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ESTIMATION OF PHENOTYPIC AND GENOTYPIC STABILITY OF SOME FABA BEAN GENOTYPES .

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ABSTRACT

Two field experiments were carried out to evaluate and estimate the stability of fifteen faba bean genotypes at two different locations; Sids Research Station in upper Egypt and Sakha Research Station in Lower Egypt, during the two growing seasons 2009/2010 and 2010/2011 in three dates 15 October, 1st November, and 15 November.

A split plot design with three replications in a randomized complete block arrangement was used in both locations. Planting dates were randomly arranged to the main plot, while the fifteen faba bean genotypes were distributed in the sub plots.

Statistical analysis for split plot design was separately carried out for each year as well as combined analysis over two years in each location and the combined data of the two experiments in the two locations were performed .

The data were analyzed by Eberhart and Russell (1966) and Tai (1971) procedures to estimate phenotypic and genotypic stability parameters for seed yield .

The results could be summarized as follows :

1- The results indicated that there was wide range for the environmental index (-2.59 to +4.02) which indicates that there was differences among the different environmental condition .

2- Highly significant environment (linear) mean squares indicating that environments differ in their effect on different genotypes.

3- The analysis of genotypic stability indicated that both of the linear regression variance and the deviation variances from linearity (non-linear) were highly significant where the main component of the stability differences was due to the linear regression by 92.3 % from the total variance

4- Highest yield /fed was given by genotype Sakha 3 being 10.38 ardab/fed followed by genotypes H 943 , Giza 3 and Sakha 1 that produced 10.29 , 9.83 and 9.77 ardab/fed. respectively.

5- Eberhart and Russell method showed that genotypes Sakha 3 , Misr 1 , Nubaria 1 and Giza 2 had phenotypic stability and stable performance in the environments which had b_i not significant different from unit and insignificant deviation from linearity .

6- Tai's parameter α and λ showed that genotypes Giza 40 and Giza 2 exhibited above average stability ($\alpha < 0$ and $\lambda \approx 1$) while , the genotypes Sakha 3 and Misr 1 had a degree of below average stability ($\alpha > 0$ and $\lambda = 1$) .

INTRODUCTION

Faba bean (*Vicia faba* L.) is the most important food legume crop in Egypt. It is very important as a source of plant protein and play a good role in farming systems as a break crop in intensive cereals systems. The planted area in Egypt was about 0.20 million fed. with an average productivity of 8.98 ardab/ fed. during the last five years (2005-2010)*.

* Source: Annual Report Food Legumes, Egypt, 2010.

There is need to improve productivity and total production to meet the increasing demand for faba bean in Egypt. This could be achieved through enhancing crop breeding and agronomy research.

The genus Vicia is one of the largest genera in the family (leguminosae) and more than 170 species are belong to this genus. They are categorized into four sections: Caracca, Ervum, Euvicia (Vicia) and faba (Yamamoto, 1973), depending upon their morphological characteristics and evolutionary status.

The development of cultivars or varieties, which can be adapted to a wide range of diverse environment, is the ultimate goal of plant breeders in a crop improvement program. Genotype x environment interaction is of major importance for the faba bean breeder because phenotypic response to a change in the environment is different among genotypes. Several techniques have been proposed to characterize the stability of yield performance when the genotypes are tested at a number of environments. Allard and Bradshaw (1964) discussed the relationship between genotype x environment interaction. Eberhart and Russell (1966) reported that regression of the mean performance of a genotype on an environmental index and the deviation from regression are two parameters to measure phenotypic stability of the tested genotypes. Another statistical procedure was described by Tai (1971) who suggested partitioning the genotype x environment interaction into two components namely: α statistic that measures the linear response to environmental effects and λ that measures the deviation from linear response in terms of magnitude of error variance.

Omar *et al.* (1999) cleared that combined analysis revealed significance of pooled deviation of genotypes, environment and its interaction. El-Hosary *et al.*, (2006) in their study on faba bean, reported that genotype, environment and genotype x environment interaction mean squares were highly significant. The methods that provide a stability-variance parameter assignable to each genotype should be useful to the breeders.

Corte *et al.* (2002) reported that adaptability and phenotypic stability estimates showed that there was generally wide adaptability and stable performance of the cultivars and lines in the environments. The current study aimed to explore the reliability of some stability statistics for evaluating fifteen faba bean genotypes grown in different environments.

MATERIALS AND METHODS

Two field experiments were carried out to evaluate and estimate the stability of fifteen faba bean genotypes at two different locations; Sids Research Station in Upper Egypt and Sakha Research Station in Lower Egypt, during the two growing seasons 2009/2010 and 2010/2011 in three dates 15 October, 1st November, and 15 November.

A split plot design with three replications in a randomized complete block arrangement was used in both locations. Planting dates were randomly arranged to the main plots, while the fifteen faba bean genotypes were distributed in the sub plots. Code number and pedigree of the studied genotypes are presented in table (1).

Table (1): Code and pedigree of the studied faba bean genotypes.

Code No.	Genotypes	Pedigree
1	Giza 3	Giza 1 x Dutch 29
2	Sakha 1	Giza 716 x 620/283/85
3	Sakha 2	Line x 952/1265 derived from (Reina blanco x 461/845/83)
4	Sakha 3	Promising line 716/402/2001 derived from cross 716 (Giza 461 x503/453/83)
5	Nubaria 1	(Reina blanca) introduced from Spain
6	Giza 843	Cross 461 x Cross 561
7	Giza 716	461/842/83 x 503/453/83
8	Misr 1	Derived from (Giza 3 x 123A/45/76) x (62/1570/66/G.2) x (Romi x Habashi)
9	Giza 429	An individual plant selection from Giza 402
10	Giza 40	An individual plant selection from Rebaya 40
11	H 943	Giza 3 x 461 / 837A /83
12	Misr 3	Line 667 x (Cairo 241 x Giza 461)
13	Nubaria 2	ILB 1550 x Radiation 2095 / 76
14	Nubaria 3	Land race
15	Giza 2	An individual plant selection from local genotypes

The experimental plot consisted of four ridges, 60cm apart and 3 meters long (7.2m2. size). Seeds were planted on both sides of the ridge, in double seeded hills, 25cm apart. All cultural practices were done as recommended for faba bean yield trial packages. Two central ridges of each plot (3.6m2) were harvested to estimate seed yield (ard/fed) and other agronomic traits.

Statistical analysis for split plot design was separately carried out for each year as well as combined analysis over two years in each location and the combined data of the two experiments in the two locations were performed according to Gomez and Gomez (1984) to asses the phenotypic and genotypic stability .

Two stability techniques were used for comparing faba bean genotypes as follows :

1- Eberhart and Russell (1966) to determine phenotypic stability .

2- Tai (1971) for estimating genotypic stability .

RESULTS AND DISCUSSION

Estimates of stability parameters for seed yield of the genotypes under twelve different environmental conditions .

The data shown in (Table 2) indicated that the mean seed yield ardb/fed. of fifteen faba bean genotypes varied among the environment with a range from 6.77 ardab/fed for the environment 9 ($L_1Y_2D_3$) to 13.38 ardab/fed for the environment ($L_2Y_1D_1$) .

The wide range of environment index (I) for seed yield (-2.59 to +4.02) indicated significant variation between the environments .

The environmental index covered a wide range and displayed a good distribution within the range .

Table (2): Means ($\bar{X}$) and environmental indices (I) for seed yield / ardab / fed of twelve environments .

Environments	Giza 3		Sakha 1		Sakha 2		Sakha 3		Nubaria 1		Giza 843		Giza 716		Misr 1	
	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I
$L_1Y_1D_1$	9.21	-0.55	9.48	-0.36	8.23	-1.03	9.15	-1.23	7.47	-1.70	9.37	0.13	9.09	-0.37	8.08	-0.79
$L_1Y_1D_2$	10.31	0.55	10.88	1.04	9.52	0.26	10.85	0.47	8.38	-0.79	10.26	1.02	10.16	0.70	8.31	-0.55
$L_1Y_1D_3$	7.55	-2.22	8.86	-0.97	6.99	-2.27	8.35	-2.03	7.18	-1.99	7.80	-1.45	7.04	-2.42	6.78	-2.09
$L_2Y_1D_1$	13.81	4.04	13.01	3.18	12.12	2.85	14.97	4.59	14.05	4.88	12.01	2.77	13.11	3.65	12.91	4.04
$L_2Y_1D_2$	10.87	1.11	10.13	0.29	10.05	0.79	11.95	1.57	12.46	3.29	11.71	2.46	11.01	1.56	11.07	2.20
$L_2Y_1D_3$	9.52	-0.25	9.28	-0.56	9.19	-0.07	10.24	-0.14	10.01	0.84	9.96	0.72	9.55	0.09	9.74	0.87
$L_1Y_2D_1$	7.47	-2.30	8.23	-1.60	7.88	-1.38	8.91	-1.47	7.39	-1.78	7.06	-2.18	8.58	-0.87	6.61	-2.26
$L_1Y_2D_2$	9.45	-0.32	9.50	-0.33	9.76	0.50	9.99	-0.39	8.76	-0.41	8.49	-0.75	9.56	0.11	7.90	-0.97
$L_1Y_2D_3$	6.16	-3.61	7.82	-2.02	7.45	-1.81	8.20	-2.18	7.14	-2.03	6.32	-2.92	7.94	-1.51	6.12	-2.75
$L_2Y_2D_1$	12.23	2.46	11.74	1.91	11.33	2.07	12.13	1.75	10.25	1.08	10.50	1.26	10.09	0.64	10.87	2.00
$L_2Y_2D_2$	11.16	1.39	10.06	0.23	10.16	0.89	10.87	0.49	9.11	-0.06	9.35	0.10	9.17	-0.29	9.67	0.80
$L_2Y_2D_3$	9.48	-0.29	9.02	-0.81	8.47	-0.79	8.96	-1.42	7.88	-1.30	8.09	-1.15	8.17	-1.29	8.34	-0.53
Average over all	9.77	0.00	9.83	0.00	9.26	0.00	10.38	0.00	9.17	0.00	9.24	0.00	9.46	0.00	8.87	0.00

L1 = Sakha L2 = Sids Y1 = 2009/2010 Y2 = 2010/2011
D1 = 15 October D2 = 1 November D3 = 15 November

Cont. of Table (2) Means ($\bar{X}$) and environmental indices (I) for seed yield / ardab / fed of twelve environments .

Environments	Giza 429		Giza 40		H 943		Misr 3		Nubaria 2		Nubaria 3		Giza 2		Average over all	ID Average
	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I	$\bar{X}$	I		
$L_1Y_1D_1$	7.48	-2.01	8.36	-0.51	8.89	-1.40	8.22	-0.77	7.75	-1.07	7.96	-1.41	7.46	-1.10	8.41	-0.94
$L_1Y_1D_2$	7.89	-1.60	8.61	-0.25	9.84	-0.45	10.04	1.05	9.22	0.41	9.57	0.20	8.89	0.33	9.52	0.16
$L_1Y_1D_3$	5.96	-3.53	7.16	-1.71	8.32	-1.97	7.33	-1.66	6.43	-2.38	7.79	-1.58	7.06	-1.50	7.37	-1.98
$L_2Y_1D_1$	14.28	4.79	13.43	4.56	14.89	4.60	13.32	4.33	12.75	3.94	14.18	4.81	11.81	3.25	13.38	4.02
$L_2Y_1D_2$	11.82	2.33	9.89	1.02	12.16	1.87	10.01	1.03	10.22	1.41	12.87	3.50	10.72	2.16	11.13	1.77
$L_2Y_1D_3$	10.51	1.02	9.42	0.56	10.63	0.34	9.65	0.66	9.31	0.49	10.09	0.72	9.07	0.51	9.74	0.39
$L_1Y_2D_1$	7.56	-1.93	7.40	-1.46	8.35	-1.94	7.62	-1.36	6.98	-1.83	6.79	-2.58	6.59	-1.97	7.56	-1.80
$L_1Y_2D_2$	8.55	-0.94	8.47	-0.39	8.46	-1.84	8.17	-0.81	7.91	-0.91	7.75	-1.62	8.03	-0.53	8.72	-0.64
$L_1Y_2D_3$	7.03	-2.46	6.19	-2.67	7.72	-2.57	6.14	-2.85	5.93	-2.88	5.70	-3.67	5.70	-2.86	6.77	-2.59
$L_2Y_2D_1$	12.69	3.20	10.01	1.15	12.53	2.23	10.15	1.17	10.95	2.13	11.03	1.66	10.04	1.48	11.10	1.75
$L_2Y_2D_2$	10.37	0.88	9.25	0.39	11.45	1.16	9.13	0.14	9.74	0.92	9.96	0.59	9.24	0.68	9.91	0.55
$L_2Y_2D_3$	9.76	0.27	8.17	-0.69	10.26	-0.03	8.06	-0.93	8.56	-0.25	8.75	-0.62	8.11	-0.45	8.67	-0.68
Average over all	9.49	0.00	8.86	0.00	10.29	0.00	8.99	0.00	8.81	0.00	9.37	0.00	8.56	0.00	9.36	0.00

L1 = Sakha L2 = Sids Y1 = 2009/2010 Y2 = 2010/2011
D1 = 15 October D2 = 1 November D3 = 15 November

Therefore , the assumption for stability analysis is fulfilled (Mather and Calgari , 1974 and Becker and Leon , 1988).

However the variety Nubaria 3 had the widest range of environmental index (-3.67 to 4.81) followed by Giza 429 (-3.53 to 4.79), while variety Giza 843 had the closet one (-2.92 to 2.77).

The wide ranges of the indices of the varieties indicate that the varieties respond in their yielding ability differently with the different environmental conditions .

Combined analysis of variance for seed yield/fed. is presented in (Table 3). Mean squares for locations , years, planting dates , genotypes and their interactions showed highly significant differences among all sources which valiated using the statistics of Eberhart and Russell and Tai's models (Table 3).

Table (3): Combined analysis among locations , years , planting dates , genotypes and their interactions.

S.O.V	D.F	M.S
		Seed yield ardb /fed
Locations	1	910.83 **
Years	1	174.08 **
Locations X Years	1	19.99 **
Error a	8	2.34
Planting dates	2	203.89 **
Locations X Planting dates	2	98.34 **
Years X Planting dates	2	6.47 **
Loc X years X Planting dates	2	3.59 **
Error b	8	0.542
Genotypes	14	10.17 **
Loc X genotype	14	5.37 **
Years X genotype	14	2.29 **
Loc X years X genotype	14	2.44 **
Plant date X genotype	28	0.516
Loc X plant date X genotype	28	0.524
Years X plant date X genotype	28	0.294
Loc X years X plant date X genotype	28	0.508
Error c	336	0.439
Total	539	

The analysis of variance for phenotypic stability (Table 4) revealed that genotypes as well as environment (linear) mean squares were highly significant indicating that environments differ in their effect on different genotypes when tested with pooled deviation . Also highly significant genotypes X environment mean squares were found meaning that genotypes differ genetically in their response to different for yield/fed environments .

The linear proportion of variance was 92.3 % from the total variance (linear and non linear components). this means that large portion of indication of genotypes X environment was accounted by the linear regression on the environmental means. Highly significant mean squares were found due to genotypes Giza 3 , Sakha 1, Nubaria 1, Giza 843 , Giza 716 , and Giza 429. The significant pooled deviation (residual of genotypes) cleared that the

non-linear components were also significant (Table 4) .These results were in close agreement with that reported by Omar *et al.* (1999), Darwish (2003) , El-Hosary *et al.* (2006) and El-Taweel *et al.* (2008) . The significant portion of non- linear components is essential to determine the stability degree of each genotype .

Table (4): Analysis of variance for stability estimated of Eberhart and Russell method for fifteen faba bean genotypes of yield ardb/fed character .

S.O.V	D.F	Mean Sguare
Total	179	38450.59
Genotypes (G)	14	33902.86 **
Env + (G X Env.)	165	38836.46 **
Environment (Linear)	1	5764899.0 **
G X Env.(Linear)	14	10718.54 **
Pooled Deviation	150	3287.06**
Giza 3	10	3642.28 *
Sakha 1	10	3615.53 *
Sakha 2	10	3016.49
Sakha 3	10	1680.98
Nubaria 1	10	5807.87 **
Giza 843	10	4658.53 **
Giza 716	10	4078.59 **
Misr 1	10	1237.73
Giza 429	10	8441.15 **
Giza 40	10	1806.67
H 943	10	2887.98
Misr 3	10	2437.36
Nubaria 2	10	950.18
Nubaria 3	10	3913.73 **
Giza 2	10	1104.87
Pooled error	360	1619.79

Table (5) indicated that yield phenotypic stability – according to the definition of Eberhart and Russell (1966),a stable preferred genotype should have approximately b =1 and $S^2d = 0$ with a high mean performance .

The genotypes Sakha 3, Misr 1, Nubaria 2 and Giza 2 *met al.*I the stability characteristics of stable genotypes as described by Eberhart and Russell and could be recommended as stable genotypes for faba bean yield .

These results are similar to these obtained by Darwish *et al.* (2003) , El-Hosary *et al.* (2006), Attia , Sabah *et al.* (2007) and El-Taweel *et al.* (2008).

Genotypic stability – Data of tai's parameters $\acute{\alpha}_i$ that measures the linear response to environmental effects and λ_i that measures deviation from linear response are presented in (Table 5) .The data showed that genotypes Giza 40 and Giza 2 will be referred as above average stability ($\acute{\alpha}<0$ and $\lambda=1$) while , The genotypes Sakha 3 and Misr 1 had a degree of below average stability ($\acute{\alpha} > 0$ and $\lambda = 1$) . these findings are in agreement with these reported by El-Hosary *et al.* (2006), Attia ,Sabah *et al.* (2007) and El-Taweel *et al.* (2008).

Table (5): Mean performance , Eberhart and Russell and Tai,s parameter for yield ardab / fed of the studied faba bean genotypes.

Genotypes	Means	Eberhart and Russell parameter Phenotypic stablity		Tai,s parameter Genotypic stability	
		b_i	S^2d	α	λ
Giza 3	9.77	1.0939	20.22	0.0946	2.4223
Sakha 1	9.83	0.7238	19.95	-0.2783	2.3917
Sakha 2	9.26	0.7769	13.96	-0.2248	1.9982
Sakha 3	10.38	1.0218	0.006	0.021	1.1189
Nubaria 1	9.17	1.1092	41.88	0.1100	3.8629
Giza 843	9.24	0.8760	30.65	-0.1249	3.1154
Giza 716	9.46	0.7794	24.58	-0.2222	2.7052
Misr 1	8.87	1.0762	-3.86	0.0767	0.8226
Giza 429	9.49	1.2673	68.21	0.2693	5.6042
Giza 40	8.86	0.9543	1.86	-0.0460	1.2018
H 943	10.29	1.1172	12.86	0.1181	1.9193
Misr 3	8.99	0.9566	8.17	-0.0437	1.6217
Nubaria 2	8.81	1.0414	-6.69	0.0418	0.6321
Nubaria 3	9.37	1.2779	22.92	0.2799	2.5893
Giza 2	8.56	0.9281	-5.14	-0.0724	0.7342

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تقدير الثبات المظهري والوراثي لبعض التراكيب الوراثية في الفول البلدي

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أقيمت هذه الدراسه بقسم المحاصيل بكلية الزراعة جامعه كفر الشيخ وقد أجريت تجربتان حقليتان في موسمي الزراعة ٢٠٠٩/ ٢٠١٠ & ٢٠١٠ /٢٠١١ في كل من محطتي البحوث الزراعية بسخا(شمال الدلتا) ومحطة البحوث الزراعية بسدس (مصر العليا) – مركز البحوث الزراعية بهدف تقييم مجموعه من التراكيب الوراثية من حيث ثباتها الوراثي والمفاضلة بينها باستخدام المعالم الوراثية لبعض طرق الثبات الوراثي بهدف الحكم علي ثبات بعض هذه التراكيب في البيئات المستخدمة وذلك بعده طرق لحساب الثبات ومنها طريقتي ابرهارت وراسل ١٩٦٦ وطريقه تاي ١٩٧١ .

ويمكن تلخيص النتائج فى النقاط التاليه :

١- معنويه العلاقه الخطيه للتاثير البيئى تشير الى تاثير البيئات المختلفه على التراكيب الوراثيه المختلفه

٢- أظهرت النتائج وجود مدى واسع لمعامل البيئه (– ٢.٥٩ الى + ٤.٠٢) مما يدل على وجود اختلافات بين البيئات المختلفه .

٣- أظهر تحليل الثبات الوراثى الى ان كل من تباين الانحدار الخطى وتباين الانحراف عنه (غير الخطى)كان عالى المعنويه وكان المكون الرئيسى للفروق فى الثبات والراجع للانحدار الخطى يمثل ٩٢.٣% من التباين الكلى.

٤- أعطى الصنف سخا ٣ أعلى محصول ١٠.٣٨ أردب للفدان ويليه التركيب الوراثى H943 وحيزه ٣ وسخا ١ حيث اعطت ١٠.٢٩، ٩.٨٣، ٩.٧٧ أردب للفدان على التوالى .

٥- باستخدام طريقه ابرهارت وراسل للثبات المظهري أظهرت التراكيب سخا ٣ومصر ١ ونوباريه٢وجيزه٢ ثباتا مظهريا خلال البيئات المختلفه حسب هذا النموذج.

٦- باستخدام طريقه تاى للثبات الوراثى أظهر الصنف جيزه ٢ ثباتا وراثيا اعلى من المتوسط (λ =١، α > ٠)

فى حين حقق الصنفان سخا٣ ومصر ١ ثباتا وراثيا اقل من المتوسط (λ =١، α < ٠) .

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