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GENOTYPE-ENVIRONMENT INTERACTION FOR SEED YIELD AND YIELD CONTRIBUTING CHARACTERS IN CHICKPEA (*Cicer arietinum* L.)

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ABSTRACT

Genotype-environment interaction was studied in seven genotypes of chickpea under four different cultural environments. Significant variation for genotype (G), environment (E) and G × E interactions were found for the characters days to maturity, plant height, pods/plant, seeds/plant, 100-seed weight and seed yield/plant. On the basis of stability parameters the genotypes Barichola-2, Barichola-3, Barichola-4, Barichola-7 and Barichola-8 could be considered stable for seed yield but suitable only under poor environments where no fertilizers were used. The genotype Barichola-1 was highly responsive but suitable for favorable environments only.

Key words: Genotype, cultural environment, G-E interaction, stability

INTRODUCTION

In terms of area and production, chickpea (*Cicer arietinum* L) is the third major pulse crop in Bangladesh. This is commonly known as "Gram" and cultivated as a low yielding rainfed rabi crop with an average yield of 600 kg/ha. It is a good source of protein for human consumption as boiled whole seed, splitted seed as 'dhal' and as flour. Dry stem and husks are good source of animal feed. The yield potential of this crop needs to be improved through an effective breeding program. The environment has much influence over productivity of a chickpea genotype. A study of genotype environment interaction is of much value in the selection of better genotypes. Specific genotypes respond differently to different environments. In dealing with unstability and uncertainty of yield and in developing improved varieties for wide adaptation; genotype-environment interaction is of major consideration for crop improvement (Eberhart and Russell, 1966). The present investigation was, therefore, undertaken to study G × E interaction and to identify both high yielding and stable genotypes over environmental changes.

MATERIALS AND METHODS

Seven genotypes of chickpea received from Bangladesh Agricultural Research Institute, Gazipur were grown in a randomized complete block design with three replications under four cultural environments during the rabi season of 2004- 2005 at Sher-e-Bangla Agricultural University, Dhaka. The environments were created by application of different chemical fertilizers and seed treated inoculums (Table 1).

Table 1 Four environments as differentiated by application of chemical fertilizer and *Rhizobium* inoculums

S.L. No	Environment	Fertilizer and Inoculums
1	E-1	Rhizobium inoculums + Urea + MP+ Boric Acid
2	E-2	Urea + TSP + MP + Boric Acid
3	E-3	Rhizobium inoculums + Urea + TSP + boric Acid
4	E--4	Control

Each genotype comprised of four lines of three meter length. The rows were spaced 30 cm apart in all environments. Before sowing the seeds were treated with *Rhizobium* inoculum and all fertilizers were applied at final land preparation. The crop was harvested when 90% seeds matured and turned brown. Data were recoded from middle row. Stability analysis was done as per Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Combined analysis of variance (Table 2) indicated the presence of significant variability of the genotypes for all the characters studied, indicating that the genotypes used in this investigation were adequately diverse. Similar results were found by Patil *et al.* (1996) and Arshad *et al*. (2003) in chickpea and Islam and Newaz (2001) in dry bean. Cultural environments had significant effects on all the traits except 100-seed weight. Significant genotype-environment interactions indicated that the genotypes responded differently over the cultural environments for all the traits. The linear component of G × E interaction was significant for days to maturity, pods/plant, seeds/plant, 100-seed weight and seed yield/plant. Results of stability and response of the genotypes to different cultural environments are described character wise as follows:

Table 2. Combined analysis of variance (MS) for eight traits in chickpea

Sources of variation	d. f.	Days to maturity	Plant height	Pods/plant	Seeds/plant	100-Seed weight	Seed yield/plant
Genotype	6	18.92**	17.12**	252.55**	399.86**	47.69**	2.31*
Env. + (Geno. × Env.)	21	1.40**	9.96**	210.33**	233.74**	9.35**	4.57**
Env. (linear)	1	3.12**	76.08**	3449.74**	3687.41**	5.81	67.04**
Geno. × Env. (linear)	6	0.94**	5.22	79.96**	115.83**	21.18**	3.09**
Pooled deviation	14	1.48**	7.28**	34.82	37.59**	4.53	0.75
Barichola-1	2	0.55	0.49	24.12	43.26*	2.29	0.16
Barichola-7	2	1.87**	2.86	77.80*	50.90**	5.31	0.62
Barichola-5	2	5.59**	22.32**	15.97	29.87*	8.38	2.95**
Barichola-3	2	1.64**	10.44*	57.80	56.12**	9.27	0.01
Barichola-4	2	0.95**	7.43	31.04	29.59*	0.23	1.02
Barichola-8	2	0.04	4.85	8.81	11.25	4.96	0.39
Barichola-2	2	1.29**	2.57	29.37	42.11*	1.27	0.10
Pooled error	48	0.20	2.99	21.14	9.09	3.76	0.80

*, ** Significant at 5% and 1% level of probability

Days to maturity: The genotypes Barichola-1, Barichola-5, Barichola-3, Barichola-4 and Barichola-2 (Table 3) showed negative phenotypic indices and thus desirable for early maturity. Deviation from regression (S^2di) of all the genotypes were significantly different

from zero except Barichola-1(b = 1.41, S^2di = 0.35) and Barichola-8 (b = -0.07, S^2di = -0.16) appeared to be more or less stable for this trait. Taking all three parameters into consideration (e.g. negative phenotypic index, bi value close to unity and non significant S^2di value) Barichola-2, Barichola-3, Barichola-4, Barichola-5 and Barichola-7 appeared to be stable for days to maturity.

Plant height: Genotypic mean ranged between 34.04 cm and 40.28 cm over all environments (Table 3). The genotypes Barichola-7 and Barichola-8 had negative phenotypic indices which were indicative of short plant height. The remaining five genotypes showed positive phenotypic index signifying relatively longer plant height. Deviation from regression (S^2di) of the genotypes Barichola-5 and Barichola-3 were significantly different from zero. So linear prediction of these two genotypes were not possible. The regression coefficients (bi) of all the genotypes were not different from the unity. Genotypes Barichola-1 , Barichola-7, Barichola-8 and Barichola-2 could be considered as stable or less affected by environmental fluctuations, since bi~1 and S^2di~0.

Table 3. Stability parameters i.e. mean (x), phenotypic index (Pi) and stability parameters in 7 chickpea genotypes under 4 cultural environments

Genotype	Days to maturity				Plant height				Pods/plant			
	$\bar{x}$	Pi	bi	S^2di	$\bar{x}$	Pi	bi	S^2di	$\bar{x}$	Pi	bi	S^2di
Barichola-1	103.7	-1.6	1.41	0.35	40.12	1.84	0.06	-2.51	54.12	7.75	1.44	2.98
Barichola-7	105.4	0.18	0.49	1.67**	37.96	-.32	1.39	-.14	43.75	-2.62	0.63	56.07*
Barichola-5	105.1	-.16	-.07	5.39**	38.64	0.35	0.67	19.32**	41.90	-4.47	1.22	-5.17
Barichola-3	104.8	-.41	3.57	1.44**	38.43	.14	2.08	7.44*	45.99	-.38	1.43	36.67
Barichola-4	104.1	-1.16	2.08	0.75*	38.52	0.23	0.85	4.44	51.79	5.42	0.44*	9.9
Barichola-8	109.9	4.63	-.07	-.16	34.04	-4.25	0.45	1.84	32.42	-13.95	0.72	-12.33
Barichola-2	103.7	-1.62	-.43	1.09**	40.28	1.99	1.49	-.43	54.61	8.24	1.12	8.23
Grand mean	105.2				38.28				46.37			

Table 3. Continued

Genotype	Seeds/plant				100-Seed weight				Seed yield/plant (g)			
	$\bar{x}$	Pi	bi	S^2di	$\bar{x}$	Pi	bi	S^2di	$\bar{x}$	Pi	bi	S^2di
Barichola-1	60.72	11.86	1.91**	34.16*	13.36	-2.02	-0.78	-1.47	8.06	0.88	1.96**	-0.64
Barichola-7	52.65	3.78	0.59	41.80**	11.58	-3.79	-0.99	1.56	6.01	-1.16	0.49	-0.18
Barichola-5	44.14	-4.72	1.27	20.77*	16.72	1.34	9.43**	4.62	6.88	-0.29	0.50	2.14*
Barichola-3	47.75	-1.11	1.09	47.02**	14.93	-0.45	1.17	5.51	7.09	-0.09	1.41	-0.79
Barichola-4	54.78	5.92	0.67	20.49*	15.04	-0.34	-5.42	-3.53	8.24	1.06	1.28	0.21
Barichola-8	29.54	-19.32	0.72	2.15	22.32	6.94	5.82	1.20	6.85	-0.33	0.54	-0.41
Barichola-2	52.45	3.59	0.73	33.01*	13.7	-1.68	-2.23	-2.48	7.12	-0.06	0.80	-0.70
Grand mean	48.86				15.38				7.18			

*, ** Significant at 5% and 1% level of probability.

$\bar{x}$ = Mean, Pi = Phenotypic index, bi = Regression Co-efficient, S^2di = Deviation from Regression.

Pods/plant: Genotypic means for pods/plant varied from 32.42 to 54.61 (Table 3). Three genotypes Barichola-1, Barichola-4 and Barichola-2 had positive phenotypic index which is desirable for selection. The results showed that bi values for all the genotypes except Barichola-4 were close to unity indicating average responsiveness to diverse environments. All genotypes except Barichola-7 showed no significant S^2di value which suggest that the genotypes are relatively stable under environmental fluctuations. The genotype Barichola-4 could be considered suitable for unfavorable environment. It is also evident that all the

genotypes except Barichola-4 and Barichola-7 having bi~1 and S^2di~0 are less sensitive and more adaptive to changed environments.

Seeds/plant: Genotypic means for seeds/plant ranged from 29.54 to 60.72 (Table 3). Four genotypes Barichola-1, Barichola-7, Barichola-4 and Barichola-2 had positive phenotypic index and so desirable for selection. The results showed that all the genotypes except Barichola-1 had bi values close to the unity indicating average responsiveness to diverse environments. All genotypes except Barichola-8 showed significant S^2di value which suggest that the genotypes are unstable under environmental fluctuations. The genotype Barichola-8 could be considered as stable or less affected by environmental fluctuations, since bi~1 and S^2di~0.

100-seed weight: The genotypic means of 100-seed weight over environments ranged from 11.58 to 22.32g (Table 3). The phenotypic index of Barichola-5 and Barichola-8 were positive and the remaining ones were negative. All genotypes showed no significant S^2di value and indicated that the genotypes are relatively stable under environmental fluctuations. Except for the genotype Barichola-5, regression coefficient in all genotypes appeared to be statistically close to the unity (i.e. bi~1), suggesting those have fair degrees of stability.

Seed yield/plant: Mean seed yield per plant of the genotypes varied from 6.01 to 8.24g per plant (Table 3). The predictable parameter was the phenotypic indices (Pi) of the individual genotypes. The genotypes Barichola-1 and Barichola-4 showed positive phenotypic indices. The genotypes Barichola-7, Barichola-3, Barichola-4, Barichola-8 and Barichola-2 could be considered stable but suitable only for poor environments. The genotypes Barichola-1 had bi value significantly different from the unity with no significant S^2di value indicating high responsiveness of the genotype but suitable for favorable environments. The genotype Barichola-3 had significant S^2di value suggesting its instability over environments. Kumar *et al*. (2002), Ozdemir and Engin (1996) and Patil *et al.* (1996) also make similar conclusion for stability of seed yield in chickpea.

REFERENCES

Arshad, M., A. Bakhsh, A. M. Haqqani and M. Bashir. 2003. Genotype environment interaction for grain yield in chickpea. Pakistan J. Bot. 35(2): 181-186.

Eberhart, S. A. and W. A. Russell. 1966. Stability parameters for compareing varieties. Crop Science. 6:36-40.

Islam, A. K. M. A. and M. A. Newaz. 2001. Genotype- environment interaction for seed yield and yield contributing characters in dry bean. Bangladesh J. Pl. Breed. Genet. 14(1): 43-48.

Ozdemir, S. and M. Engin. 1996. Stability analysis of some large seeded chickpea genotypes in Cukurova region. Turkish J. Agril. Forest. 20(2): 157-161.

Patil, J. C., A. D. Dumbre and S. K. Rajoli. 1996. Stability analysis of yield and its components in chickpea. Legume Research. 19(1): 47-51.