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Phenotypic stability for yield and other traits in chickpea (*Cicer arietinum*)

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Abstract

The present investigation was conducted during the winter seasons of 2003, 2004 and 2005 to study the phenotypic stability of ten diverse genotypes of chickpea (*Cicer arietinum* L.) for nine yield related characters. The G x E interaction was significant for all the characters except branches per plant and pods per plant, revealing thereby the varying performance of genotypes over years for these traits. The G x E (linear) was found significant for characters like days to flower, days to maturity, plant height, biological yield, harvest index and 100 seed weight, indicating the predictability of expression of the genotypes under varied environmental conditions. Two genotypes ICCV 90201 and ICCV 96911 with high yield, unit regression and small deviations were revealed to be stable genotypes over years.

Key words: *Cicer arietinum* L, genotypes x environment interaction, stability analysis.

Introduction

India is the premier chickpea growing country and it accounts for 76 per cent of the total area and production in the world. The area and production of chickpea in the recent years has fairly stabilized and year to year variation in yield is the direct reflection of the environmental influence. It is a major *rabi* pulse crop in Himachal Pradesh and occupies an area of 1.4 thousand hectares with production of 1.01 thousand tonnes (Anonymous, 2005).

The first and immediate goal of any pulse improvement programme is to develop cultivars with higher and stable yield. Since chickpea yields are subject to considerable environmental fluctuations, growing of its genotypes over years and situations should be an integral part of a plant breeding programme aimed at evolving widely adapted varieties. A number of studies based on data of multilocations or over the years had been carried out in the past to identify the stable genotypes for wider adaption for a specific sowing period (Deshmukh *et al.*, 1998, Popalghat *et al.*, 2001 and Sirohi *et al.*, 2001). The study of G x E interactions serves as a guide and helps in identifying suitable genotypes for future breeding programme and cultivation in various environmental niches. Accordingly, the present study was aimed to investigate the stability of chickpea genotypes over years for yield and other attributes.

Material and Methods

The experimental material comprising ten diverse genotypes including three checks, namely HPG 17, ICCX810800 and ICCV 90201 were evaluated in a randomized complete block design with three replications and spacing of 30 cm x 5 cm, at the experimental farm of CSKHPKV, Palampur for three consecutive years during *rabi* seasons of 2003-2006. The observations were recorded on five randomly taken plants from each plot for days to flower, days to maturity, plant height (cm), branches per plant, pods per plant, biological yield per plant (g), yield per plant (g), harvest index (%) and 100 seed weight (g). The stability analysis was done as per the model of Eberhart and Russell (1966).

Results and Discussion

Pooled analysis of variance for stability revealed significant differences among genotypes for all the characters except yield per plant (Table I). The genotype x environment interaction was significant for all the characters except branches per plant and pods per plant, revealing thereby the varying performance of genotypes over years for these traits. The importance of Gx E interaction has also been observed by Khan et al., 1996; Toker, 1998 and Singh & Sandhu, 2006. Significant variance due to environments (linear) for all the characters studied indicated larger macro-environmental differences in three years for these characters. High pooled deviations indicated

Table 1. Analysis of variance combined over environments

Source of variation	DF	Days to flower	Days to maturity	Plant Height (cm)	Branches/ plant	Pods/ plant	Biological yield /plant (g)	Yield/ plant (g)	Harvest Index (%)	100 seed weight (g)
Genotypes	9	43.01**	7.0**	55.02**	2.18**	82.53**	38.04**	0.88	26.07**	23.11**
Genotypes x Environments	18	38.83**	10.32**	69.06**	2.52	66.41	127.75**	5.08*	84.92**	8.64**
Environments+ Genotypes x Environments	20	360.11**	124.76**	73.90**	5.93**	64.28**	175.77**	5.45**	43.95	5.54
Environments (Linear)	1	6969.15**	2433.34**	1063.72**	103.47**	887.18*	2748.81**	78.75*	369.65*	58.93**
Genotypes x Environments (Linear)	9	21.35*	4.18**	19.63**	0.65	8.30	21.43*	1.21	46.10**	4.40**
Pooled deviation	10	4.09	2.43	23.77**	0.92	32.38*	57.37**	1.95*	9.46	1.22*
Pooled Error	60	2.78	1.56	5.86	0.53	15.80	9.50	0.94	4.86	0.58

* and **significant at P=0.05 and P=0.01, respectively

difficulty in predicting the performance of genotypes over years for plant height, pods per plant, biological yield per plant and 100 seed weight. The values for G x E (linear) were found significant for characters like days to flower, days to maturity, plant height, biological yield per plant, harvest index and 100 seed weight, which indicated the predictability of expression of the genotypes under varied environmental conditions. Based on the stability parameters (Table 2), five genotypes (ICCV 95503, ICCV 90201, ICCV 96911, HPG 17 and ICCV 95909) in order of merit exhibited higher seed yield than the population mean. However, three of these (ICCV 95503, HPG 17 and ICCV 95909) were not stable genotypes as they had significant deviations from linearity. Further, the present study indicated that ICCV 95503 and HPG 17 performed well only under favorable environment, whereas ICCV 95909 with bi<1 retained and manifested its inherent potentiality fully well under unfavorable conditions. Only two genotypes ICCV 90201 and ICCV 96911 had above average yield, unit regression and small deviations and could be considered stable genotypes over years. Beside yield, the genotype ICCV 90201 was observed to be a stable genotype for all the characters studied except plant height, whereas ICCV 96911 was observed to be a stable genotype for days to maturity and biological yield and showed adaptation to favorable environment for days to flower, plant height, harvest index and 100 seed weight. Partap (1999) also reported genotype ICCV 90201 as stable for pods per plant, seeds per pod and days to 75% maturity. Genotype HPG 17 was observed to be stable for biological yield, plant height and 100-seed weight.and responded well to poor environment for days to flower, days to maturity and harvest index. Similarly, genotypes ICCV 95503 and ICCV 95909 were found to be stable for days to maturity, plant height, biological yield per plant and 100-seed weight, whereas both genotypes were showing responsiveness to unfavorable environment for early flowering. Singh and Bajija (1990), Sood *et al.* (2001) and Partap & Basandrai (2005) had also concluded that stability for seed yield is not necessarily associated with stability of yield components.

Table 2. Stability parameters for yield and other characters in chickpea

Characters	Parameters	Genotypes									
		ICCV 95909	ICCV 96904	ICCV 810800	BGD 112	ICCV 96907	ICCV 95503	ICCV 90201	HPG 17	ICCV 96910	ICCV 96911
Days to flower	Mean	122.00	125.67	126.89	133.89	121.11	122.89	126.22	129.78	125.11	127.11
	bi	1.20**	0.88*	0.92**	0.82**	1.22**	1.32**	0.94	0.85**	0.97	0.90**
	s^2 d	0.24	0.009	0.004	0.010	0.005	0.0 80	0.028	0.009	0.69	0.006
Days to maturity	Mean	190.00	189.00	188.33	191.00	186.56	190.22	189.00	191.11	187.89	187.44
	bi	0.93	0.89	1.15*	0.96	1.26*	0.98	0.86	0.88*	1.11*	0.99
	s^2 d	0.026	0.122	0.005	0.002	0.034	0.023	0.020	0.006	0.003	0.020
Plant height (cm)	Mean	56.58	55.60	56.82	59.87	55.89	57.01	55.11	66.40	55.44	66.00
	bi	0.85	0.75*	1.37*	0.15**	1.13	1.11	0.76	1.14	0.94**	1.78**
	s^2 d	0.073	0.003	0.008	0.014	0.112	0.119	0.310*	0.003	0.00	0.033
Biological yield / Plant (g)	Mean	37.00	34.44	33.11	30.00	31.44	39.11	38.11	40.56	31.67	35.33
	bi	1.12	1.25**	1..36*	1.23	1.06	1.10	0.69	1.00	0..51**	0.68
	s^2 d	0.006	0.002	0.013	0.72*	0.135	0.020	0.022	0.017	3.097	0.0 72
Yield/ plant (g)	Mean	8.79	8.59	8.52	8.47	7.78	9.51	9.49	8.90	8.19	9.01
	bi	0.50*	1.00	0.68**	0.85	1.39	1.62**	0.51	1.22**	0.84**	1.39
	s^2 d	0.007	0.016	0.000	0.210	0.084	0 .008	0.002	0.010	0.000	0.009
Harvest Index (%)	Mean	25.59	27.33	30.76	32.10	25.68	24.23	25.46	22.12	26.10	25.50
	bi	1.71	1.81**	3.17*	1.87	0.83	0.13**	0.75	0.11**	0.01**	0.38**
	s^2 d	0.024	0.006	0.148	0.119	0.001	0.007	0.012	0.005	0.001	0.000
100 seed weight (g)	Mean	18.10	13.12	13.70	16.86	16.26	15.63	15.75	23.16	17.80	17.40
	bi	1.59	0.52**	0.26	-0.16	0.00	0.73	1.04	2.06	1.75*	2.22**
	s^2 d	0.049	0.001	0.0 033	0.061	0.065	0.029	0.038	0.055	0.022	1.159

* and **significant at P=0.05 and P=0.01, respectively

The results in general, revealed difficulty in making any generalization regarding stability of a genotype. The stability parameters of yield and component characters suggested that each genotype was stable for different characters. Therefore, it is concluded that plasticity of different characters should be taken into account while selecting for stability in yield. On the basis of present investigation, two genotypes viz. ICCV 90201 (Himachal Chana-2) and ICCV 96911 having high mean yield and good to average stability can be considered as ideal genotypes. Besides these, ICCV 96910, ICCV 96904, BGD 112 and ICCV 96907 can also be considered as promising genotypes from stability point of view. Such genotypes can be used in future hybridization programme to develop high yielding and stable strains of chickpea.

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