Bulgarian Journal of Agricultural Science, 18 (No 6) 2012, 905-911
Agricultural Academy

STABILITY ANALYSIS ON SEED YIELD AND ITS COMPONENTS IN PEAS

E. CEYHAN[1]*, A. KAHRAMAN[1], M. K. ATES[1] and S. KARADAS[2]
[1]*Selcuk University, Faculty of Agriculture, Department of Field Crops, Konya, Turkey*
[2]*Selcuk University, Coordinator of Farabi Exchange Program, Konya, Turkey*

Abstract

CEYHAN, E., A. KAHRAMAN, M. K. ATES and S. KARADAS, 2012. Stability analysis on seed yield and its components in peas. *Bulg. J. Agric. Sci.,* 18: 905-911

Two cultivars and seven of newly developed pea lines were tested to determine the genotypic variability, heritability, adaptation and stable ability of individual lines for seed yield and yield components at Experiment Field of the Selcuk University, Konya, Turkey. The genotypes were evaluated in three years (2007, 2008 and 2009). Results from the combined analysis of variance indicated that there were significant differences between years and genotypes for the characters. The stability parameters were subjected to regression to determinate regression coefficient and deviations values. Differences in the response of environment were found between genotypes for all traits. The genotypes PS57 and PS53-1 were well adapted to seed yield in good environments. The best-adapted genotypes for seed yield in various environments were PS29-1, PS49, PS100 and PS48 lines. The common parts of the examined genotypes were exhibited specific adaptation ability to different environment; therefore, they represented a target to developing individual plant material for the purpose of breeding programs.

Key words: pea, genotype x environment interaction, stability analysis, heritability

Introduction

The pea had been as a good source of nutritious food since Neolithic times. The *Pisum sativum* L. is the type, which is most widely used for human consumption and interested in using for animal feed, so it had been subjected to increase in recent years in Europe and other countries. As a legume crop, it complies well into cereal rotations with providing nitrogen to the soil and, it can reduce the intensity of diseases in non-legume crops if it is managed properly (Sehirali, 1988).

One of the main issues to be considered in plant breeding programs is the evaluation of changes in seed yield and quality of candidate or new cultivars under different environments or seasons. The adaptability of a genotype is usually tested by the degree of its interactions with diverse environments. A variety is considered more adaptive or stable if it has a high mean of yield with low degree of fluctuation in yield ability for growing over different locations or seasons (Amin et al., 2005). Several biometrical methods have been proposed to determine the stability of new cultivars. The most widely used method is the joint regression analysis for yield stability (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966). The average departure from regression line (σ^2_i) and the regression coefficient (*bi*) are two mathematical indices for the assessment of stability (Eberhart and Russell, 1966). A genotype with a high value of *bi* and σ^2_i reacts easily to change in the environment and possesses considerable variability, whereas cultivars with a *bi* <1.0 and σ^2_i near to 0.0 react weakly to changing on growing conditions and they were considered to be stable in yield (Shindin and Lokteva, 2000).

A number of the genotype x environment interaction has been carried out on various crops (Arshad et

E-mail: eceyhan@selcuk.edu.tr

al., 2003; Cakmak et al., 2006; Vassilevska-Ivanova and Naidenova, 2006). The stability parameters have been studied in edible legumes to measure phenotypic stability (Arshad et al., 2003; Cakmakci et al., 2006; Vassilevska-Ivanova and Naidenova, 2006), but still it is very important information that the stability parameters should be available for the accessions of pea varieties.

One subject to be considered in breeding programs is the evaluation of changes in yield and yield components of candidate or registered varieties under different environmental conditions. Therefore, we were presented an evaluation of some yield components, seed yield for different environmental conditions, the behavior of genotypes in genotype x environment interactions were determined, and we made an assessment for phenotypic stability and adaptability of studied characters owing to stability parameters.

Material and Method

Seven cycles of pedigree selection were made and 1000 pea crosses from pea breeding program of Assoc. Prof. Dr. Ercan Ceyhan were selected from those promising lines based on seed yield and different agronomical traits. The plant materials, which were used in this study, consisted from 17 pea lines and two cultivars (Bolero and Jofs) as controls. These cultivars were chosen according to their prevalence in Turkey. Experiments were conducted in Experiment Field of the Selcuk University, Konya, Turkey (37^o 51' 56N, 32^o 28' 57E, 1020 m above the sea level) during consecutive three years (2007, 2008 and 2009). Soil characteristics of the experimental field were as follows: clay structure, pH 8.03, lime 37.6 %, organic matter 2.25 %, potassium 17.9 kg ha^{-1}, iron 14.74 ppm and zinc 0.32 ppm.

Sowings were carried out during 20th of March for the both of first and second year and 24 March for the last year. In all 3 years of the research, the preceding crop was cereals. Each entry was sown in a five-row plot with 3m long. The rows were spaced with 50 cm distance, and plants were spaced every 8 cm inside a row. The experimental plots were arranged in the "Randomized Complete Block Design" with three replications. Hence, the experiments were performed in different years and under several natural conditions, each was considered as a distinct environment (Vassilevska-Ivanova and Naidenova, 2006). Table 1 shows average temperature, rainfall and relative humidity of the growing seasons. During field preparation for sowing, 30 kg ha^{-1} nitrogen (in the form of diammonium phosphate-DAP) was applied as fertilizer (Ceyhan, 2003). The experimental crops were irrigated one time (during flowering initiation time) for the first year, two times (during flowering initiation and pod filling time) for second year and three times (during flowering initiation and two times during pod filling time) for last growing season. Weeds were removed by hand in all 3 years. Six of the agronomical traits were measured in the research. In general, the studied traits were determined consider with important yield and yield related components in pea. Number of branches per plant was calculated by counting of the branches on a plant. Plant height (cm) was measured from the soil-level base of the plant to the main stem termination point of the flowers. Number of seeds per pod was calculated by counting the seeds in a pod. Number of pods per plant was calculated by count-

Table 1
Total monthly rainfall, relative air humidity and mean air temperature during 2007, 2008 and 2009 growing seasons

Moths	Average air temperature, ^{o}C			Rainfall, mm			Relative air humidity, %		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
March	7.30	10.80	5.90	15.40	38.10	24.40	57.60	49.70	61.90
April	10.00	15.20	11.50	16.10	20.50	45.70	50.40	44.90	59.70
May	20.40	16.60	16.20	16.30	15.90	0.40	42.20	47.60	52.10
June	23.20	23.00	22.30	23.40	7.50	5.50	40.90	37.70	39.20
July	26.40	25.40	24.10	55.80	2.70	11.70	29.10	32.70	43.10
Mean/Total	17.50	18.20	16.00	127.00	84.70	87.70	44.00	42.50	51.20

ing the pods on a plant. The thousand seed weight was determined by weighting of 100 seeds with four replications. Seed yields were calculated from the plants in each harvest area, as fallows; seeds were separated and the data were expressed as t ha^{-1} unit. These traits were measured by using ten plants, which were selected randomly from a plot of each year. Plots were harvested by hand after removing two outer rows in each plot as side effect as an internal area of 4.5 m^2 totally. So, this area was designated as the harvest area.

Variance components estimates to different traits of each genotype for 3 years were based on the mean squares of the variance factorial analysis (Mather and Jinks, 1977). Stability analyses were done by using of overall trial means for each response in each year as environmental indices (Eberhart and Russell, 1966). Analysis of variance and stability were calculated by using of the TARPOPGEN computerized statistical program (Ozcan and Acikgoz, 1999).

Results and Discussion

The variance analyses of investigated traits in this study were presented in Table 2 form. There were statistically significant ($p< 0.01$) differences for both of environment and years for all characters. The genotypes had shown significantly difference ($p<0.01$) for all traits by indicating the presence of sufficient genetic variability for effective selection of superior genotypes. Statistically significance ($p<0.01$) were observed for all traits with respect to genotypes x environment interactions. According to Eberthart and Russel (1966), the ideal genotype has the highest yield (or other traits of interest) over a broad range of environments, a regression (b_i) value of 1.0, and a deviation from the regression (σ^2_i) value of 0.0 worth. Zubair et al. (2002) suggested that the stability of these genotypes should be judged upon other two parameters so that i.e. x and σ^2_i, if regression coefficients of the genotypes are not significantly different from the regression value of 1.0 (r^2=1) worth.

The rainfall was different both for total amount and in terms of distribution within the years. For instance, rainfall for growing seasons was 127.0, 84.7 and 87.7 mm in the years of 2007, 2008 and 2009, respectively. The greatest differences within the three growing seasons were observed in the period of May, June and July months. When a comparison made for rainfall, the first year was 95.5 mm totally for all 3 May, June and July months on the location, and only 26.1 mm fell in 2008 and 17.6 mm for 2009 year. Temperatures were not showed significantly difference between the growing seasons. However, relative humidity values changed significantly in the mean of moths, especially for May, June and July (Table 1). Differences in the rainfall, temperature and relative humidity within the growing season resulted in a great variation between the yield and its components for genotypes.

Genotypic and phenotypic variances were high for thousand seed weight (83.718 and 104.055) followed

Table 2
The combined analysis of variance of plant height, branches per plant, pods per plant, seeds per pod, thousand seed weight and seed yield for 17 pea genotypes evaluated for 3 years

Source of variation	d.f.	Plant height	Branches per plant	Pods per plant
Environments plood	6	1,019	0.289	2,102
Genotypes	16	945,564**	2,738**	137,794**
Environments	2	628,020**	2,420**	77,404**
Interactions	32	88,747**	0,282*	14,283**
Error	96	5,500	0.171	2,967
Source of variation	**d.f.**	**Seeds per pod**	**Thousand seed weight**	**Seed yield**
Environments plood	6	0.237	5,189	0.002
Genotypes	16	4,981**	4877,317**	0,474**
Environments	2	2,349**	936,493**	0,143**
Interactions	32	0,464**	183,035**	0,035**
Error	96	0.237	7,931	0.004

**: p< 0.01

by plant height with values of 59.919 and 69.780, respectively. Lowest genotypic and phenotypic variances were 0.012 and 0.016, respectively in terms of seed yield (Table 3). Phenotypic variances were larger as comparing with genotypic variances for all the traits which indicating the influence of environmental effect (Ceyhan, 2003; Ceyhan et al., 2008).

The highest heritability (h^2) was observed for branches per plant (0.883) followed by plant height (0.859), pods per plant (0.816), thousand seed weight (0.805), seeds per pods (0.803) and seed yield (0.755) (Table 2). High heritability was obtained for all traits. These traits are greatly affected by a series of environmental factors (Arshad et al., 2003; Ceyhan and Avci 2005; Ceyhan et al., 2008).

Plant height

The genotypes PS53, PS23, PS21, PS37, PS48, PS49, PS29, PS30 and PS31 had a high grand mean of the regression coefficients (b_i) which 4.193, 0.366, 0.352, 0.791, 0.682, 1.389, 1.882, 1.349 and 1.026 respectively and they had highly significant deviation from regression (Table 4). Due to high values of σ^2_i these genotypes are sensitive to environmental changes and would be recommended for cultivation under favorable conditions (Eberthart and Russel 1966; Arshad et al., 2003).

Table 3
Variance component estimates of agronomical characters and heritability's of these characters

Traits	σ^2_e	σ^2_g	σ^2_{gy}	σ^2_p	h^2
Plant height	5,500	59,919	27,749	69,780	0.859
Branches per plant	0.171	0.238	0.037	0.269	0.883
Pods per plant	2,967	7,013	3,772	8,600	0.816
Seeds per pod	0.237	0.209	0.076	0.261	0.803
Thousand seed weight	7,931	83,718	58,368	104,055	0.805
Seed yield	0.004	0.012	0.01	0.016	0.755

Table 4
Phenotypic regression parameters for plant height and braches per plant in pea lines

Genotypes	Plant Height			Braches per Plant		
	x (cm)	b_i	σ^2_i	*x* (number)	b_i	σ^2_i
Bolero	36.59	-1.51	38,296**	4.6	1.266	0.054
PS21	68.51	0.352	7,529*	5.41	2.183	0.002
PS23	69.54	0.366	7,063*	4.74	0.628	0.128
PS29	62.3	1.882	18,816**	4.58	-0.124	0.073
PS29-1	50.69	0.763	75,349**	4.48	2.22	0.015
PS30	61.51	1.349	11,247*	4.81	-0.773	0.113
PS31	60.93	1.026	20,000**	4.19	-1.234	0.11
PS37	67.49	0.791	24,354**	4.31	0.974	0.055
PS45	51.61	1.553	13,152**	3.77	1.987	0.014
PS48	65.57	0.682	25,248**	4.73	1.858	0.108
PS49	63.27	1.389	11,339*	3.69	1.808	0.162
PS53	75.84	4.193	46,903**	4.29	0.658	0.062
PS53-1	57.00	1.936	3.416	5.64	0.516	0.013
PS57	67.83	2.011	1.549	4.08	1.674	0.05
PS66	49.49	-0.494	40,220**	5.47	0.989	0,289**
PS100	58.96	0.404	14,771**	4.82	2.016	0.124
Jofs	43.31	0.308	0.244	4.32	0.353	0.009
Mean	59.44			4.59		

*: $p< 0.05$, **: $p< 0.01$

The genotype PS57 showed a high mean with 2.011 regression values and it was not showed significantly difference in terms of regression, thus it was indicated specific adaptability to favorable environmental conditions. The genotype PS57 could be considered as an ideal genotype (Eberthart and Russel 1966; Arshad et al., 2003 and Vassilevska-Ivanova and Naidenova 2006) due to its relative plant height in all environments.

Braches per plant

Two genotypes PS53-1 and PS21 showed a high grand mean with the regression coefficients 0.516 and 2.183 respectively and they were not showed significantly deviation from regression. Due to low values of σ^2_i, PS53-1 and PS21 were specifically adapted to unfavorable environmental conditions (Table 4). The genotype PS66 had a high number of braches per plant (5.47) but it had a high value of σ^2_i because of showing sensitivity to environmental changes and an unpredictable braches per plant (Eberthart and Russel, 1966).

Pods per plant

The genotypes PS57, PS21, PS53-1, PS49, PS29-1 and PS23 had superior values by the mean of number of pods and had greater regression values than 1.0 and highly significant deviation from regression. These genotypes were sensitive to environmental changes and would be recommended to cultivation for only favorable environments. There were some genotypes (PS100, PS48 and PS31) which showed greater number of pods per plant with the regression values less than 1.0 and these genotypes were not significant with the values of σ^2_i, therefore, these genotypes were insensitive to environmental changes and better adapted to poor environments (Table 5). Genotypes with stability and adaptability parameters defined as ideal by Vassilevska-Ivanova and Naidenova (2006) for number of pods per plant.

Seeds per pod

For number of seeds per pod, genotypes PS29-1 and PS49 had a greater number of seeds (6.01) with the regression values 1.185 and 3.049, respectively and they showed highly significant deviation from regression. These genotypes could be considered with adapted to specific favorable environments. Five of the genotypes (PS23, PS66, PS100, PS53-1 and PS45) and one of the cultivars (Jofs) recorded superior number of seeds per

Table 5
Phenotypic regression parameters for number of pods per plant and seeds per pod in pea lines

Genotypes	Pods per Plant			Seeds per Pod		
	x (number)	b_i	σ^2_i	x (number)	b_i	σ^2_i
Bolero	15.37	-0.307	0.04	5.58	0.937	0.146
PS21	23.33	1.808	3,808*	5.89	2.176	0.102
PS23	18.98	1.573	12,836**	7.67	0.873	0.01
PS29	14.23	-0.662	2.514	4.89	2.119	0,603**
PS29-1	21.17	1.973	6,600*	6.81	1.185	0,342*
PS30	15.71	2.521	0.278	5.19	-0.348	0.003
PS31	19.88	-0.728	14,463**	6.06	-1.838	0.045
PS37	12.92	0.582	1.776	4.89	0.515	0,274*
PS45	17.07	0.187	0.003	6.02	2.306	0.035
PS48	20.36	0.112	0	6.09	-0.014	0.036
PS49	22.3	2.215	4,246*	6.8	3.049	0,430**
PS53	17.96	-0.609	3.072	5.08	0.914	0.164
PS53-1	22.6	1.82	14,210**	6.33	2.08	0.004
PS57	23.99	3.642	5,490*	5.77	1.735	0,458**
PS66	13.29	0.882	4,646*	6.49	0.201	0.088
PS100	22.14	1.562	0	6.38	0.493	0.005
Jofs	12.34	0.429	0.366	6.23	0.617	0.134
Mean	18.45			6.01		

*: p< 0.05, **: p< 0.01

pod and for the regression values (0.873, 0.201, 3.049, 2.080, 2.306 and 0.617) with non-significant standard deviation by indicating the stability over all the locations (Table 5). These genotypes may be recommended for cultivation in different environments (Vassilevska-Ivanova and Naidenova, 2006).

Thousand seed weight

The genotypes PS29-1, PS48 and PS100 had a high value of thousand seed weight (144.64) with the regression values 1.812, 3.361 and 1.061, respectively and highly significant deviation from regression. Therefore, these genotypes were indicated well adaptation ability to favorable environments. Five of the genotypes (PS31, PS21, PS37, PS49 and PS53) showed greater values of thousand seed weight and not significant deviation from regression (Table 6). These genotypes insensitive to environmental changes and might be recommended for cultivation under all conditions (Eberthart and Russel 1966; Arshad et al., 2003; Vassilevska-Ivanova and Naidenova 2006).

Seed yield

The genotypes PS57 and PS53-1 gave the highest seed yield (1.44 and 1.40 t/ha^{-1}) with the regression values 1.185 and 3.199, respectively and highly significant b_i value. Due to high values of σ^2_i, these genotypes are expected to give better yield under favorable environmental conditions. The genotypes PS21, PS23 and PS31 had also promising for average seed yield 1.261, 1.171 and 1.119 t/ha^{-1}, respectively (Table 6). They had significance for b_i and high values of σ^2_i due to showing sensitivity to environment. These genotypes gave higher yield when the environmental conditions were conducive. The genotypes PS29-1, PS49 PS100 and PS48 had also promising in terms of average seed yield 1.29, 1.25, 1.22 and 1.19 t/ha^{-1}, respectively. They showed non-significant b_i value by regression; thereby these genotypes were revealed stable performance across the environments. The yield performance of the genotypes; Jofs, Bolero, PS53, PS45, PS29, PS66, PS30, and PS37 was poor. They produced less seed yield. The genotypes Bolero, PS45 and PS66 had high b_i revealing sensitivity to environmental fluctuations (Table 6). Although other genotypes had non-significant b_i *value*, they exhibited less sensitivity to environmental changes. These genotypes cannot be recommended due to their poor performance overall.

Table 6
Phenotypic regression parameters for thousand seed weight and seed yield in pea lines

Genotypes	Thousand seed weight			Seed yield		
	x (g)	b_i	σ^2_i	*x* (t/ha^{-1})	b_i	σ^2_i
Bolero	118.43	0.686	83,599**	0.98	0.833	0,005*
PS21	150.84	0.253	3.894	1.26	2.352	0,005*
PS23	124.82	4.593	108,514**	1.17	1.909	0,041**
PS29	87.07	-0.221	233,474**	0.8	-1.751	0
PS29-1	170.77	1.812	136,474**	1.29	2.938	0.003
PS30	153.88	1.696	15,258*	0.78	0.159	0.002
PS31	183.08	0.366	1.854	1.12	0.021	0,019**
PS37	150.34	1.945	9.305	0.72	2.64	0.002
PS45	142.84	0.248	1.187	0.87	-1.198	0,007*
PS48	165.14	3.361	48,509**	1.19	0.539	0.001
PS49	147.64	1.987	0.788	1.25	3.21	0.001
PS53	146.39	1.289	5.151	0.96	-1.434	0.002
PS53-1	147.41	-0.966	1.324	1.4	3.199	0,009**
PS57	162.69	-0.744	16,100*	1.44	1.185	0,010**
PS66	111.3	-0.411	2.503	0.79	-1.146	0,006*
PS100	153.36	1.061	13,200*	1.22	2.287	0
Jofs	142.79	0.046	4.19	0.99	1.255	0.001
Mean	144.64			1.07		

*: $p< 0.05$, **: $p< 0.01$

The deviation from regression for half of the genotypes was highly significant. They revealed the unpredictable response and they were more suitable for the site, which has better environment. The genotypes PS57 and PS53-1 had maximum seed yield and highly significant deviation linearity, so they might be recommended for better environments. On the other hand, while the candidate genotypes, which were showed non-significant deviation value from regression, four genotypes (PS29-1, PS49, PS100 and PS48), had significantly higher seed yield. Therefore, they appeared to be the best varieties with regards of stability (Eberthart and Russel, 1966). Other researchers (Khan et al., 1987; Khan et al., 1988; Arshad et al., 2003) also reported similar results.

Conclusion

Estimating the behavior of genotypes to different environments or seasons is very important for breeders' selections who are interested in recommending plant materials for known cultivation conditions. The results of this research demonstrated that environment has a great impact on the performance of pea genotypes. The most of these pea genotypes were particularly elevated for plant height, number of pods per plant, seed per pod, thousand seed weight and branches per plant. Probably they could be grown in different environments without significantly compromising because of their yield. By contrast, the yield of genotypes had showed too much sensitivity in terms of environment. The genotypes PS57 and PS53-1 were adapted to good environments because of their maximum seed yield values. For seed yield, the best-adapted ones to all environments were PS29-1, PS49, PS100 and PS48 genotypes.

Acknowledgements

This study was supported by Selcuk University, Coordinator of Scientific Research Project (BAP) Konya –Turkey.

References

Amin, M., T. Mohammad, A. J. Khan, M. Irfaq, A. Ali and G. R. Tahir, 2005. Yield stability of spring wheat (*Triticum aestivum* L.) in the North West Frontier Province, Pakistan. *Songklanakarin J. Sci. Technol.*, **27** (6): 1147-1150.

Arshad M., A. Bakhsh, A. M. Haqqani and M. Bashir, 2003. Genotype - Environment interaction for grain yield in chickpea (*Cicer arietinum* L.). *Pakistan Journal of Botany*, **35:** 181-186.

Ceyhan, E., 2003. Determination of some agricultural characters and their heredity though line x tester method in pea parents and crosses. *Selcuk University, Gradutate School of Natural and Applied Science, Ph.D. Thesis*, pp. 103 (Tr).

Ceyhan, E. and M. A. Avci, 2005. Combining ability and heterosis for grain yield and some yield components in pea (*Pisum sativum* L.). *Pakistan Journal of Biological Sciences*, **8** (10):1447-1452.

Ceyhan, E., M. A. Avci and S. Karadas, 2008. Line x Tester analysis in pea (*Pisum sativum* L.): Identification of superior parents for seed yield and its components. *African Journal of Biotechnology*, **7** (16): 2810-2817.

Cakmakci, S., B. Aydinoglu, M. Karaca and M. Bilgen, 2006. Heritability of yield components in common vetch (*Vicia sativa* L.). *Acta Agriculture Scandinavian Section B-Soil and Plant Science*, **56:** 54 -59.

Eberhart, S. A. and W. A. Russell, 1966. Stability parameters for comparing crop varieties. *Crop Science*, **6:** 36–40.

Finlay, W. and G. N. R. Wilkinson, 1963. The analysis of adaptation in a plant breeding programme. *Australian Journal of Agricultural Research*, **14:** 742-754.

Khan, I. A., B. A. Malik and M. Tahir, 1987. Phenotypic stability for yield in chickpea. *Pakistan Journal of Science and Industrial Research*, **30** (6): 455-456.

Khan, I. A., B. A Malik and M. Bashir, 1988. Investigation of genotype x environment interaction for seed yield in chickpea (*Cicer arietinum* L.). *Pakistan Journal of Botany*, **20** (2): 201-204.

Mather, K. and J. L. Jinks, 1977. Introduction to Biometrical Genetics. *Chapman & Hall*, London.

Özcan, K. and N. Açıkgöz, 1999. Populasyon Genetiği için bir İstatistik Paket Proğram Geliştirmesi. *3. Tarımda Bilgisayar Uygulamaları Sempozyumu, Çukurova Üniv., 3-6 Ekim*, Adana (Tr).

Shindin, I. M. and O. V. Lokteva, 2000. Evaluation of spring wheat varieties at primorskey for ecological plasticity. *Annual Wheat Newsletter*, **46:** 105-106.

Şehirali, S., 1988. Pulses, A. Ü. Zir. Fak. Yay. 1089. Ders kitabı 314, Ankara, (Tr).

Vassilevska-Ivanova R. and N. Naidenova, 2006. Assessment of the stability and adaptability of waxbloom and-waxless pea (*Pisum sativum* L.) mutant lines. *Scientia Horticulturae,* **109:** 15–20.

Zubair, M., M. Anwar, A. M. Haqqani and M. A. Zahid, 2002. Genotype - Environment interaction for grain yield in mash (*Vigna mungo* L. Happer). *Asian Journal of Plant Sciences*, **1** (2): 128-129.

Received February, 2, 2012; accepted for printing July, 2, 2012.