIELD AND ITS COMPONENTS IN BREAD WHEAT

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ABSTRACT

This investigation aimed to study the phenotypic stability and performance across 6 environments of twenty genotypes of grain yield and its components. Combined analysis of variance across environments indicated that, the mean squares due to (E), (G) and G x E were highly significant for all traits studied. Yield performance of each genotype showed different ranking across the studied environments at two seasons (2005 (Y1) and 2006 (Y2)) and the three locations i.e., Gemmeiza (L1), Sers El- Lian (L2) and Ettai El- Baroud (L3). Phenotypic stabilities were computed for number of days to 50% heading, and maturity , plant height, number of spikes/m^2, number of grains/spike, 1000-grain weight and grain yield (ard./fad.).

The results revealed highly significant differences among wheat genotypes (G), environments (E) and their interactions. Wheat genotypes differed in their response to the changes in environments. The most stable desired wheat genotypes were 3, 4, 6, 9, 15 and 20 for grain yield. On the other hand, the results confirmed the importance of number of spikes/m^2 in increasing grain yield in wheat that it is a major component for grain yield. Also, these genotypes showed high stable under this study and could be used in breeding programs for improving the productivity of wheat in different environments.

INTRODUCTION

Wheat (*Triticum aestiuvum* L.) is the most important and most widely cultivated cereal crop in the world. Its importance drived from many properties and uses of its kernels, which make it a stable food for more than one, third of the world population (Sabry et al 1999).

The magnitude of the environmental effects on the expression of the different genotypic characters varies, some being more highly influenced by the environment than others. The amount by which the expression of an individual character of a genotype is changed in different environments has terned its "phenotypic plasticity" by Bardshaw (1965). Consequently, the under standing of gene type environment interaction in plant breeding is a matter of great interest.

Spring wheat is successfully grow in a very large of environments. Yield stability is a measure of variation between potential and actual yield of genotype across changing environments (Blum 1980). Poor grain yields as observed in cereal crops, may be associated with stability in yield (Fischer,Maurer 1978) but the association between two characteristics that has not been adequately analyzed and under stood often a reduction in yield component which may be compensated by an increase in another (Bingham 1969). Aggarwal and Sinha (1987) reported that, the maintenance of spikes per unit land area provides an advantage to wheat crop in environments varying in soil water availability.

Stability of production in different environments is important consideration in plant breeding programs. Usually the performance of genotypes changes from environment to another. Such change is mainly due to genotype x environment interaction (GxE). Plant breeder has been long faced the problem of GxE in the development of plant cultivars. It has been suggested that a significant GxE reduces the correlation between phenotypic and genotypic values as well as the progress from selection (Comstock, Moll 1963 and Kang and Martin 1987). Finaly and Wilkinson (1963) and Eberhart and Russel (1966) used the regression of the average genotype yield on an environmental index to evaluate stability of genotypes across several environments. The latter also proposed the use of deviation from the regression as a second measure of stability. Although Eberhart and Russell"s method is the most frequently used. Kang and Miller (1984) suggested that the methods of partitioning GxE into components assignable to each genotype may be more useful to plant breeder.

Since many stability parameters are available to breeder, particular choices in most cases may be difficult to justify. Some attempts have been mad review and compare several stability parameters in use, both empirically and statistically, in studying be GEI (Becker et al,1981; Lin et al 1986; and Pham and Kang, 1988). Many investigators have assessed the phenotypic stability for yield performance in wheat genotypes (Langer et al 1979; Salem et al 1990; El Shouny et al 1990; Misra et al 1991; Mishra and Chandraker 1992; Keser et al 1996 and Hassan 1997). Also, many investigators reported significant differences among wheat cultivars in their response to the environmental conditions and hence, their grain yields (Ismail 1995; Salem et al 1990; Shehab El-Din et al 1999; Mosaad et al 2000; Shehab El-Din et al 2000; Ibrahim 2004 and Moussa et al (2006).

The objectives of this study were to identify the effects of environments and cultivars as well as environment interaction on wheat grain yield and its contributing characters under six environments representing the combination between three locations and two growing seasons and estimates the stability parameters of twenty bread wheat genotypes as well as to determine the relationships among these parameters for grain yield/fadan.

MATERIALS AND METTHODS

Six filed experiments were carried out i.e., three locations at two seasons. These locations are El-Gemmeiza – Gharbyia governorate, Sirs El – laian – Minufyia governorate and Ettai El- Baroud (El-Behera governorate) at two successive seasons at (2004/2005 and (2005/2006) to study phenotypic stability, these six field experiment were considered as a six environments. E1 and E4 for El-Gemmeiza , E2 and E5 for Sirs El Laia and E3 and E6 for Etti –E1 Baroud over two growing seasons, respectively. .The pedigree of these genotypes is shown in Table (1) . The genotypes were grown in a Randomized Complete Block Design with three replications at six environments (3 location x 2years) .Six rows , four meter) long. Distance between rows was 20 cm and distance between plants within row was 10 cm with two plants . Cultural practices were done according to recommendations

.The three guarded rows were harvested and evaluated for grain yield /fed. Data of yield components were recorded on ten guarded plants per plot .Data recorded were , number of days to heading (number of days from planting 50% of the heads protruded from the flag sheath) , number of days to maturity (number of days from planting to 50% of spike reached physiological maturity),plant height (cm) , number of spikes/ m^2 ,number of grains / spike , 1000 – grain weight (g) and grain yield (ardab/Fadan) were recorded . The analysis of variance was performed according to Gomes and Gomes (1984) – least significant differences (L.S.D) was used for comparing means . Genotypic stability analysis was computed as outlined by Eberhart and Russell (1966) .

Table (1): Pedigree, origin and number of the evaluated bread wheat genotypes.

No	Cross and Pedigree	Origin
1	Gemmeiza 7	Egypt
2	Gemmeiza 9	Egypt
3	Gemmeiza 10	Egypt
4	Sakha 93	Egypt
5	Sakha 94	Egypt
6	Giza 168	Egypt
7	PBW343 CM85836-4Y-0M-0Y-8M-0Y-01ND	Mixico
8	KAUZ/2*STAR CMBW91M3009M-0T0PY-20M010Y-010M-010Y-2Y-0M-7KBY	Mixico
9	RABE/2*MO88 CMSS92Y01634T-18Y-010M-010Y-010Y-2M-0Y	Mixico
10	KAUZ//BOW/NKT CMSS92Y02933S-20Y-015M-010Y-010Y-2M-0Y	Mixico
11	BUC/PRL//WEAVER CMSS92M00233S-015M-0Y-0Y-050M-26Y-3M-0Y	Mixico
12	PRINIA/STAR CMSS92M00579S-015M-0Y-0Y-050M-10Y-1M-0Y	Mixico
13	CHEN/AEGILOPS SQUARROSA (TAUS)//BCN/3/KAUZ CMSS93Y00868S-13Y-2KBY-010M-010Y-8M-0KBY-0M-12KBY	Mixico
14	CHOIX/STAR/3/HEI/3* CNO79//2*SERI CMSS93Y02712T-40Y-010Y-010M-010Y-7M-0Y	Mixico
15	KAUZ/PASTOR CMSS93B0025S-48Y-010M-010Y-010M-9Y-0M	Mixico
16	SITE/MO/3/VORONA/BAU//BAU CMSS93B00566S-2Y-010M-010Y-010M-9Y-0M	Mixico
17	SITE/MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC CMSS93B00567S-72Y-010M-010Y-010M-9Y-0M	Mixico
18	PYN/BAU//MILAN CMSW94WM00188S-0300M-0100Y-0100M-13Y-4M-0Y	Mixico
19	WEEBILLI CGSS95B000146T-099Y-099B-099Y-099B-35Y-0B	Mixico
20	FRET 2 CGSS96Y000146T-099B-099Y-099B-12Y-0B	Mixico

Homogeneity test of variance was computed according to Bartlett method (1937). Bartlett test of homogeneity of variances suggested to that the variance estimates for both sites and years were homogeneous , then, combined analysis was estimated .

Further more , two stability statistics were estimated i.e., (b) whereas refer to regression coefficient of the performance for each genotype under different environments on the environmental means overall genotypes and (S^2d) refers to the mean square deviation from linear regression. The significance of GxE interaction was also tested using the method given by **Eberhart and Russell (1966**) .

The ideal genotype must be characterized by three characteristics :

1. Regression coefficient should be significantly different from zero (b /o) and not significantly differed from the unity (b=1) .
2. Minimum value of the deviation from linear regression i-e , S^2d=o.
3. high yield performance within a reasonable of environmental variations

RESULTS AND DISCUSSION

Genotypic mean performance :

Breeding genotypes with wide adaptability has long been a universal goal among plant breeding. To achieve this goal, replication of breeding lines over time (year) and space (location) has become an integral part of any plant breeding program. Despite such rigorous tests and sub sequent selections, genotype x environment (G xE) interaction, i.e., failure of genotypes to perform consistently relative to each other under varying environments, remains a major problem. Standard analysis of variance procedure is useful for estimating the magnitude of G x E interaction, but it fails to provide information on the contribution of individual genotypes to G x E interaction Ghaderi et al (1980).

The Combined analysis of variance for grain yield and its components of twenty variety and /or lines were evaluated under six different environmental conditions is presented in Table (2) .

Table (2): Combined analysis of variance for all traits under study.

Source of variation	D.F.	No. of days to heading	No. of days to maturity	Plant height	No. of spikes/m^2	No. of grains/spike	1000-grain weight	Grain yield
Rep. in Enviro.	12	4.8	5.1	20.8	1240.7	6.7	2.4	4.0
Environments	5	592.1**	1491.9**	677.7**	229982.4**	890.4**	75.2**	440.5**
Genotypes	19	81.9**	49.3**	418.3**	6444.2**	237.2**	179.7**	19.8**
Env.xGenotypes	95	19.6**	15.2**	93.9**	4108.1**	116.5**	34.7**	10.6**
Error	228	3.8	3.0	13.9	878.2	6.5	2.8	3.0
Total	359							

Genotypes (G) mean squares were highly significant for all traits studied, revealing that these genotypes under study had a genetic diversity for these studied traits and great variability exist among the tested genotypes. Also, mean squares du to the tested environments were highly significant for all traits study, indicating that these traits were significantly influenced by seasonal factors .The combined analysis of variance also indicating highly significant differences for the three locations for all traits studied this reflect the wide differences between the three locations .The interaction of environment x genotypes was significant indicated that the environmental .Components (year and locations) were sufficient to obtain reliable information about the studied wheat genotype indicating that, the effect of genotypes were varied from environment to anther for all traits studied and wheat genotypes behaved differently when exposed to different environment .

Table (3): Mean values of all studied traits under the studied environments.

Varieties	Heading date						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	95.7	97.7	101.0	99.3	100.0	98.7	98.7
2	99.7	101.7	106.0	107.3	96.3	103.0	102.3
3	95.3	100.7	105.0	106.7	100.3	102.0	101.7
4	97.0	93.0	100.7	97.0	97.7	92.7	96.3
5	96.7	94.7	100.0	103.3	101.7	101.3	99.6
6	96.7	96.3	102.3	99.0	99.3	91.7	97.6
7	97.0	95.0	103.7	105.7	96.0	102.7	100.0
8	99.0	101.7	107.0	104.7	96.3	103.3	102.0
9	102.3	100.7	113.0	103.0	99.3	100.7	103.2
10	98.7	93.7	106.3	100.3	98.7	97.7	99.2
11	101.0	97.3	106.0	99.7	95.0	96.0	99.2
12	95.0	101.0	100.7	108.0	95.7	104.0	100.7
13	97.3	97.0	103.7	101.0	94.7	99.3	98.8
14	96.3	101.0	101.0	103.7	97.7	101.0	100.1
15	101.7	98.3	107.0	106.7	99.3	101.0	102.3
16	102.0	101.3	111.0	108.0	95.7	103.3	103.6
17	102.0	99.7	110.3	103.0	95.7	101.3	102.0
18	101.7	101.7	110.3	108.3	98.3	104.0	104.1
19	99.7	100.3	108.3	105.7	99.7	103.3	102.8
20	98.3	95.0	106.3	100.0	98.0	94.7	98.8
Mean	98.7	98.4	105.5	103.5	97.8	100.1	100.6
L.S.D. .05							
Gynotypes							1.3
Env.							0.7
ExG int.							3.2

Notes: E1 and E4 for Gemmeiza location
E2 and E5 for Sers El- Lian location
E3 and E6 for Ettai El- Baroud location

Significant differences that showed among genotypes for; heading date , maturity date , number of spikes /m2 , number of grains /spike , 1000 -grain weight and grain yield and their inconstant response to different environments may be suggest that it is essential to determine degree of stability for each genotype. This results was in harmony with the procedures of Shehab El-Din (1993) , Ismail (1995) , Hassan (1997) and Moussa et al (2006) which detected significant environmental effects for the yielding ability of some wheat genotypes As shown in Table (3), the mean values for heading date indicated that, the earlest mean environment were E2 (98.4 days) and E5 (97.8 days). On the other hand, the entries number 4 (96.3 days) and 5 (99.6 days) had the earliest genotypes for overall environments. For maturity date, E1 (143.0 days) and E6 (149.0days) had a minimum number of days to maturity. At the same time, gene types number, 1 (148.1 days), 7 (148.4 days) and genotype number 11 (148.4days) behave the same direction. Early maturity in wheat is a desirable attribute especially in Egypt, where it is associated with escape from pests, drought, heat and rust diseases especially stem rust and other stress injuries that occur late in the growing season. On the other hand, early maturity needed in Egypt for changing the system of crop rotation that it can be cultivate wheat as a previous crop to cotton, thus it can be increasing wheat area using this tool.

Cont. (3)

Varieties	Maturity date						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	146.0	141.0	150.0	152.0	152.3	147.3	148.1
2	149.7	145.3	159.3	161.0	153.0	154.0	153.7
3	145.0	144.0	155.3	155.0	154.0	147.3	150.1
4	147.3	142.7	152.7	154.7	152.3	147.7	149.6
5	143.0	142.3	155.0	154.0	154.3	146.7	149.2
6	144.3	143.3	153.7	151.7	153.3	146.3	148.8
7	143.3	142.0	151.0	152.7	154.3	147.3	148.4
8	145.7	140.7	157.7	160.0	152.7	154.3	151.8
9	149.0	144.0	158.0	156.7	152.3	149.0	151.5
10	146.0	139.3	156.7	147.3	148.3	145.0	147.1
11	145.3	142.7	158.3	150.7	147.0	146.3	148.4
12	143.3	144.0	158.0	160.3	148.0	151.7	150.9
13	144.3	142.7	152.0	155.0	151.7	148.7	149.1
14	144.7	144.0	156.3	157.3	154.3	154.3	151.8
15	145.7	144.7	154.3	153.7	154.0	147.3	149.9
16	147.0	143.7	155.3	154.3	151.0	152.3	150.6
17	148.7	145.0	156.7	158.0	150.3	152.3	151.8
18	148.3	144.3	155.7	158.7	152.7	152.0	151.9
19	146.3	143.3	158.0	152.0	154.0	150.0	150.6
20	148.3	140.7	157.3	151.7	153.3	143.3	149.1
Mean	146.1	143.0	155.7	154.8	152.2	149.2	150.1
L.S.D. .05							
Gynotypes							1.1
Env.							0.6
ExG int.							2.8

Dwarf or semidwarf wheat are preformed to taller ones or for their resistance to lodging. The data that resultant in Table (3) showed that, the tallest genotypes were numbers 1 and 6 (118.3 cm) whereas the shortest one was genotype number 15 (95.0cm) in the E1. For E2 and E3 the tallest genotype was also number 1 (121.7 cm) while, genotype number 15 (96.7 cm) and number 4 (93.5 cm) had a shortest ones for E2 and E3, respectively.

For E4, the tallest genotype was number 2 (117.7 cm) and the shortest one was number 10 (99.2 cm). For E5, genotype number 8 had the shortest one (88.5 cm) while, genotype number 20 resulted the tallest genotype(111.9 cm). The same direction was shown for E6, that genotype number 15 had the shortest genotype (100.2 cm) and genotype number 17 was tallest one (175.2 cm). On the other hand, E1 and E4 reported the lowest values for plant height (107.5 and 107.0 cm), respectively. Meanwhile, overall mean environmental values, showed that, genotypes number 4(100.6cm) and number 15 (98.4cm). These results could be take in consideration these last two genotypes when breeding for plant height.

Number of spikes per plant or m^2 is an important yield components in wheat because of its close relationship with grain yield. Thus, it may require special emphasis in breeding programs. As number of spikes/m^2 or per plant is a complex character and is also influenced by the environmental conditions. Thus, studies the stability of this character may useful.

The results for number of spikes/m^2 (Table,3) showed that, the highest number of spikes/m^2 were resulted in E2 (546.3) and E5 (473.0). Also, genotypes number 9 (494.9) and 14 (493.8) had the highest number of spikes/m^2 .

Cont. (3)

Varieties	Plant height						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	118.3	121.7	121.7	114.0	101.0	120.0	116.1
2	115.0	115.3	119.8	117.7	89.8	120.3	113.0
3	108.3	103.3	110.1	99.6	112.0	104.9	106.4
4	98.3	104.7	93.5	100.2	106.4	100.8	100.6
5	106.7	118.3	107.0	112.7	102.7	118.8	111.0
6	118.3	118.3	117.6	101.2	102.9	109.6	111.3
7	106.7	108.3	109.2	106.2	108.6	114.5	108.9
8	111.7	111.7	114.7	107.2	88.5	109.4	107.2
9	111.7	105.0	114.7	100.9	109.7	113.2	109.2
10	105.0	98.3	104.8	99.2	108.7	101.2	102.9
11	98.3	103.3	98.6	100.2	99.5	108.7	101.4
12	96.7	108.3	103.2	110.2	98.5	111.2	104.7
13	111.7	111.7	119.3	103.7	102.7	112.1	109.5
14	101.7	110.0	99.8	108.1	104.1	113.7	106.2
15	95.0	96.7	94.7	100.2	103.6	100.2	98.4
16	110.0	116.7	114.4	109.4	105.7	118.0	112.4
17	110.0	116.7	103.3	115.0	97.6	125.2	111.3
18	105.0	113.3	110.3	112.4	100.6	114.2	109.3
19	113.3	120.0	117.5	116.4	102.5	121.9	115.3
20	108.3	118.3	111.0	108.0	111.9	110.3	111.3
Mean	107.5	111.0	109.1	107.1	102.9	112.4	108.3
L.S.D. .05							
Gynotypes							2.5
Env.							1.3
ExG int.							6.0

The mean values of number of grains/spike which presented in Table (3), showed that, the highest number of grains/spike was detected in E3 (62.8) and E5(64.2). On the other hand, genotype numbers; 1 (66.3), 2 (65.5), 6 (62.8) and 16 (63.2) resulted the highest number of grains/spike in over all mean environments.

The data in Table (3), showed that, E2 and E5 showed the highest values for 1000-grain weight which had 51 gm for E2 and 50.5 gm for E5. At the same direction, genotype numbers; 1 (55.3 gm), 5 (54.4 gm) and 20 (52.8 gm). These genotypes had the highest 1000-grain weight.

Grain yield in wheat is the end product of large numbers of physiological and biochemical processes in the plant and therefore, is genetically complex characters. Also, mean yields effected of the seasonal variations as a major factor of the environments and their influence on changing in temperature and prevalence of pests and diseases. The results in Table (3) showed that, E3 (27.7 ard./fad.) and E5 (27.3 ard./fad.) had the highest grain yield. Meanwhile, genotypes number; 2 (25.5 ard./fad.), 3(25.8 ard./fad.), 5 (25.5 ard./fad.) and 19 (25.8 ard./fad.), these genotypes had highest grain yield all over the studied environments.

Cont. (3)

Varieties	**No. of spikes/m^2**						
	2004/2005			**2005/2006**			**Mean**
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	
1	466.7	595.0	358.0	293.3	521.7	403.3	439.7
2	491.7	568.3	375.3	356.0	488.3	488.3	461.3
3	466.7	561.7	388.0	390.7	453.3	436.7	449.5
4	415.0	561.7	389.3	431.3	483.3	466.7	457.9
5	481.7	553.3	354.0	419.3	501.7	490.0	466.7
6	496.7	590.0	350.7	412.7	473.3	440.0	460.6
7	513.3	561.7	398.0	415.3	500.0	521.7	485.0
8	516.7	533.3	400.7	348.7	523.3	493.3	469.3
9	500.0	588.3	490.7	420.7	515.0	455.0	494.9
10	508.3	591.7	382.7	447.3	473.3	433.3	472.8
11	466.7	565.0	432.7	470.7	390.0	498.3	470.6
12	516.7	581.7	418.7	446.7	408.3	513.3	480.9
13	453.3	585.0	484.7	454.0	420.0	476.7	478.9
14	516.7	545.0	431.3	524.7	453.3	491.7	493.8
15	516.7	536.7	367.3	374.0	463.3	488.3	457.7
16	441.7	546.7	345.3	380.7	445.0	450.0	434.9
17	458.3	563.3	378.7	320.0	483.3	488.3	448.7
18	483.3	556.7	407.3	362.7	516.7	515.0	473.6
19	508.3	576.7	381.3	368.7	536.7	446.7	469.7
20	441.7	523.3	364.7	397.3	409.3	396.7	422.2
Mean	483.0	564.3	395.0	401.7	473.0	469.7	464.4
L.S.D. .05							
Gynotypes							19.6
Env.							10.7
ExG int.							47.9

Cont. (3)

Varieties	No. of grains/spike						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	58.7	58.0	71.4	66.6	78.9	64.3	66.3
2	63.3	63.7	64.7	63.4	65.6	72.5	65.5
3	52.0	52.3	63.1	54.3	76.8	75.1	62.3
4	47.7	48.7	64.5	51.8	62.8	61.3	56.1
5	59.7	58.3	62.7	62.0	55.3	76.1	62.3
6	67.0	65.0	59.7	56.4	65.0	63.9	62.8
7	55.3	55.0	60.9	54.6	47.6	57.7	55.2
8	60.3	59.3	64.0	49.7	66.4	47.7	57.9
9	45.7	46.0	60.0	58.2	68.5	61.9	56.7
10	49.7	49.7	63.1	62.9	73.9	64.7	60.7
11	55.0	55.3	60.1	55.6	56.0	67.7	58.3
12	60.0	60.0	60.6	54.6	63.1	45.3	57.3
13	56.3	60.0	53.3	47.7	62.3	59.2	56.5
14	62.3	62.3	61.2	52.7	58.5	56.7	59.0
15	52.3	54.3	65.5	57.0	56.5	58.5	57.4
16	57.3	59.3	67.1	57.7	66.0	71.9	63.2
17	52.3	51.7	61.3	59.4	64.1	79.7	61.4
18	44.3	44.7	58.1	47.9	65.8	51.7	52.1
19	63.0	62.7	69.1	61.5	53.5	54.5	60.7
20	60.0	59.0	65.1	49.6	76.8	59.8	61.7
Mean	56.1	56.3	62.8	56.2	64.2	62.5	59.7
L.S.D. .05							
Gynotypes							1.7
Env.							0.9
ExG int.							4.1

Analysis of phenotypic stability:

Allard and Bradshaw (1965) classified the environmental effects into two classes, predictable and unpredictable variations. The first category includes; day length planting date, sowing rate, method of harvest, soil type and major location features. The second category includes; fluctuations in temperatures and rainfall. The interaction between genotypes x years was included in the second category while the interaction between locations and genotypes was included in the first class.

Significant variety x location or variety x treatment interactions would be suggest breeding for the specific environment. The interaction of years x genotypes, would be hard to breed certain genotypes for each year. The only solution for the latter type would be through developing stable varieties.

Cont. (3)

Varieties	1000-grain weight						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	53.7	54.0	55.2	60.5	55.2	53.3	55.3
2	52.3	53.0	50.3	50.4	53.9	51.9	52.0
3	53.3	54.0	55.0	48.8	48.7	46.5	51.1
4	44.7	45.3	44.1	46.6	50.8	48.2	46.6
5	66.0	66.3	54.2	52.9	50.6	48.4	54.4
6	58.3	58.7	54.4	48.8	47.4	44.9	52.1
7	50.0	51.0	54.4	49.6	51.3	48.8	50.8
8	50.3	51.0	52.9	51.3	48.7	46.0	50.0
9	52.3	52.3	46.9	49.3	44.5	42.0	47.9
10	49.0	49.3	46.6	47.9	46.7	43.9	47.2
11	46.0	47.0	47.0	46.4	48.2	45.5	46.7
12	49.3	50.3	47.9	50.7	52.3	48.9	49.9
13	46.3	47.3	49.4	53.5	55.4	52.3	50.7
14	48.0	48.7	47.8	50.6	50.3	48.2	48.9
15	44.0	44.7	45.8	43.0	44.9	42.5	44.2
16	47.7	49.0	45.5	46.8	47.8	45.1	47.0
17	48.3	49.0	45.1	45.5	45.7	42.7	46.1
18	47.3	51.3	45.5	43.2	52.0	48.8	48.0
19	51.0	50.0	51.0	54.5	54.5	51.9	52.2
20	46.7	47.7	45.3	58.1	61.4	57.4	52.8
Mean	50.2	51.0	49.2	49.9	50.5	47.9	49.8
L.S.D. .05							
Gynotypes							1.1
Env.							0.6
ExG int.							2.7

Cont. (3)

Varieties	Grain yield(ardab/fad.)						
	2004/2005			2005/2006			Mean
	E1	E2	E3	E4	E5	E6	
1	23.5	25.9	24.6	23.4	23.0	19.3	23.3
2	25.0	25.2	28.4	24.4	30.1	19.7	25.5
3	25.1	21.9	31.5	27.0	27.3	22.2	25.8
4	22.1	23.4	25.9	21.1	28.3	18.8	23.3
5	22.2	22.6	30.6	24.7	31.0	21.8	25.5
6	22.6	25.8	26.8	21.6	26.7	19.8	23.9
7	19.7	26.5	30.4	26.8	23.8	20.9	24.7
8	25.9	27.9	30.4	21.8	26.7	19.8	25.4
9	24.0	28.1	26.8	23.9	28.2	19.7	25.1
10	22.2	24.2	28.1	21.8	27.0	19.3	23.8
11	22.3	22.7	29.9	21.6	28.5	20.1	24.2
12	21.8	24.4	26.1	23.4	28.3	20.6	24.1
13	21.0	26.1	31.3	25.5	26.4	22.0	25.4
14	22.8	27.3	25.9	25.5	25.7	21.1	24.7
15	23.0	23.9	25.9	21.6	29.2	20.0	23.9
16	21.9	20.8	24.8	25.5	25.5	21.6	23.4
17	20.7	26.3	24.3	26.8	28.0	21.3	24.6
18	22.1	22.5	23.5	20.3	25.3	17.6	21.9
19	24.6	22.0	28.1	25.7	30.7	23.9	25.8
20	24.0	24.1	29.7	25.2	27.2	21.7	25.3
Mean	22.8	24.6	27.7	23.9	27.3	20.6	24.5
L.S.D. .05							
Gynotypes							1.1
Env.							0.6
ExG int.							2.8

The mean squares of linear regression analysis of variance for yield and yield components of twenty wheat genotypes grown under six environments are shown in Table (4) Highly significant differences among the studied genotypes were detected except for, number of spikes / m2 and grain yield (ard./ Fad.) indicating the presence of genetic variability among these genotypes in must studied traits which resulted from the irradiation of the parental genotypes. Similar finding were found by Rabie et al (1998), Salem et al (1990 and 2000), Abd-El Moneim (1998) and El-Marakby et al (2002).

Table (4): Means squares of analysis of variance for genotypes, environment and genotypes by environments interaction for all traits under study.

Source of variation	D.F	Mean squares						
		1	2	3	4	5	6	7
Total	119	17.9	27.5	56.7	4657.5	56.1	19.9	10.0
Genotypes	19	27.3**	16.4**	139.4**	2148.4	79.1**	59.9**	6.6
Env+(var*env.)	100	16.1**	29.7**	41.0**	5134.2**	51.7**	12.3	10.7**
Env.(Liner)	1	987.0**	2487.4**	1130.0**	383302.2**	1484.4**	125.0**	734.1**
V+Env.(Liner)	19	5.7	2.8	63.76**	1609.4	64.0*	10.8	2.5
Pooled Dev.	80	6.4**	5.3**	22.0**	1244.3	30.9**	11.2**	3.6**
Genotype 1	4	2.5	4.0	16.6	2414.3*	29.7**	8.6*	3.7
2	4	4.8	3.9	53.0	444.2	10.5	2.0	1.4
3	4	7.6*	2.2	21.0	144.4	23.3*	11.9**	7.1*
4	4	7.7*	2.0	24.3	1238.9	4.8	8.0*	1.7
5	4	11.0*	3.6	15.0	816.5	61.9**	44.2**	3.9
6	4	11.7*	3.3	57.6*	596.1	19.8*	28.0**	1.7
7	4	6.6	6.0*	7.6	503.4	24.0*	4.7	10.3*
8	4	3.9	6.5*	43.3*	1959.0*	66.1**	5.4*	6.7*
9	4	8.5*	1.9	34.0*	1390.7	29.6**	10.7*	3.3
10	4	6.8	11.9*	10.0	1118.2	38.3**	1.1	0.5
11	4	8.2*	10.4*	9.8	2701.3*	21.3*	0.7	2.4
12	4	20.7**	14.1**	26.8*	2042.6*	52.5**	1.9	1.0
13	4	0.9	2.1	14.8	2498.7*	29.2**	15.3**	4.7
14	4	5.2	5.6*	24.3	1660.3*	17.9*	1.6	2.8
15	4	1.7	2.5	11.9	868.5	16.0*	1.5	2.6
16	4	4.0	2.3	1.3	167.1	9.1	0.3	3.4
17	4	6.3	4.3	38.9*	1177.1	68.4**	1.5	6.3*
18	4	1.1	2.5	8.7	1271.6	16.9*	13.0**	1.8
19	4	0.6	4.2	4.8	1277.1	36.7**	4.6	5.9*
20	4	7.8*	13.0*	16.4	594.7	42.6**	58.8**	1.2
Pooled Error	228	1.2	1.0	4.6	292.7	2.1	0.9	1.0

Notes: 1= Heading dates 2- Maturity dates 3- Plant height (cm)
4- Number of spikes/m^2 5- Number of grains/spike 6- 1000-grain weight
7- Grain yield (ard./fad.)

The mean squared due to environments (E) were also significant reveling wide range of environmental effects. However significant mean squares due to environments + GXE interaction for all traits studied revealing that genotypes interacted with environments .The linear component of GXE interactions was significant and predictable for all traits studied . Results also showed that the pooled deviation from regulation for all traits studied were found to be highly significant except number of spikes/m2 indicating that, the studied wheat genotypes were differed markedly regarding their phenotypic stability for these traits . In this respect , Eberhart and Russell (1966) maintained that the most important stability parameter appeared to be the deviation from regression mean squares, where all types of gene action are to be involved in this parameter, Also, Backer et al (1982) reported that the mean square for deviation from regression was to be most appropriate criterion for measuring phenotypic stability in an agronomic, because this parameter gave the predictability of genotypic reaction to environmental conditions. The significant interaction between genotypes and environment reflected that grain yield of the tested genotypes were more sensitive to the changes in the environments Kheiralla and Ismail (1995), Mishra and Chandraker (1992), Hamada et al (2002) and Moussa et al (2006) .

The three stability parameters proposed by Eberhart and Russell (1966) i.e mean (x^-), regression coefficient (bi) and deviation from regression (s^2d:) were estimated for all traits, and presented in table (5) and will be discussed as follows:

Table (5): Mean values (x^-) and stability parameters for all traits studied, of twenty wheat genotypes

Genotypes	Heading date					Maturity date				
	x^-	b	S^2d	t_{b-1}	t_{b-0}	x^-	b	S^2d	t_{b-1}	t_{b-0}
1	98.72	0.36	1.61	-1.78	0.99	148.11	0.78	3.01	-1.05	3.78**
2	102.33	1.13	3 .59	0.36	3.14**	153.72	1.12	2.88	0.59	5.42**
3	101.67	0.99	6.37	-0.02	2.76*	150.11	1.02	1.24	0.08	4.92**
4	96.33	0.55	6.49	-1.24	1.54	149.56	0.86	0.98	-0.69	4.15**
5	99.61	0.46	9.73	-1.50	1.28	149.22	1.14	2.63	0.66	5.49**
6	97.55	0.61	10.47	-1.09	1.69	148.78	0.88	2.31	-0.60	4.23**
7	100.00	1.24	5.38	0.67	3.45**	148.44	0.91	5.02	-0.42	4.42**
8	102.00	1.10	2.69	0.27	3.05**	151.83	1.40	5.53	1.94	6.78**
9	103.17	1.36	7.28	0.98	3.76**	151.50	1.03	0.91	0.12	4.96**
10	99.22	1.09	5.56	0.25	3.02**	147.11	0.95	10.94	-0.26	4.57**
11	99.17	0.99	6.99	-0.03	2.74**	148.39	0.94	9.45	-0.28	4.56**
12	100.72	0.89	19.43	-0.29	2.48**	150.89	1.26	13.14	1.25	6.08**
13	98.83	0.98	-0.31	-0.05	2.73**	149.06	0.92	1.16	-0.38	4.45**
14	100.00	0.54	4.01	-1.28	1.49	151.83	1.11	4.58	0.54	5.37**
15	102.33	1.11	0.51	0.31	3.08**	149.94	0.86	1.51	-0.66	4.17**
16	103.55	1.62	2.76	1.71	4.49**	150.61	0.86	1.28	-0.69	4.15**
17	102.00	1.36	5.09	0.10	3.77**	151.83	0.91	3.27	-0.42	4.41**
18	104.06	1.41	-0.11	1.12	3.90**	151.94	0.98	1.54	-0.07	4.76**
19	102.83	1.13	-0.66	0.35	3.12**	150.61	0.99	3.20	-0.03	4.81**
20	98.72	1.10	6.60	0.26	3.04**	149.11	1.08	12.0	0.39	5.23**
Over all mean	100.65	0.99	5.17			150.13	1.00	4.33		

1- days to 50% heading :

Date in Table(5) showed that bi-values which ranged from 0.36 - 1.62 deviated significantly from unity for most studied genotypes exhibiting general adaptability across different environments . viz genotypes number 20,15 , 10, 8,3 and 11 had mean number of days to heading above the general mean with b_i - values closely to - unity, indicating the ability of these genotypes to respond to increments in an improved environment as the average dose . The deviation from regression mean squares (S^2d) has been termed stability index by Ebarhart and Russell (1966) .

The data indicate that S^2d values significantly differed from zero for all genotypes except genotypes number 5,20 , 15,10, 8 and 11 indicating that they could be classified as being in this connection. Backer et al (1982) ranged mean square from deviation to be the most appropriate criterion for measuring phenotypic stability in an agronomic since because this parameter measure the predictability of genotypic reaction to environments.

Cont. (5)

Genotypes	Plant height					No. of spikes/m^2				
	x^-	b	S^2d	t_{b-1}	t_{b-0}	x^-	b	S^2d	t_{b-1}	t_{b-0}
1	116.11	2.09	12.02	1.75	3.35**	439.67	1.64	2121.61	2.50*	6.42**
2	112.98	2.84	48.45	2.95**	4.55**	461.33	1.26	151.47	1.03	4.95**
3	106.38	-0.63	16.42	-2.61	-1.01	449.50	1.01	-148.30	0.06	3.98**
4	100.64	-0.41	19.69	-2.25	-0.65	457.89	0.85	946.21	-0.60	3.33**
5	111.02	1.69	10.38	1.11	2.71**	466.67	1.05	523.84	0.20	4.13**
6	111.34	1.22	52.96	0.35	1.95	460.56	1.26	303.40	1.04	4.96**
7	108.91	0.51	2.98	-0.79	0.81	585.00	0.99	210.74	-0.05	3.87**
8	107.19	2.21	38.73	1.94	3.54**	469.33	1.05	1666.31	0.21	4.13**
9	109.19	0.26	29.45	-1.18	0.42	494.95	0.75	1097.96	-0.99	2.93**
10	102.88	-0.82	5.45	-2.92	-1.32	472.78	1.05	825.48	0.21	4.13**
11	101.44	0.83	5.25	-0.27	1.33	470.56	0.60	2408.57	-1.58	2.34*
12	104.69	1.22	22.19	0.35	1.95	480.89	0.87	1749.91	-0.50	3.43**
13	109.53	1.12	10.20	0.19	1.79	478.95	0.56	2206.01	-1.72	2.20*
14	106.24	0.86	19.81	-0.22	1.38	493.78	0.40	1367.63	-2.37	1.55
15	98.39	-0.49	7.35	-0.39	-0.79	457.72	1.08	575.76	0.32	4.24**
16	112.35	1.39	-3.25	0.62	2.22*	434.89	1.10	-125.60	0.39	4.31**
17	111.32	2.42	34.33	2.28*	3.88**	448.67	1.31	884.39	1.21	5.13**
18	109.31	1.40	4.09	0.64	2.24*	473.61	1.08	978.87	0.30	4.22**
19	115.27	1.98	0.18	1.57	3.17**	469.72	1.27	984.38	1.06	4.98**
20	111.30	0.31	11.81	-1.11	0.49	422.17	0.82	302.05	-0.70	3.23**
Over all mean	108.32	1.00	17.42			464.43	0.99	951.53		

Cont. (5)

Genotypes	No. of kernels/spike					1000-grain weight				
	x^-	b	S^2d	t_{b-1}	t_{b-0}	x^-	b	S^2d	t_{b-1}	t_{b-0}
1	66.33	1.63	27.56	0.98	2.53*	55.32	0.35	7.74	-0.49	0.26
2	65.53	0.53	8.39	-0.73	0.82	51.98	0.59	1.10	-0.31	0.44
3	62.27	2.72	21.15	2.67**	4.22**	51.05	1.44	10.98	0.33	1.07
4	56.13	1.90	2.65	1.40	2.94**	46.61	-0.16	7.08	-0.87	-0.12
5	62.34	0.44	59.81	-0.87	0.67	56.41	4.54	43.31	2.64	3.39
6	62.83	0.05	17.64	-1.48	0.07	52.07	3.12	27.13	1.58	2.33
7	55.19	-0.09	21.87	-1.70	-0.15	50.85	0.28	3.78	-0.54	0.21
8	57.91	0.58	63.92	-0.65	0.90	50.04	1.05	4.46	0.04	0.78
9	56.71	1.10	27.45	1.55	3.10**	47.89	2.73	9.76	1.27	2.04
10	60.66	1.98	36.13	1.52	3.07**	47.24	1.58	0.21	0.44	1.18
11	58.28	0.72	19.20	-0.44	1.11	46.70	0.51	-0.20	-0.36	0.38
12	57.26	-0.10	50.34	-1.70	-0.15	49.91	0.84	0.96	-0.12	0.63
13	56.47	0.58	27.07	-0.65	0.90	50.70	-0.73	14.39	-1.30	-0.55
14	58.97	-0.04	15.76	-1.62	-0.07	48.92	0.41	0.72	-0.44	0.31
15	57.35	0.73	13.88	-0.42	1.13	44.16	0.50	0.62	-0.37	0.37
16	63.23	1.38	6.96	0.59	2.14*	46.98	1.24	-0.61	0.18	0.93
17	61.42	1.83	66.24	1.28	2.83**	46.06	1.81	0.61	0.61	1.36
18	52.08	1.97	14.77	1.51	3.06**	48.03	0.97	12.09	-0.03	0.72
19	60.70	-0.56	34.59	-2.42	-0.87	52.16	-0.02	3.70	-0.75	-0.01
20	61.71	1.76	40.46	1.17	2.72**	52.76	-1.06	57.90	-1.53	-0.79
Over all mean	59.67	0.99	28.79			49.79	1.00	10.29		

From the above mentioned results, it can be indicated that the most desired genotype under a wide range of environments was the genotype No. 20 (x^- = 98.72 , bi = 1.10 and s^2d = 6.60) followed by genotypes No 15 (x^-= 102.33 , bi = 1.11 and s^2d = 0.51) No. 10 (x- = 99.22 , bi = 1.09 and s^2d =5.56) , No.8 (x^- = 102, bi = 1.10 - and s^2d = 2.69) and No.11 (x^- = 99.17, bi = 0.99 and s^2d =6.99).This results are in harmony with the result obtained by Singh and Mishra (1997) .

Cont. (5)

Genotypes	Grain yield(ard./fad.)				
	$\bar{x}$	b	S^2d	t_{b-1}	t_{b-0}
1	23.27	0.51	2.53	-1.57	1.61
2	25.46	1.27	0.43	0.85	4.03**
3	25.83	1.00	6.13	-0.02	3.17**
4	23.27	1.19	0.74	0.61	3.80**
5	25.48	1.42	2.95	1.34	4.52**
6	23.88	1.00	0.67	0.01	3.20**
7	24.68	1.02	9.34	0.06	3.25**
8	25.42	1.17	5.68	0.53	3.72**
9	25.09	1.04	2.34	0.14	3.33**
10	23.78	1.21	-0.45	0.66	3.85**
11	24.18	1.40	1.41	1.26	4.44**
12	24.12	1.00	-0.03	-0.01	3.17**
13	25.37	1.15	3.67	0.47	3.65**
14	24.71	0.64	1.79	-1.14	2.04*
15	23.93	1.08	1.61	0.24	3.42**
16	23.35	0.50	2.39	-1.59	1.60
17	24.56	0.74	5.27	-0.83	2.36*
18	21.87	0.88	0.83	-0.38	2.81*
19	25.84	0.83	4.91	-0.54	2.64*
20	25.32	0.97	0.19	-0.09	3.09**
Over all mean	24.47	0.99	2.63		

2-Maturitiy date .

The results of stability parameters for number of days to maturity in Table (5) revealed that, the studied genotypes had significant (bi) values. Meanwhile, significant s^2d values were detected for all genotypes . Considering all stability parameters, the most desired and stable genotypes were the genotypes numbers 8 , 14 , 20, 19 and 18 since it had high mean performance and low s^2d) .

3-Plant height :

Data in Table (5) show that (bi) were significant for most studied traits except genotypes No.3 , 4 , 6 , 7 , 10, 11, 12, 13, 14, 15 and 20 Also, s^2d values showed significant except genotype No.19 and the most desired genotypes No.11 ($\bar{x}$ = 101.44 , bi = 0.83 and s^2d = 5.25 No.14 ($\bar{x}$ = 06.24 , bi = 0.86 and s^2d = 19.80), No 13 ($\bar{x}$ = 109.53 bi= 1.12 and s^2d = 10.20) and genotype No.12 ($\bar{x}$= 104.688 , bi = 1.22 and s^2d = 22.19) . Similar results were obtained by Singh and Mishra .(1997) .

4- Number of spikes /m2 .

As shown in Table (5) the (bi) values were significant for all genotypes except genotype number 14 whereas (s^2d) values were significant for all genotypes indicating the importance of (S^2d) parameter in measuring the stability of performance of wheat genotypes . The most desired and stable genotypes were the genotypes No.15 , 5 , 10 , 18 , 7.which had a high mean performance and law (S^2d) .

5- Number of kernels / spike .

Data in Table (5) show that both (bi) and (S^2d) values for this traits were not significant for must genotypes except for; genotype number 1 , 3, 4 , 9 , 10 , 16, 17 , 18 and 20 in which (bi) values were significant where the other genotypes were being stable considering all three stability parameters, The most desired genotypes were 11,15 and 16 that they had high mean performance and low (S^2d) values .

6- 1000 - grain weight :

Data in Table (5) show that (bi) values for this trait were not significant for all genotypes except genotypes No 5,6 and 9 in which (bi) ranged from 2.72 - 4.540 and had high mean performance and low (S^2d) values . There fore, genotypes 12 , 8 and 18 were considered as high stable genotypes for this trait .

7- Grain yield ard. / fad) .

As shown in Table (5) regression coefficient (bi) values were significant for all studied genotypes indicating that, the studied genotypes were not adapted to the most environments, Meanwhile (S^2d) values were significant for all studied genotypes except genotype number 20 .Considering the three stability parameters, the most desired genotypes were the genotypes numbers 6, 4 , 3 , 20 , 9 and 15 since it exhibit relative high grain yield /fad and had smallest in significant (S^2d) in this respect Simane et al (1993) reported adaptability and above average of stability for some wheat genotypes concerning number of days to 50% heading, plant height, number of spikes / m2 and grain yield / plant. Also, the results indicated that the relatively unpredictable component (deviation from linear response) of GXE interaction may be more important than the relatively predictable component (linear response) for grain yield / fad .

In conclusion , the results of the comparative stability parameters indicated that the genotypes numbers 15 , 18, 8 , 14 and 20 may be the most stable genotype . The stability statistics used in the present study may lead to a more simplified description of the interaction and in addition to trait means, proved useful . information to breeders for the selection of superior and stable genotypes .

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تحليل الثبات المظهري للمحصول ومكوناته لقمح الخبز

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البرنامج القومي لبحوث القمح ، معهد بحوث المحاصيل الحقلية ، مركز البحوث الزراعية ، جيزة ،

أجريت هذه التجربة فى ستة بيئات مختلفة تشمل ثلاث مناطق هى الجميزة وسرس الليان وايتاى البارود فى موسمين زراعيين هما ٢٠٠٥/٢٠٠٤ و ٢٠٠٦/٢٠٠٥ لتقييم سلوك ودراسة الثبات المظهري لعدد عشرون صنف وسلالة من قمح الخبز. وقد تم تقدير مكونات التباين للتراكيب الوراثية وتفاعلاتها مع البيئة وكذلك الثبات المظهري لصفات عدد الأيام حتى طرد ٥٠% من السنابل وتاريخ النضج وارتفاع النبات وعدد السنابل فى المتر المربع وعدد الحبوب فى السنبلة ووزن الألف حبه ومحصول الحبوب (أردب/فدان).

ويمكن تلخيص النتائج المتحصل عليها كما يلى:

- أشارت النتائج الى وجود اختلافات معنوية للتراكيب الوراثية والبيئات وكذلك تفاعلاتها لجميع الصفات المدروسة مما يوضح أن مكونات البيئة (السنوات والمواقع) غير كافية لتقييم التراكيب الوراثية لهذه الصفات.
- أظهرت معنوية التفاعل بين التراكيب الوراثية x البيئة (الخطى) لجميع الصفات تحت الدراسة اختلاف التراكيب الوراثية فى استجابتها للتغيرات فى البيئة.
- تعتبر التراكيب الوراثية ٣، ٤، ٦، ٩، ١٥ و٢٠ هى الأكثر ثباتا وقبولا لصفة المحصول ويمكن الاستفادة منها عند تقييم برنامج للتربية فى قمح الخبز.