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STABILITY PARAMETERS FOR SOYBEAN GENOTYPES AS CRITERIA FOR RESPONSE TO ENVIRONMENTAL CONDITIONS

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ABSTRACT: ***This investigation was carried out at Sakha, Zarzoura, Mallawy and Shandaweel Research Stations during the two successive seasons 1999 and 2000. Three soybean genotypes along with five cultivars were used to evaluate phenotypic and genotypic stability for these genotypes across locations and years. The combined analysis of seed yield over locations suggested that some varieties were more stable in yield performance than others.***

It can be concluded that, three genotypes namely: Giza 35, H_2L_{12} and Giza 111 had a high seed yield performance and high stability at phenotypic and genotypic levels and it could be grown over wide range of environments. The estimates of phenotypic correlation coefficients indicated that seed yield (ton/feddan) was highly significant positive corrletated with number of pods and seed yield/plant, hence seed yield by it self may not be the best criteria for selection.

Key Words: Soybean , Genotypic stability, Breeding, Phenotypic stability.

INTRODUCTION

Soybean (Glycine max L. Merr) is one of the most improtant crops that has the potential to provide the world's increasing demand for food and forage. In Egypt, soybean acreage and production declined dramatically in the last five years (1996-2000) as a result of sever competition with corn , rice and cotton for arable land. Therefore, developing high yielding early maturing varieties under a wide rang of locations and years is of vital importance to increase soybean area and production.

Yield trials over sites and years are an integral part of any plant breeding program and are used to evaluate yield potential, adaptability, and stability of selected lines.

Stability in performance in one of the most desirable properties of a genotype to be released as a variety for wide cultivation. The genotypic stability for yield is predominant important in soybean especially when genotypes are tested over series of locations and years. Comstock and Moll (1963) suggested the plant breeder, who seeks high performing genotypes, may direct his program towards the development of cultivars that perform well in a broad spectrum of environments (small genotype x environment interaction) or cultivars that are adapted to specific environments (large genotype x environment intreaction).

Finlay and wilkinson (1963) stated that the regression coefficient of varietal means on environmental means could be used as indicator for phenotypic stability. Allard and Bradshow (1964) indicated that most of the best genotype is the one that has consistently high performance over several environments. Genotype x environment intreaction plays a significant role in the phenotypic performance of a variety and in the success of any breeding programes for the development of genetic stocks adapted to wide range geographical areas. Eberhart and Russell (1966) suggested that the regression of varietal mean performance on an enviroment index and the deviation from regression could be used as parameters for measuring the varietal phenotypic stability. The lack significance of genotype x location or genotype x year interaction indicate that neither locations nor years had any consistent effect on differential genotypic responses. Radi et al (1993) evaluated five soybean genotypes under different locations and years. Results revealed that seed yield was remarkably affected by varying locations and years. The ratio between linear and non-linear response was found to be high reflecting a considerable role of the linear response in stability reactions. Deka and Talukdar (1997) studied the stability behaviour of twenty one soybean germplasm collections under five different environments. The results indicated that some genotypes showed average stability for seed yield, whereas one genotype had above average stability. Bakheit (2000) evaluated fifteen soybean genotypes during three successive seasons. Data confirmed the fact that high yielding genotypes, more likely to have lower stability and vice versa low yielding genotypes tend to have high stability at different environments. Therefore, yield by itself may not be the best criterion for selection. To facilitate breeding for high yield it is logical to examine the primary yield components, viz. number of pods/plant, seed yield/plant and seed size. Ansari (1990) suggested that positive correlation between seed yield/plant and pods/plant. Meanwhile, Hassan and Ibrahim (1993) reported that positive and significant phenotypic correlation between seed yield/plant and each of number of pods/plant and seed index which were considered the major contributing components to seed yield variation. Singh et al (1994) reported that seed yield/plant showed high positive association with biological yield/plant, number of pods/plant and harvest index. Days to 50% flowering showed high positive correlation with plant height and seed index. Number of pods/plant had a strong correlation with plant height. On the other hand, number of pods/plant gave a negative association with seed index.

The present study aimed at a) determine the nature of genotype x environment interactions and to estimate the phenotypic and genotypic stability parameters to identify the stable soybean genotypes for seed yield under different environments and b) to estimate phenotypic correlation coefficient between yield and its important components.

MATERIALS AND METHODS

Three soybean genotypes (H_2L_{12}, H_2L_{24} and $H_{15}L_{17}$) as well as five released cultivars (Giza 21, Giza 35, Giza 83, Giza 111, and Crawford) were evaluated at Sakha and Zarzoura (North Delta), Mallawy (Middle Egypt) and Shandaweel (Upper Egypt) Research stations, A.R.C. during the two successive seasons 1999 and 2000. The pedigree, maturity group, days to maturity and origin of these genotypes are shown in Table 1.

The randomized complete block design with four replications was used. Each plot consisted of six ridges, 60 cm apart and four meter long. The recommended cultural practices for soybean production were applied. At harvest ten guarded plant were taken at random from the central ridges of each experimental plots. Plant height, days to flowering and maturity, number of pods per plant, weight of seeds per plant, 100- seed weight and seed yield (ton/feddan) were estimated.

Table (1):Maturity group, days to maturity and pedigree of the soybean genotypes.

Genotype	Pedigree	Maturity Group	Days to maturity
$H_2 L_{12}$	Crawford x celest	IV	115-120
$H_2 L_{24}$	Crawford x celest	IV	115-120
Giza 35	Crawford x celest	III	105-110
Giza 111	Crawford x celest	IV	115-120
$H_{15} L_{17}$	Crawford x D79-10426	IV	115-120
Giza 83	(union x L76-0038) (MBB 80-133)	II	95-100
Crawford	Williams x columbus	IV	125-130
Giza 21	Crawford x celest	IV	120-125

The combined analysis of varince over years and locations was applied as mentioned by Snedecor and Cochron (1969) to estimate the main effects of years, locations, genotypes and their interactions. Phenotypic stability parameters for seed yield were estimated using the statistical procedures developed by Eberhart and Russell (1966). Moreover, the genotypic stability analysis was computed according to Tai (1971) who suggested partitioning the genotype-environment interaction effect of the genotype into two statistics parameters namely α and λ measure linear response to environmental effects and the deviation from linear, respectively.

The phenotypic correlation coefficient between seed yield (ton/feddan) and some its components were calculated using the formula developed by Burton (1952).

RESULTS AND DISCUSSION

Stability analysis:

Mean performance of genoypes, locations and its interaction over two seasons within four locations for seed yield (ton/feddan) are presented in Table 2.

The results indicated that seed yield ranged from 1.425 t/fed. in Shandaweel during 2000 season to 1.937 t/fed in Mallawy during 1999 season with significant differences between them. Significant differences were also detected among the tested genotypes in their response. Over all locations, Giza 35 followed by the two genotypes Giza 111 and H_2L_{12} recorded the highest seed yield with an average of 1.764, 1.749 and 1.745 t/fed., respectively. On the other hand, the genotype Giza 83 gave the lowest seed yield (1.448 t/fed.). These remarkable differences may indicate that the genotypes were subjected to a wide range of environmental conditions under the present investigation.

The combined analysis of variance for stability of the studied soybean genotypes at the eight environments (4 locations x 2 years) are presented in Table 3. Highly significant differences were detected among the tested genotypes, indicated that the presence of genetic variability among the studied genotypes. The lack significant of genotype x location interactions indicated that some varieties were more stable in yield performance than others over environments.

These findings agreed with those obtained by Eberhart and Russell (1966). Data are presented in Table 2 indicated that the most stable genotypes for seed yield were $H_2 L_{12}$ and Giza 111. Meanwhile, the unstable genotypes were H_2L_{24} and Giza 21.

The environmental conditions plays an important role in the final phenotypic and genotypic expression of any character, therefore it is imperative that different genotypes are tested under different environments (locations or years) to evaluate their real potential and stability performance. Finlay and Wikinson (1963) suggested that the regression of the phenotypic values in different environments on the means of the different environments will given an indication of the phenotypic stability of the particular variety. When this associated with high yield, genotypes have general adaptability; when associated with low mean yield genotypes are poorly adapted to all environments. Different phenotypic stability parameters (b and s^2d) measured by Eberhart and Russell (1966) for various genotypes at different environments are presented in Table 4. With respect to the mean performance of Giza 35 followed by Giza 111, H_2L_{12} and Giza 21 had highly mean values, wherese two genotypes: Giza 83 and Crawford had low mean

Table (2) Mean performance of genotypes under different environments and its interactions for seed yield (ton/fed).

Genotype	Zarzoura		Sakha		Mallawy		Shandaweel		Mean
	99	2000	99	2000	99	2000	99	2000	
H_2L_{12}	1.810	1.593	1.771	1.973	1.984	1.800	1.504	1.523	1.745**
H_2L_{24}	1.655	1.373	1.491	1.797	1.990	1.697	1.444	1.361	1.601
Giza 35	1.813	1.549	1.922	1.891	2.019	1.789	1.606	1.528	1.764**
Giza 111	1.832	1.548	1.760	1.854	2.060	1.779	1.569	1.587	1.749**
$H_{15}L_{17}$	1.762	1.553	1.615	1.805	1.920	1.733	1.530	1.454	1.672**
Giza 83	1.608	1.386	1.588	1.610	1.720	1.357	1.111	1.204	1.448
Crawford	1.707	1.422	1.695	1.843	1.833	1.501	1.313	1.242	1.573
Giza 21	1.793	1.559	1.870	1.884	1.970	1.780	1.255	1.503	1.702**
Mean	1.748	1.498	1.714	1.832	1.937	1.679	1.416	1.425	

L.S.D at %1 0.051
%5 0.043

values over all environments. These results indicated that yield potential of Giza 83 and Crawford not adapted to these regions.

Table (3) Combined analysis of variance for stability of seed yield (ton/fed).

Source of variation	D .F	M .S
Total	63	0.0475
Varieties	7	0.0958**
Env + (var x Env)	56	0.04148**
Env. (Linear)	1	2 .0507**
Var x Env (linear)	7	0.0047
Pooled Deviation	48	0.0050*
H_2L_{12}	6	0.00117*
H_2L_{24}	6	0.00964**
Giza 35	6	0.00380**
Giza 111	6	0.00243
$H_{15}L_{17}$	6	0.00286*
Giza 83	6	0.00716**
Crawford	6	0.00424**
Giza 21	6	0.00853**
Poold Error	129	0.00300

** significant at 0.05 and 0.01 levels .

With regard to estimates of phenotypic stability parameters (Table 4), all genotypes had regression coefficient estimates did not differ significantly from unit (b=1) but it differed significantly from zero (b=0). However, the ideal variety is one with a high mean performance, unit regression coefficient (b=1) and the deviation from regression close to be zero as possible as (S^2d = 0). According to these assumptions, it can be generally concluded that three genotypes: Giza 35, Giza 111 and H_2L_{12} exhibited regression coefficients equal to units, low values of S^2d, high mean yield and were characterized by general and specific stability for high performance. This indicated that soybean breeders should consider environmental conditions and general stability as a criteria for selecting high yielding genotypes.

On the other hand, estimates of genotypic stability parameters (α and λ) were calculated according to Tai's method using the combined analysis of variance over locations and years. According to Tai's theroy, the above average stable variety should have an estimates of α= -1.0 and λ= 1.0, while a variety that has only average stable might have an estimates of α= 0.0 and λ= 1.0. The estimates of genotypic stability parameters and means for all tested genotypes are presented in Table 4.

The genotypes distributed according to their values of α and λ as shown in Figure 1. Data revealed that the estimated of αi did not differ significantly from zero for all genotypes indicating their stability to the predictable environments. Significant genotype-environment interactions were also detected by Comstock and Moll (1963)., Allard and Bradshow (1964), Eberhart and Russell (1966) and Radi et al (1993).

The distribution of genotypes according to their values of αi and λi (Fig. 1) showed that all genotypes were unstable with respect to unpredictable variations. Three genotypes: H_2L_{12}, Giza 35 and Giza 111 were the nearest to the average stability, however, they ranked the third, first and second in yield, respectively. According to the interpretation of Tai (1971), these results may indicate that the relative unpredictable component of variance (the deviation from the linear response) of genotype x environment interaction may be more important than the relative predictable component (the coefficient of the linear response). These results suggested that the best performing high yielding genotypes were not necessarily the best stable ones.

Correlation among seed yield and its components:

The estimates of phenotypic correlations for seed yield (t/fed.) and some of its variables are presented in (Table 5).

Seed yield (ton/feddan) was highly significant positive correlated with number of pods and seed yield/plant. Moreover, seed yield/plant was highly significant with positive expression correlated with number of pods/plant. 100-seed weight (seed index) had highly significant positive correletion with seed yield/plant. However, the rest characters had negatively correlations estimates. Therefore, the breeder should use special breeding programmes to break linkages among these characters.

Similar results were reported by Ansari (1990), Hassan and Ibrahim (1993) and Singh et al (1994).

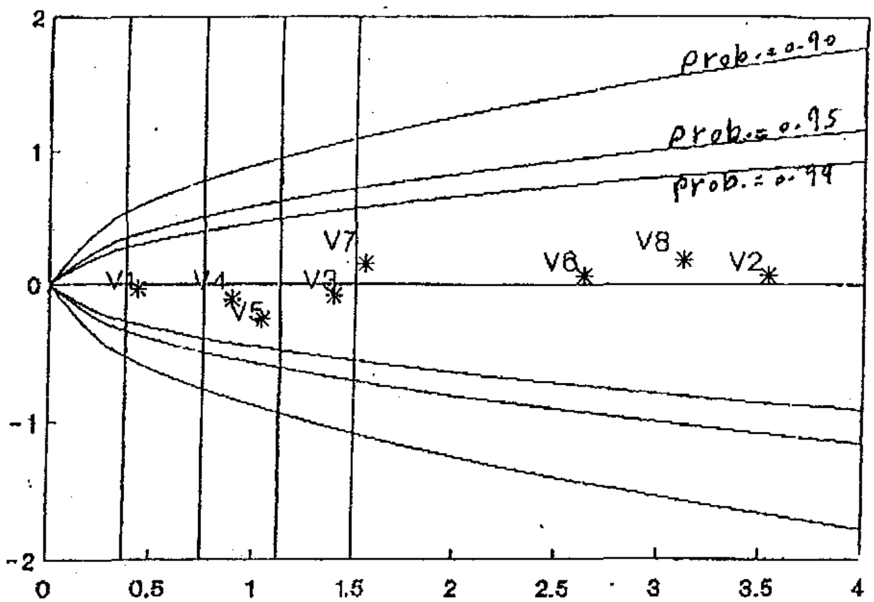

Fig (1) Distribution of stability statistics of some soybean varieties

<u>Finally, it can be concluded that:</u>

1- Genotype x environment interactions play a significant role in the success of any breeding programmes for development of genetic stocks adapted to wide range of environments.
2- Three genotypes namely, Giza 35, H_2L_{12} and Giza 111 had a high mean performance and high stability at phenotypic and genotypic levels and it could be grown over wide range of environments.
3- The highest performance genotype was not necessarily has the highest stable genotype.
4- Seed yield by itself may not be the best criteria for selection.

Table (4) Phenotypic and genotypic stability parameters of soybean genotypes for soybean seed yield.

Genotypes	Stability parameters							Degree of stability		
	X	α	λ	b	S^2d	$t_b=0$	$t_b=1$	0.99	0.95	0.90
H_2L_{12}	1.745	0.0327	0.4297	0.9678	0.0018	537.66**	-17.88**	++	++	++
H_2L_{24}	1.601	0.0658	3.5311	1.0647	0.0067**	158.91**	9.65**		+	+
Giza 35	1.764	0.0889	1.3903	0.9126	0.0008	1140.75**	-109.25**		+	+
Giza 111	1.749	0.1183	0.8850	0.8837	0.0005	1767.4**	-232.6**		+	+
$H_{15}L_{17}$	1.672	0.2167	1.0350	0.7870	0.0001	7870.0**	-2130**		+	+
Giza 83	1.448	0.0593	2.6237	1.0583	0.0042*	13.88**	13.88**		+	+
Crawford	1.573	0.1499	1.5469	1.1474	0.0013	882.61**	113.38**		+	+
Giza 21	1.702	0.1816	3.1154	1.1786	0.0056**	210.46**	31.89**		+	+

Table (5) Simple correlation coefficient between (Y) seed yield (ton/fed.) and some different soybean variables.

	Y	X1	X2	X3	X4	X5	X6
Y	1.00000						
X_1	0.72782**	1.000					
X_2	0.22794**	39263**	1.0000				
X_3	- 30867**	- 11727*	- 30763**	1.0000			
X_4	- 35708**	- 34420*	- 17880**	- 02770	1.0000		
X_5	- 42441**	- 44233*	- 12203*	- 11861*	- 69289**	1.0000	
X_6	- 02423	- 13466**	- 01150	- 26170**	- 04058	- 25207**	1.0000

Crittical value (1-tail 0.05) = + or - 10307
" " (2-tail 0.05) = +/ - 12263

X_1	No. of pods/plant	X_2	Seed weight/plant (gm)
X_3	100-seed weight (gm)	X_4	Days to 50% flowering
X_5	Days to 95% maturity	X_6	Plant height cm.

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معالم الثبات لبعض التراكيب الوراثية من فول الصويا كمدلول لإستجابتها للظروف البيئية

خير الدين على الأصيلى ، سند رياض صليب ، سعيد حليم منصور ، محمد سيد على

قسم بحوث المحاصيل البقولية ــ معهد بحوث المحاصيل الحقلية ــ مركز البحوث الزراعية ــ الجيزة

الملخص العربـــى

أجـــريت هـــذه الدراسة بمحطات البحوث الزراعية بكل من سخا، زرزورة، ملوى، شندويل ــ مركـــز البحوث الزراعية خلال موسمى الزراعة ١٩٩٩، ٢٠٠٠م. وقد أستخدمت ثمانى تراكيب وراثية من فول الصويا مختلفة من حيث الأصل الوراثى ومجاميع النضج. أظهرت نتائج الدراسة تفاوت سلوك الـــتراكيب الوراثية جيزة ٣٥، هــ٢ع١٢ وجيزة ١١١ ثباتاً على المستويين المظهرى والوراثى بالإضافة لـــتفوقهم فى المحصول مما يشير إلى نجاح زراعة هذه التراكيب تحت ظروف بيئية متباعدة. وبالنسبة لمعـــامل الأرتـــباط المظهـــرى فقد أظهرت النتائج أن هناك إرتباط عالى المعنوية موجب بين المحصول (بـــالطن/فـــدان) وكـــل من عدد القرون ومحصول البذور/نبات مما يؤكد أهمية عدم الإعتماد على صفة محصول البذور فقط عند إجراء الإنتخاب.