ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 45(3): 1045-1056, (2007).

GENOTYPE X ENVIRONMENT INTERACTION, MATURITY AND YIELD STABILITY OF SOME WHITE LUPIN GENOTYPES UNDER EGYPTIAN CONDITIONS

BY

El-Sayad, Z.S.; EL-Harty, E.H.; Yamani, Kh.M. and Abd El-Hafez, G.A.
Food Legumes Res. Section, Field Crops Res. Inst., ARC, Giza, Egypt

ABSTRACT

Twelve promising white lupin (*Lupinus albus* L.) genotypes were evaluated at five locations (Sers El-lian, Mallawi, Shandaweel, New Valley and East Owinat Research Stations) during three seasons (2004/05-2006/07) to investigate genotype x environment interaction and stability performance for seed yield and maturity of these genotypes. The combined analysis of variance for yield and maturity showed that, all sources of variance were highly significant, indicating the importance of genotype, environment and their interaction as factors affecting the white lupin yield and maturity. The AMMI model was applied to analyze the G X E interaction and estimate genotype stability. It was concluded that the selected line Improved Dijon 2 showed wide stability and gave the highest seed yield performance with earliness in maturity across wide range of environments. Meanwhile, Mutant 33 was the most stable genotype in maturity, but it was moderate in earliness and yielding ability.

Key words: White lupin, *Lupinus albus,* AMMI, Biplot, Stability, Genotype, Environment, Seed yield, Maturity.

INTRODUCTION

In Egypt, white lupin (*Lupinus albus* L.) has been cultivated as a grain legume for more than 3000 years. It has considerable value for human and animal nutrition, as well as for medical and industrial purposes. Because of its efficient nitrogen fixation system, lupin is an environment friendly crop which can improve traditional cereal rotations and protein supply in low input farming systems (Hamblin *et al.*, 1993 and Julier *et al.*, 1994). Nowadays, white lupin makes a minor contribution to Egyptian grain legume production as its exploitation has been restricted due to several factors including late maturity and low yield of commercial varieties. Therefore, increasing white lupin production could be achieved by developing early maturity and high yielding varieties with wide adaptation to dry climatic conditions for increasing the cultivated area through newly reclaimed lands.

The importance of genotype x environment interaction reflects the necessity of evaluating genotypes in more than a single environment to select the stable ones. Stability in performance is one of the most desirable properties of genotype to be released as a variety for wide cultivation. Maximizing productivity and stability performance are two features desired in increasing production for white lupin

For the past 40 year of concept of genotype environment interactions and its stability statistic are being analyzed in different ways varied between the simple method, which use the fluctuations of the variety means from one environment to another as an indicator for the relative stability, and the recent advanced methods. Finlay and Wilkinson, 1963 proposed the average yield of all genotypes grown at a particular site in a particular season as a measure of that environment. They used the regression coefficient of the variety means on its environments as an indicator for its phenotypic stability and adaptation. Recently, the Additive Main effects and Multiplicative Interaction (AMMI) model proposed as hybrid analysis that incorporates both the additive and multiplicative components of the two-way data structure (Shafii *et al.* 1992; Shafii and Price 1998). In this model, main effects are first accounted for by analysis of variance, where after the interaction is analyzed by a principal component analysis (Gauch 1988, Gauch and Zobel 1988).

The present study aimed at determining the variability in maturity and yield of some lupin genotypes as well as the nature of genotype x environment interactions and stability of these genotypes.

MATERIALS AND METHODS

This investigation was undertaken to study the performance of twelve white lupin genotypes, including two commercial cultivars (Giza 1 and Giza 2), a selected line from the introduced variety obtained from France (Improved Dijon 2), six induced mutant lines (Mutant 7, 22/2, 23, 33, 35/3, and 37/3). These genotypes were selected according to a previous study done by El-Sayad and El-Barougy 2002, besides three landraces (Belbies 9, Family 9 and Sohag 2) which have been assessed by El-Sayad *et al.*, 2002. The origin and pedigree of the genotypes are presented in Table (1).

These genotypes were grown in five locations: three in old land, *viz.* Sers El-lian (Middle Delta), Mallawi (Middle Egypt) and Shandaweel and two locations in new reclaimed land *viz.* New Valley (Upper Egypt) and East Owinat (South the valley), Research Stations, ARC, during the three winter growing seasons 2004/05, 2005/06 and 2006/07. Every location in each season is considered as environment so this study consisted of 15 environments.

The experimental design was a randomized complete block design with four replications at each location. The plot consists of 5 ridges, 3m long and 60cm between ridges. Planting took place on one side of the ridge with double seeded/hill, 20 cm apart. Agricultural practices were applied as recommended in lupin fields. Data on number of days from sowing to when 50% of plants matured were recorded in each plot at three locations and seed yield in ard/fed. was estimated on plot basis (9 m^2) at the five locations.

Table (1): The studied genotypes and their origin or pedigree

No.	Genotype	Origin/pedigree	No.	Genotype	Origin/pedigree
G1	Giza 1	Egyptian variety	G7	Mutant 33	M_9-induced mutant line derived from Giza 2 by 2.5 KR*
G2	Giza 2	Egyptian variety	G8	Mutant 35/3	M_9-induced mutant line derived from Giza 2 by 10 KR*
G3	Im.Dijon2	Selected line from the French varity Dijon 2	G9	Mutant 37/3	M_9-induced mutant line derived from Giza2 by 40 KR*
G4	Mutant 7	M_9-induced mutant line derived from Dijon 2 by 5 KR*	G10	Belbies 9	Egyptian Landrace
G5	Mutant 22/2	M_9-induced mutant line derived from Giza 1 by 2.5 KR*	G11	Family 9	
G6	Mutant 23	M_9-induced mutant line derived from Giza 1 by 2.5 KR*	G12	Sohag 2	

*Kilo RAD gamma-rays.

Statistical methods:

A regular analysis of variance was applied on individual environment as mentioned by Snedecor and Cochran (1967). Then combined analysis of variance was performed on the twelve genotypes in the three seasons and the five locations or only three locations (Mallawi, Shandaweel and New Valley) for seed yield ard./fed. and number of days from sowing to 50% maturity, respectively,.

The G x E interaction was partitioned according to the AMMI model, as proposed by Zobel *et al.* (1988). Both postdictive and predictitive assessments were used to analyze the G X E interaction (Gauch and Zobel, 1988). In the postdictive assessment, those interaction principal component analysis (IPCA) axis which were not significant were pooled into the residual term. In the predictive assessment, two random replications for each GE combination were used for construction of the model and the other two replications were reserved as validation observations. When one IPCA axis accounts for most G X E, a related graphical aid in interpreting the G X E interaction effects is the biplot as suggested by Zobel *et al.* (1988). Genotypes and environments are plotted on the same diagram, facilitating inference about specific interactions of individual genotypes and environments by using the sign and magnitude of IPCA1 values.

RESULTS AND DISCUSSION

1- Maturity

The combined analysis of variance for days to maturity at nine environments (3 seasons x 3 locations) in Table (2a) showed that all sources of variance were highly significant, revealing the importance of genotype, environment (season and location) and their interactions as factors affecting white lupin maturity. The variance due to environmental effect (location and season) was greater than that of either genotype or all interactions. The large magnitude of mean square value of the season indicated that, there were wide differences between the three seasons. Moreover, the genotype x season interaction variance was greater than the other interactions, such result changes the relative ranking of the genotypes in maturity from season to another at the same location. For example, Belbies 9 was the third earliest matured genotype in 2004/05 (157.75 days), but it was the second latest one in maturity (176.25 days) in 2006/07 at Mallawi (Table 3). The results showed that, the seasons have an important effect on maturity of the studied genotypes. However, in the first season these genotypes were matured earlier than the other two seasons at each location. The average days to maturity at the three locations were 168.19, 149.34 and 159.19 days, respectively. The shorter growing seasons were in Shandweel and New Valley reflect the high air temperature which caused fast growth and early maturity of white lupin genotypes.

Data in Table (3) showed that the tested genotypes varied significantly in days to maturity from location to another, reflecting the effect of environment x genotype interactions. For instance, Mutant 35/3 was the earliest in maturity (156.25 days) at Mallawi 2004/05, but it ranked the second latest one in maturity (156.25 days) at Shandaweel 2006/07. It is noteworthy that, the improved genotype Dijon 2 was clearly the earliest genotype in maturity at Shandaweel during the three seasons, but it exhibited different ranking in maturity at the other two locations. Changes in genotype ranking make it difficult for plant breeders to decide which genotype could be selected as a wide adapted to all environments and hence stability analysis would be solve such a problem. The obtained results are agreed with Julier *et al.,* (1993) who found significant effects of season, location, genotype and their interactions on date of maturity in white lupin.

Table (2a): Combined analysis of variance for maturity and seed yield of the twelve white lupin genotypes.

Source of variance	Days to maturity		Seed yield	
	df	MS	df	MS
Season (S)	2	12805.74**	2	84.91**
Location (L)	2	1138.85**	4	113.25**
S x L	4	1071.78**	8	57.93**
Genotype (G)	11	124.78**	11	9.73**
S x G	22	181.35**	22	3.77**
L x G	22	8.50**	44	2.52**
S x L x G	44	9.77**	88	2.20**
Error	297	2.55	495	0.33

** indicated significant at 0.01.

Table (2b): Additive main effects and multiplicative interaction analysis of variance for days to maturity and seed yield including the interaction principal component analysis (IPCA) axis.

S O V	Days to maturity		Seed yield	
	df	MS	df	MS
Environment	8	4022.04**	14	80.96**
Genotype	11	124.78**	11	9.73**
Genotype x Env.	88	52.35**	154	2.52**
IPCA1	18	224.07**	24	4.71**
IPCA2	16	15.45**	22	4.11**
IPCA3	14	11.21**	20	2.95**
IPCA4	12	6.81**	18	2.11**
IPCA5	10	5.43*	16	2.01**
IPCA6	8	3.11NS	14	1.77**
IPCA7	6	1.12NS	12	1.28**
Residual	301	2.553	523	0.327
Total	431		719	

*,** indicated significant at 0.05 and 0.01, respectively.

Additive main effects and multiplicative interaction analysis showed that environments, genotypes and GxE interaction had highly significant and assessment selected AMMI as the best model (Table 2b) accounted effect on maturity 87.56% of the genotype x environment interaction variance. This percentage is very high because this trait is taken visually. A clear pattern of specific adaptation of the twelve lupin genotypes was identified by the AMMI based Biplot, resulting three groups of genotypes (Fig.1), group 1 included the most stable genotypes 7, 12, 4 and 5 (M 33, Sohag 2, M7 and M22/2, respectively). Their IPCA1 scores are positive and very close to zero. However, group 2 consists of genotypes 6, 8, 9, 10 and 11 (Mutant 23, Mutant 35/3, Mutant 37/3, Belbies 9 and Family 9, respectively) They showed similar maturity, but their interaction for IPCA1 score are negative and moderate. Goup 3 included the earliest genotypes 1, 2 and 3 (Giza 1, Giza 2 and Improved Dijon 2, respectively) but they showed less stability.

2- Seed yield

Data of the combined analysis of variance for seed yield of the five locations over three seasons (fifteen environments) in Table (2a) showed that all sources of variance were highly significant among genotypes, environments (season and location) and their interaction. The results indicated that all sources of variance had important effects on yielding ability of the tested genotypes. Significant genotype, environment and their interactions were also detected for seed yield in white lupin by Julier *et al.*, (1993).

The variance due to location effect was greater than the variance of either genotype, environment or season and their interactions, revealing that there were fluctuation in the environmental condition throughout the experiments. Variation among environments (5 locations in 3 seasons) was highly significant (Table 2a).

Mean seed yield varied from 5.19 ard./fed. at Mallawi in 2006/07 season to 9.77 ard./fed. at E. Owinat in 2004/05 season (Table 4). Concerning the yield performance of locations, East Owinat performed the highest seed yield of 8.11 ard./fed., followed by Sers El-lian (7.30 ard./fed.), Shandaweel (6.47 ard./fed.)New Valley (5.53 ard./fed.) and Mallawi (5.45 ard./fed.) over the three seasons.

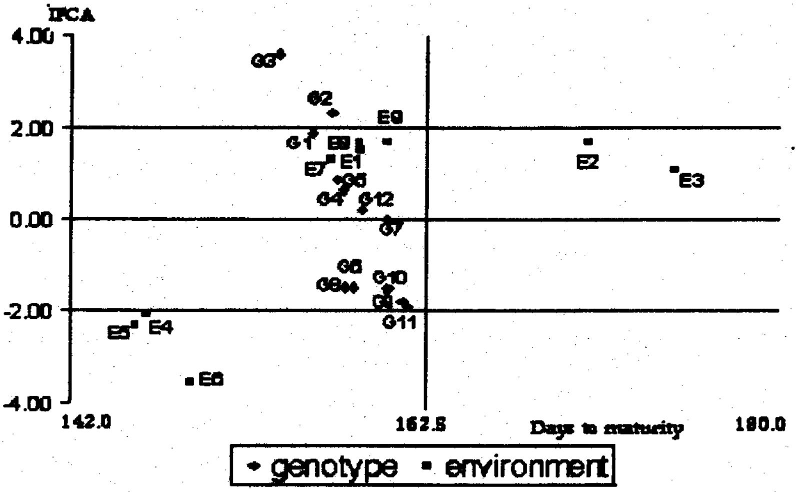

Fig (1): Biplot of principal component analysis (IPCA1) axis 1 against number of days to maturity for 12 genotypes grown in 9 environments.

The significance of genotypes as a source of variation (Table 2a) indicated the existence of wide variability among the studied genotypes for seed yield. In addition, the mean performance of genotypes, environments and their interactions over three seasons within five locations (Table 4) indicated that, the tested genotypes interacted significantly different to environmental effects. For example, the genotype Sohag 2 gave the highest seed yield of 10.95 ard./fed. at E. Owinat in 2004/05, while it yielded 5.32 and 6.62 ard./fed. in 2004/05 and 2005/06, respectively and ranked the last at Sers El-lian. However, the genotype Improved Dijon 2 retained its potentiality over the most environments and gave the highest seed yield (ard./fed.) at all studied environments, except New Valley 2005/06 and Mallawi during the three seasons. Moreover, Improved Dijon 2 followed by the three genotypes Belbies 9, Mutant 7 and Mutant 23 recorded the highest seed yield with overall averages of 7.61, 6.76, 6.74 and 6.74 ard./fed., respectively. On the other hand, the genotype Mutant 22/2 followed by Sohag 2 gave the lowest seed yield (6.13 and 6.22 ard./fed., respectively).

Genotype, environment and their interaction were highly significant, suggesting a broad range of genotypic diversity and environmental variation. The AMMI7 for seed yield was statistically significant, but the AMMI1 was superior

(Table 2b). The biplot shown in Fig.1 simultaneously summarizes information on genotypic and environmental main effects and interactions (IPCA1) as defined by AMMI1. Displacement along the abscissa reflected differences in main effects, whereas displacement along the ordinate illustrated differences in interaction effects. Genotypes with IPCA1 values close to zero show wider adaptation to the tested environments. A large genotypic IPCA1 values reflects more specific adaptation to environments with IPCA1 values of the same sign. Only one genotype, Improved Dijon (G3) exceeded the grand mean with IPCA1 values near zero also, four genotypes i.e. Family 9, Mutant 7, Sohag 2 and Mutant 6 (G11, G4, G12, G6, respectively) perform stable which their IPCA1 values are positive and near zero, while their mean yield differ from each other. On the other hand the genotypes Mutant 37/3, Mutant 22/2, Belbies 9 and Mutant 33 (G9, G5, G10 and G7, respectively) were stable, but their IPCA1 values are negative.

The AMMI biplot analysis is considered to be an effective tool to diagnose the G x E interaction patterns graphically biplot, it is not only for comparing the genotypes in their response to the environments, but also for comparing the environments for their discriminations of the genotypes. The biplot display of IPCA scores plotted against genotypes mean provides visual inspection and interpretation of the G x E interaction components. Integrating biplot display and genotypic stability statistics enables genotypes to be grouped based on the similarity of performance across diverse environments.

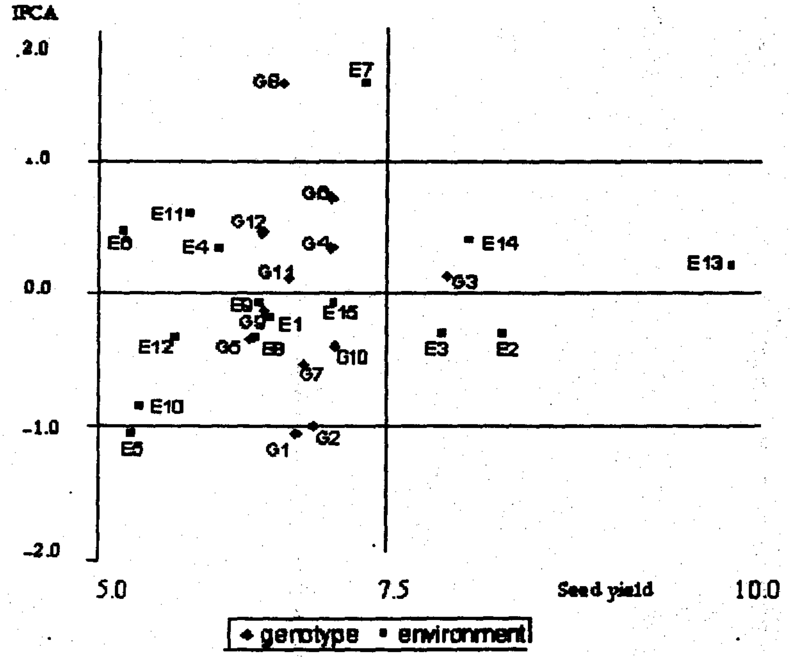

Fig (2): Biplot of principal component analysis (IPCA1) axis 1 against seed yield for 12 genotypes grown in 15 environments.

Table (3): Mean of day to maturity of the twelve white lupin genotypes grown in nine environments and their interactions.

Genotype	Mallawi				Shandaweel				New Valley				Comb.
	2004/05 (E1)	2005/06 (E2)	2006/07 (E3)	Comb.	2004/05 (E4)	2005/06 (E5)	2006/07 (E6)	Comb.	2004/05 (E7)	2005/06 (E8)	2006/07 (E9)	Comb.	L X S
Giza 1(G1)	158.75	169.75	173.25	167.25	141.75	141.75	144.75	142.75	159.00	160.75	162.00	160.58	156.86
Giza2(G2)	163.25	173.50	176.25	171.00	141.00	142.50	144.25	142.58	157.75	160.75	160.75	159.75	157.78
Im.Dijon2(G3)	158.25	170.25	174.50	167.67	140.00	141.00	132.75	137.92	158.00	159.50	162.75	160.08	155.22
Mutant 7 (G4)	157.75	173.00	174.75	168.50	146.50	146.75	148.75	147.33	157.75	159.00	161.25	159.33	158.39
Mutant22/2(G5)	160.50	171.25	174.75	168.83	145.00	145.50	148.75	146.42	158.00	160.75	158.50	159.08	158.11
Mutant23 (G6)	157.50	167.25	172.75	165.83	151.50	152.75	155.00	153.08	157.00	158.25	157.75	157.67	158.86
Mutant33 (G7)	162.50	171.50	176.25	170.08	150.00	149.75	154.00	151.25	158.50	159.00	163.00	160.17	160.50
Mutant35/3(G8)	156.25	165.25	173.50	165.00	150.50	151.00	156.25	152.58	158.25	156.75	158.50	157.83	158.47
Mutant37/3(G9)	159.25	172.25	174.75	168.75	154.50	155.50	159.75	156.58	156.25	160.50	158.75	158.50	161.28
Belbies9 (G10)	157.75	171.50	176.00	168.42	154.50	154.25	156.25	155.00	157.50	158.25	159.25	158.33	160.58
Famly 9(G11)	159.00	170.25	175.75	168.33	156.25	155.75	159.75	157.25	157.75	157.50	161.75	159.00	161.53
Sohag2(G12)	160.25	170.50	175.25	168.67	147.75	149.50	150.75	149.33	158.25	159.25	162.25	159.92	159.31
Mean	159.25	170.52	174.81	168.19	148.27	148.83	150.92	149.34	157.83	159.19	160.54	159.19	158.91
LSD at 5% G	3.09	1.37	2.29	1.33	2.37	2.51	3.56	1.62	1.26	1.01	1.93	0.82	0.74
S				1.27				1.14				0.47	0.37
G X S				2.30				2.80				1.42	1.28
L													0.37
G X L													1.28
G X S X L													2.21

Table (4): Mean seed yield (ard./fed.) of the twelve white lupin genotypes grown in fifteen environments and their interactions.

Genotype	Sers El-lian				Mallawi				Shandaweel				New Valley				E.Owinat				Com. L X y
	2004/05 (E1)	2005 /06 (E2)	2006 /07 (E3)	Com.	2004/05 (E1)	2005 /06 (E2)	2006 /07 (E3)	Com.	2004/05 (E1)	2005 /06 (E2)	2006 /07 (E3)	Com.	2004/05 (E1)	2005 /06 (E2)	2006 /07 (E3)	Com.	2004/05 (E1)	2005 /06 (E2)	2006 /07 (E3)	Com.	
Giza 1(G1)	5.75	8.00	7.47	7.07	5.43	5.71	5.31	5.48	5.69	7.03	5.92	6.21	6.58	4.63	6.52	5.91	8.55	7.14	7.31	7.67	6.47
Giza2(G2)	6.95	8.04	7.66	7.55	5.43	6.62	4.48	5.51	5.94	6.96	6.59	6.49	6.18	6.11	5.78	6.02	8.21	7.40	6.66	7.42	6.60
Im.Dijon2(G3)	7.52	8.60	8.41	8.17	6.34	5.59	6.03	5.98	10.28	7.70	7.33	8.43	7.08	5.00	6.77	6.28	10.47	9.31	7.77	9.19	7.61
Mutant 7 (G4)	6.65	8.42	7.87	7.65	6.09	5.02	5.42	5.51	8.68	6.36	6.33	7.12	5.93	5.55	5.50	5.66	9.47	6.70	7.03	7.73	6.74
Mutant22/2(G5)	5.78	8.44	7.61	7.28	5.43	4.72	4.87	5.01	5.16	5.99	5.77	5.64	4.11	4.78	5.37	4.75	10.32	6.72	6.94	8.00	6.13
Mutant23 (G6)	6.81	8.18	7.46	7.48	5.93	4.58	4.98	5.16	6.99	6.44	6.44	6.62	3.48	7.65	5.55	5.56	10.92	8.80	6.94	8.88	6.74
Mutant33 (G7)	5.81	8.14	7.75	7.23	6.26	6.53	4.41	5.73	7.27	4.88	5.81	5.99	6.58	4.81	5.69	5.69	10.43	7.50	6.11	8.01	6.53
Mutant35/3(G8)	5.23	7.43	6.94	6.53	6.67	3.92	6.57	5.72	8.72	5.18	5.48	6.46	4.45	6.72	5.32	5.50	8.33	7.63	6.94	7.63	6.37
Mutant37/3(G9)	7.26	8.39	7.55	7.73	5.59	4.83	4.99	5.14	5.64	6.22	6.22	6.03	3.37	5.06	5.37	4.60	8.66	8.01	6.38	7.68	6.23
Belbies9 (G10)	6.09	8.38	8.05	7.51	5.35	7.03	4.96	5.78	6.47	5.33	6.07	5.96	5.59	6.23	5.60	5.81	10.69	8.63	6.94	8.75	6.76
Famly 9(G11)	6.16	7.86	7.69	7.24	6.51	3.60	4.95	5.02	6.31	6.81	5.99	6.37	6.01	5.92	4.44	5.46	10.29	7.91	5.74	7.98	6.41
Sohag2(G12)	5.32	6.62	6.46	6.13	5.84	4.85	5.31	5.33	6.93	5.25	6.59	6.26	4.36	5.80	5.04	5.07	10.95	7.65	6.38	8.33	6.22
Mean	6.28	8.04	7.58	7.30	5.91	5.25	5.19	5.45	7.01	6.18	6.21	6.47	5.31	5.69	5.58	5.53	9.77	7.78	6.76	8.11	6.57
LSD at 5% G	0.45	0.66	0.67	0.35	0.70	0.96	0.47	0.42	1.14	0.93	0.73	0.54	0.71	0.76	0.88	0.45	1.29	0.99	0.59	0.55	0.20
S				0.28				0.26				0.18				0.25				0.53	0.10
G X S				0.59				0.72				0.93				0.77				0.96	0.36
L																					0.13
G X L																					0.46
G X S X L																					0.80

The environments show much variability in both main effects and interactions, IPCA1 for environments showing no clear patterns for maturity or seed yield (Fig. 1 and 2). Similar results have bean reported by many authors for different crops, Flores *et al.* (1996), Link *et al.* (1996) in faba bean; Romagosa *et al.* (1996) in barley; El-Shaarawy, (1998) in cotton Ajibade *et al.* (2002) in maize and Berger *et al.* (2002) in chickpea and Rubio *et al.* (2004) in lupin.

Reviewing the results based on G x E interaction and stability, it could be concluded that:

1- On the basis of yield performance and earliness in maturity over locations, genotypes Mutant 7, Mutant 23 and Belbaies 9 were relatively less sensitive to environmental changes and can successfully be grown over Egyptian conditions.
2- The improved genotypes Dijon 2 (derived from the introduced variety Dijon 2) retained its high yield and stability combined with early/medium maturity over varied soil and climatic conditions. However, the improved genotype Dijon 2 gave higher mean yield over locations, and will be useful genetic stock.

REFERENCES

Ajibade, S. R.; Ogunbodede, B. A. and Oyejola, B. A. (2002): AMMI analysis of genotype-environment interaction for open-pollinated maize varieties evaluated in major agro-ecologies of Nigeria. Tropical Agriculture 79(4): 265- 270

Berger, J.; Turner, N.C. and Ali, B.M. (2002): AMMI analysis of genotype by environment interaction across India and Australia reveals specific adaptation in dryland chickpea. Plant breeding for the 11th millennium: Australasian Plant Breeding Conference, 12th, 15-20 Sept. 2002, Perth WA, McComb, J. (ed):507-509.

El-Shaarawy, S.A. (1998): Use of AMMI model to analysis genotype-environment interaction for Egyptian cotton. Egypt. J. Agric. Res., 76 (2): 773-783.

El-Sayad, Z.S. and Ebtehag, El-Barougy (2002): Development of some white lupin mutant lines high yielding, early maturing and resistant to Fusarium wilt. Annals, Agric. Sci., Ain Shams Univ., Cairo, 47 (2): 641-657.

El-Sayad, Z.S.; Mohamed, N.A.; El-Lithy, R.E. and Abd El-Mohsen, M.I. (2002): Performance of some promising white lupin genotypes and determination of the relative importance of yield factors in newly reclaimed lands. J. Agric. Sci. Mansoura Univ., 27 (10):6567-6582.

Finlay, K.W. and Wilkinson, G.N. (1963): The analysis of adaptation in a plant breeding program. Aust. J. Agric. Res. 14: 742-754.

Flores, F.; Moreno, M.T. and Cubero, J.I. (1996): Stability of varieties of *Vicai faba* resistant to *Orobanche crenata.*

Gauch, H.G., (1988):. Model selection and validation for yield trials with interaction. Biometrics, 44: 705-715.

Gauch, H.G. and Zobel, R.W. (1988): Predictive and postdictive success of statistical analysis of yield trials. Theoretical and Applied Genetics. 76: 1-10.

Hamblin, J.; Delane, R.; Bishop, A.and Adam, G. (1993): Effect of different lupin genotypes and management. Aust. J. Agric. Res., 44: 645-659.

Julier, B.; Huyghe, C.; Papineau, J.; Milford, G.F.J.; Day, J.M.; Billot, C. and Mangin, P. (1993): Seed yield and yield stability of determinate and indeterminate autumn-sown white lupin (Lupinus albus) grown at different locations in France and UK. J. of Agric. Sci., 121 (2): 177-186.

Julier, B.; Huyghe, C. and Papineau, J. (1994): Dry matter and nitrogen accumulation in indeterminate autumn-sown white lupin (*L. albus*) cv. Lunable, Eur. J. Agron. 3: 153-160

Link, W; Schill, B. and Von Kittlits, E. (1996): Breeding for adaptation in faba bean. Euphytica 92: 185-190.

Romagosa I; Ullrich, S.E; Han, F. and Hayes, P.M. (1996): Use of the additive main effects and multiplicative interaction model in QTL mapping for adaptation in barley. Theoretical and Applied Genetics, 93 (1-2): 30-37 Jul.

Rubio, J.; Cubero, J.I.; Martín, L.M; Suso, M.J. and Flores, F. (2004): Biplot analysis of trait relations of white lupin in Spain. Euphytica, 135 (2): 217-224

Shafii B.; Mahler, KA; Price, W.J. and Auld, D.L (1992): Genotype by environment interaction effects on winter rapeseed yield and oil content. Crop Science, 32: 922-927.

Shafii B and Price, W.J. (1998): Analysis of genotype-by-environment interaction using the additive main effects and multiplicative interaction model and stability estimates. J. Agric. Biol. Environ. Stat. 3:335–345.

Snedecor, G.W. and Cochran, W.G. (1967): Statistical Methods 6th Ed. Iowa States Univ. Press Ames, IA. USA.

Zobel, R.W.; Wright, M.J. and Gauch, H.G. (1988): Statistical analysis of a yield trial. Agronomy Journal, 80: 388-393.

التفاعل البيئي الوراثي وثبات النضج والمحصول لبعض التراكيب الوراثية من الترمس تحت ظروف الزراعة المصرية

زغلول سيد الصياد، ايهاب حلمي الحارتي، خالد محمد اليماني،
جمال عبد العزيز عبد الحافظ
قسم بحوث المحاصيل البقولية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر

أجريت هذه الدراسة بمحطات البحوث الزراعية بكل من سرس الليان، ملوي، شندويل، الوادي الجديد، شرق العوينات – مركز البحوث الزراعية- خلال ثلاثة مواسم زراعية (٢٠٠٤/٢٠٠٥ – ٢٠٠٦/٢٠٠٧) لتقييم عدد اثنى عشرة تركيب وراثية منتخب ومبشر من الترمس وكذلك لدراسة مدي أقلمتهم للظروف البيئية

المتباينة، ايضا لدراسة التفاعل البيئي الوراثي لصفتي محصول البذور وعدد الأيام من الزراعة حتي النضج.

أظهر التحليل التجميعي أن مصادر الاختلاف التراكيب الوراثية والبيئات وكذلك تفاعل التراكيب الوراثيةx البيئات عالية المعنوية في سلوك الصفات تحت الدراسة لذا فقد اختلفت التراكيب الوراثية معنويا كما أن التأثيرات البيئية كانت مؤثرة في سلوك نباتات الترمس وأما معنوية التفاعل بين التراكيب الوراثية x البيئات فانها تدل علي أن التراكيب الوراثية المدروسة تختلف في ترتيبها من بيئة لأخري مما يسمح بدراسة ثبات السلوك فى البيئات المختلفة. ومن ثم استخدمت طريقة التحليل الإحصائي الجديدة AMMI في تحليل التفاعل البيئي الوراثي وقياس ثبات التراكيب الوراثية تحت الدراسة. وقد أوضحت النتائج أن السلاله المحسنة التي انتخبت من الصنف المستورد Dijon 2 قد احتفظت بتفوقها من حيث كمية محصول البذور وأظهرت درجة ثبات عالية وتأقلم لكل البيئات التي زرعت بها بينما كان سلوكها مختلفا في صفة عدد الأيام حتي النضج حيث كانت أكثر التراكيب الوراثية تبكيرا في النضج في بعض البيئات (شندويل) بينما كانت متوسطة التبكير في بيئات أخري (ملوي – الوادي الجديد). كما أن الطفرة ٣٣ كانت أكثر التراكيب الوراثية ثباتا من حيث عدد الأيام حتي النضج لكل البيئات التي زرعت بها إلا أنها كانت متوسطة التبكير في النضج والإنتاجية مقارنة بباقي التراكيب الوراثية.وقد اظهرت التراكيب الوراثية الأخرى تحت الدراسة درجات متفاوتة من الثبات الوراثى لصفتي المحصول والنضج وتشير النتائج ظهور تفوق للطفرة ٧ والطفرة ٢٣ والسلالة بلبيس ٩ من حيث الإنتاجية والتبكير فى النضج فى معظم البيئات تحت الدراسة مقارنة بالأصناف الموصى بها (جيزة ١، جيزة ٢)