

Effect of environmental stresses on certain quality traits in chickpea (*Cicer arietinum*)*

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The grain legumes including chickpea (*Cicer arietinum* L.) have more protein than cereals. Further more protein of these legumes compliments cereals protein because of relatively high concentration of lysine and sulphur containing amino acids in cereals. In India, the productivity of pulse crops including chickpea is low because of several constraints, like inadequate availability of quality seed of improved varieties, cultivation of pulses on the poor and marginal lands under rainfed conditions without recommended inputs application. Selection and yield testing are the two major phases of varietal development and the latter one is highly influenced by the locations and years of testing.

One of the major objectives in any plant breeding programme has been to develop the well buffered/stable varieties, which minimize the effects of environments on their performance. The breeding approaches and crop improvement programme have been initiated to improve the productivity of chickpea through development of high-yielding plants types and other improved production technologies. Most of the available varieties of chickpea generally produce excessive vegetative growth with poor economic yield. Therefore, there is a need for identifying chickpea genotypes with higher productivity, responsiveness to inputs and consistent yield under various conditions as has been emphasized by various research workers (Jeswani 1986, Dahiya *et al.* 1990).

The magnitude of $G \times E$ interaction and its components has a direct bearing on the environmental domain of the varieties to be recommended for commercial cultivation. Few studies are available on the importance of genotype \times

environment interactions on quality traits in chickpea (Mehla *et al.* 2001, Singh *et al.* 2004). Keeping the above facts in view, the present investigations was undertaken to identify stable and promising cultivars for certain quality traits in chickpea.

Genotypes of chickpea (20) collected from Indian Agricultural Research Institute, New Delhi were grown over 8 diverse environments, i e timely and late sown in rainfed and irrigated conditions during 2004–06 at the Research Farm of Kisan PG College, Simbhaoli (Ghaziabad), Uttar Pradesh. The experiments were conducted in randomized block design with 3 replications. Each genotype was assigned to 3 rows of 3 m length with a distance of 30 cm and 20 cm between rows and plants, respectively. During both the years, the pre-sowing irrigation was provided for both the experiments (rainfed and irrigated) to ensure proper germination because the rain water could not be conserved. The basal application of fertilizer (recommended) dose was applied for healthy crop stand. Sowings were done timely and the other recommended cultural practices were also adopted to ensure normal crop growth and development. The irrigation was provided according to the experiments in both the environments during both the years. The observations on seed yield and seven quality traits, viz protein content in seed (%), volume of seed (ml), density (dry seed), hydration capacity, swelling capacity, cooking time and swelling index (%) in each experiment were recorded on 5 competitive plants in each replication for each environment separately during both the years. The mean data on 5 plants in each replication for each genotype was utilized for the statistical analysis. Eberhart and Russell (1966) method was followed to estimate the 3 parameters of stability namely mean, regression coefficient (bi) and mean squared deviation (S^2_{di}) for each genotype.

An experiment was conducted to identify the stable genotypes for yield and quality traits by pooled analysis over 8 environments using the procedures developed by Eberhart and Russell (1966).

*Short note

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Table 1 Pooled regression analysis for yield and certain quality traits in chickpea

Source of variance	d.f.	Seed yield/plant (g)	Protein content (%)	Volume of seed (ml)	Density of seed	Hydration capacity	Swelling capacity	Cooking time (min.)	Swelling index (%)
Genotype (G)	19	26.97**	5.174**	90.39**	1.33**	0.0713**	0.065**	770.01**	11141.09**
Environments (E)	7	98.41**	11.79**	10.06	0.064	0.0046	0.001	171.39**	20008.05**
G×E	133	2.88**	0.424	0.90	0.114**	0.0031**	0.022**	3.39	1661.04**
Pooled error	304	0.103	0.461	30.13	0.028	0.00003	0.00004	2.95	5.24
Environment (linear)	1	688.92**	82.60**	75.99**	0.447*	3.228	1.024	1198.99**	146215.99**
(G×E) (linear)	19	6.09**	0.459	7.37	0.246**	0.0112	0.004	10.58**	1743.86**
Pooled deviation	114	2.23**	0.396	8.81	0.088**	0.016**	0.017**	2.09	1564.89**

* $P=0.05$, ** $P=0.01$ level

The pooled analysis of variance for stability revealed that genotypes differed significantly for all the characters (Table 1). The environments also differ significantly for seed yield, protein content (%), cooking time and swelling index (%). Further, $G \times E$ interactions were found significant for all the characters except protein content (%), volume of seed and cooking time. This indicated the differential response of genotypes in the expression of the characters to varying environments. Non-significant $G \times E$ interaction was observed for protein content (%), volume of seed and cooking time which indicated that these characters are least influenced by the environments (Table 1). The variance due to environment (linear) was significant for all the characters except hydration capacity and swelling capacity which suggested that variation among the environments was linear. Dahiya *et al.* (1983) in similar studies inferred that when the linear component of $G \times E$ interaction was predominant, the mean performance of the varieties could be predicted over environments. A linear environmental variance signifies unit change in environment index for each unit change in the environmental conditions. The $G \times E$ (linear) variance was significant for seed yield, density of seed, cooking time and swelling index and non-significant for protein content (%), volume of seed, hydration capacity and swelling capacity. Further, pooled deviation was significant for seed yield, density of seed, hydration capacity, swelling capacity and swelling index suggesting that performance of different genotypes fluctuated significantly from their respective linear path of response to environments. In other words, the unpredictable environments formed the major portion of the $G \times E$ interaction. However, on analyzing the individual varieties fluctuation from linearity, it becomes clear that a few genotypes fluctuated significantly from linearity. A perusal of Table 3 indicate the pre-dominance of linear component of $G \times E$ interaction for seed yield, density of seed, cooking time and swelling index.

The seed yield as well as other quality traits varies under variable environments. Therefore, it is necessary to breed the varieties suitable/stable for the different environments and can be used as donor parents in future breeding

programmes. The genotypes identified for different characters are presented in Table 2. A perusal of Table 2 indicated that the genotypes 'BG 1004', 'BG 1020' and 'BG 1105' were found stable for seed yield as these genotypes had high mean, unit regression ($b=1$) and non-significant deviation from regression ($S^2di=0$). Since, cultivation of chickpea generally has been done on marginal and poor land, therefore in order to realize the full potential of the genotypes for seed yield and other quality characters, 'BG 1063,' 'BG 1075,' 'BG 1107'

Table 2 Stable genotypes and their estimates of stability parameters for different quality characters in chickpea

Stable genotype	Mean	bi	S ² di
<i>Seed yield2 (g)</i>			
'BG 1004'	13.16	1.20	1.71
'BG 1020'	11.31	0.98	4.31
'BG 1105'	13.62	1.21	1.77
<i>Protein content (%)</i>			
'BG 1003'	22.69	0.97	-0.06
'BG 1053'	22.28	1.05	-0.10
<i>Volume of seed (ml)</i>			
'BG 1075'	21.00	0.95	2.00
'BG 1077'	18.25	1.53	4.34
'BG 1101'	20.50	1.42	6.29
'BG 1109'	21.25	1.47	10.44
<i>Hydration capacity</i>			
'BG 1101'	0.28	1.01	0.00
'BG 1108'	0.19	0.98	0.00
<i>Swelling capacity</i>			
'BG 1003'	0.27	-1.58	0.00
'BG 1020'	0.30	1.07	0.00
'BG 1109'	0.20	1.04	0.00
<i>Cooking time (min)</i>			
'BG 1075'	84.75	0.86	0.56
'BG 1077'	100.00	0.99	2.92
'BG 1088'	98.75	1.29	0.75
'BG 1103'	81.88	1.47	-0.04
<i>Swelling index (%)</i>			
'BG 267'	148.29	1.19	36.49
'BG 1003'	127.31	1.24	16.84
'BG 1109'	120.67	0.98	3.21

Table 3 Magnitude of linear and non-linear portion of G×E interaction for different quality characters

Character	Linear component (%)	Non-linear component (%)
Seed yield (g)	73.19	26.81
Protein content (%)	53.68	46.32
Volume of seed (ml)	45.55	54.45
Density of seed	73.65	26.35
Hydration capacity	41.18	58.82
Swelling capacity	19.05	80.95
Cooking time (min)	83.50	16.50
Swelling index (%)	52.70	47.30

and 'BG 1108' can be considered as responsive and can give higher yield under high inputs and better management conditions. Further, the linear component were pre-dominant for seed yield, protein content, density of seed, cooking time and swelling index (Table 3).

Ozdemir and Engin (1996) reported yield stability analysis with 14 genotypes relating to Flip-84 and Flip-85 series of ICARDA, Syrian origin and observed that 4 of these genotypes showed adaptation to favourable conditions, 5 to unfavourable or stress environments while the remaining 5 had general adaptability. Popalghat *et al.* (1999) identified the cultivars 'G 12' and 'Vishal' as most stable across environments. However, 'Phule G 5' a semi-erect wilt resistant genotype revealed below mean performance in respect of seed yield and its components.

SUMMARY

Twenty genotypes of chickpea were evaluated under 8 diverse environments (early and late planting under irrigated

and rainfed conditions over 2 years) to study the genotype × environment interaction and stability of genotypes for seed yield and certain quality traits. Significant G × E interaction was noticed for all the characters except protein content (%), volume of seed and cooking time indicating differential response of the genotypes in expression of characters to varying environments. Based on the statistics of stability parameters, 3 genotypes 'BG 1004,' 'BG 1020' and 'BG 1105' were found to be most stable in different environments for varied agronomic conditions.

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