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PHENOTYPIC STABILITY OF GRAIN YIELD AND ITS COMPONENTS IN CHICKPEA

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ABSTRACT

Twenty chickpea genotypes were grown in six environments to study the phenotypic stability of grain yield and its components. It was found that the linear component of G x E interaction was more important for yield and other characters. Four genotypes *i.e.*, SGM 84-104, IH 83-6, SG 2 and SGM 84-117 were found to have average response and high stability and high mean for grain yield. However, SGM 84-112 the highest yielding genotype was highly unstable. There was positive and significant correlation between the mean of the genotypes and the responsiveness for number of pods/plant, 100-grain weight and single plant yield which indicated that the genotypes with high mean were, in general, better responsive to favourable environments. There was lack of general association between stability of yield and its components which calls for cautious selection of genotypes based on yield alone.

KEY WORDS : *Cicer arietinum*, Chickpea, Phenotypic Stability, Genotype x Environment Interaction.

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops of India. Development and adaptation of high yielding varieties appear to be the most important step for increasing production. Although number of improved varieties of gram have been evolved, the yield of these varieties is not stable over environments which is one of the reasons for their poor adaptation. Thus stability is one of the desirable properties of a genotype sought for in a variety. Though the information on genotype x environment (G x E) interaction has been adequately worked out in cereal crops, the relative basic information on chickpea is limited. Therefore, the present investigation was planned to collect the information about stability in chickpea.

MATERIALS AND METHODS

The experimental materials consisted of 20 genotypes of chickpea including 3 varieties *viz.*, BR 77, C 235 and SG 2 and 17 advance generation lines. In all, six environments were created by growing them in two dates of sowing at two different locations *i.e.*, Bhagalpur and Muzaffarpur during 1985-86 and 1986-87. The first sowing was done in the first week of November and second in the first week of December each year. The entries were sown in a randomised complete block design with three replications in 4m long rows, spaced 30 cm apart, with plant to plant distance of 10 cm. Recommended agronomical practices were followed throughout the crop season. Observations were recorded on five randomly selected plants in each entry on the number of pods/plant, 100 grain weight (g), single plant yield (g) and grain yield (q/ha). Grain yield was calculated from plot yield. The stability analysis was performed according to the model suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSIONS

Highly significant variances due to genotypes revealed the presence of considerable genetic variability among the genotypes for all the characters studied (Table 1). Highly significant mean squares due to environments and genotype x environment interactions suggested the presence of considerable interactions of the genotypes with the environmental conditions. Highly significant variances due to environment (linear) indicated that creations of the environments by manipulating dates of sowing, locations and years was effective.

Table 1. Analysis of variance for grain yield and its components in chickpea

Sources	df	M.S.			
		Grain yield (q/ha)	Single plant yield (g)	No. of pods/plant	100-grain weight (g
Genotype (G)	19	15.96**	3.08**	129.48**	13.01**
Env. + (Geno x Env.)	100	42.44**	5.34**	128.51**	3.42**
Env. (Lin.)	1	3803.81**	410.81**	8642.29**	224.94**
Gen. x Env. (Lin.)	19	5.32++	3.38**	90.44**	1.86*
Pooled dev.	80	4.23++	0.74++	31.13++	1.02+
Pooled error	228	1.98	0.22	8.70	0.56

* and ** significant at 5 and 1 per cent probability level respectively when tested against pooled deviation.
\+ and ++ significant at 5 and 1 per cent probability level respectively when tested against pooled error.

The linear component of G x E interaction was higher in magnitude than non-linear component. The deviation from linear response of variety (pooled deviation) was found significant for all characters. Mehra and Ramanujam (1979) and Govil (1981) reported that a large portion of G x E interaction was accounted for by the linear regression although non-linear component of G x E interaction was also significant in gram for four characters.

Phenotype may be defined as a linear function of genotype (G), Environment (E) and G x E interaction effect. Relative importance of main and interaction effects may vary from genotype to genotype and with the environments. Thus, the study of G x E interactions serves as a guide and help in identifying suitable genotypes for various environmental niches. Finlay and Wilkinson (1963) considered linear regression as a measure of stability, whereas, Eberhart and Russell (1966) emphasised that both linear (bi) and non-linear (Sd^{-2}) components of interaction be considered while judging the phenotypic stability of a genotype. From subsequent studies on this aspect, it is suggested (Paroda and Hayes, 1971) that the linear regression (bi) could simply be regarded as measure of response of a particular genotype whereas, deviation from regression (Sd^{-2}) should be considered as measure of stability. Individual genotypes have been discussed in the light of above information for different characters.

Pods/plant

An examination of stability parameters (bi) and Sd^{-2} for the number of pods per plant showed that fifteen genotypes had unit regression value, three had bi value greater than one and two genotypes had bi value below one. Thus, these genotypes may be categorised as average, abov average and below average sensitive respectivel SGM 84-117 and SGM 84-120 having significantl high regression value indicated very high respons had high mean performance suggesting thereb better performance of these genotypes in bett environments (normal sown). However, thes genotypes were found highly unstable. In contra to these, variety SG 2 showed highest mean, abov average response and was found stable. SGM 84-113 had above average performance, averag response and was found stable. However, Jain e *al.*, (1984) reported that none of the genotypes ha high pod number combined with unit regressio and non-significant deviation from regression. I this study, varieties C 235, SGM 84-154, IH 83-19, IH 83-18, IH 83-10, and IH 83-9 had belov average performance, average response and wer found to be stable.

100 grain weight

Hundred grain weight varied from 11.50 (IH 83-6) to 17.60 (SGM 84-104). The genotypes SGM 84-104 and IH 83-10 having relatively bolder seed size had above average response but were found highly unstable. Singh and Choudhary (1980) in soybean reported that varieties with boldest seed measured by 100-seed weight, were most suited for growing in favourable environment. Tomer *et al.* (1973) while studying phenotypic stability in bengal gram concluded that large seeded cultivars were phenotypically more unstable than small seeded ones.

Yield / plant

Thirteen genotypes had average (bi = 1), three had above average (bi> 1) and four had below average response (bi<1). SGM 84-117 and SGM

Table 2. Estimates of stability parameters for yield and its components

Genotypes	No. of pods/plant			100-grain weight		
	$\bar{X}$	bi	Sd^{-2}	$\bar{X}$	bi	Sd^{-2}
IH 83-4	28.6	0.492	1.903*	11.9	0.366*	0.097
IH 83-6	34.0	0.879	12.768*	11.5	0.759	0.086
IH 83-9	27.2	1.087	2.742	14.9	0.789	.390**
IH 83-10	19.1	0.509	8.581	16.6	1.742*	.690**
IH 83-14	30.3	1.530	26.797**	13.7	1.199	0.043
IH 83-16	28.2	0.379*	65.623**	12.9	0.487	0.329
IH 83-18	24.2	0.675	11.697	13.2	0.924	0.259
IH 83-19	28.2	0.566	4.626	13.7	0.732	0.138
IH 83-23	24.7	0.326*	69.426**	13.9	1.051	0.485
IH 83-62	31.5	1.054	16.950*	12.8	0.561	0.011
IH 83-103	31.8	1.172	24.484**	14.2	0.812	0.205
SGM 84-104	32.5	0.985	25.032**	17.6	1.905**	.622**
SGM 84-112	34.7	1.119	14.171*	14.1	1.676*	.146*
SGM 84-113	34.4	1.550	12.077	14.1	0.905	0.073
SGM 84-117	34.6	1.726*	78.384**	15.1	1.282	0.179
SGM 84-120	31.0	1.629*	23.920**	14.6	1.049	1.897*
SGM 84-154	29.3	1.128	2.876	13.9	1.149	0.431
BR 77	27.2	0.485	26.603**	12.6	0.781	0.466
C 235	28.7	1.005	6.607	12.8	0.831	0.514
SG 2	38.8	1.704*	-4.065	12.6	0.897	0.263
Mean	30.0			13.8		

* and ** significant at 5 and 1 per cent probability level respectively.

Genotypes	Single plant yield			Grain yield		
	$\bar{X}$	bi	Sd^{-2}	$\bar{X}$	bi	Sd^{-2}
IH 83-4	4.9	0.592*	0.465*	18.2	1.220	-0.534
IH 83-6	5.6	0.592*	0.253	19.5	0.860	-0.287
IH 83-9	5.4	1.312	0.332*	17.1	1.076	-0.295
IH 83-10	4.1	0.623	0.045	14.4	0.864	3.243
IH 83-14	5.0	1.341	0.338*	15.9	1.262	1.453
IH 83-16	5.1	0.748	0.913**	18.2	1.260	3.882*
IH 83-18	4.2	0.727	-0.022	15.1	1.143	-0.552
IH 83-19	5.3	0.792	0.107	18.1	0.869	1.760
IH 83-23	4.6	1.323**	1.611**	17.1	1.035	1.979
IH 83-62	5.4	0.831	1.221**	19.0	1.236	8.782**
IH 83-103	5.9	1.450	0.169	17.3	0.801	0.733
SGM 84-104	6.7	1.357	-0.107	20.5	0.836	0.507
SGM 84-112	6.5	1.256	0.472*	20.9	1.027	4.933*
SGM 84-113	5.9	1.308	0.295	17.8	0.763	-1.552
SGM 84-117	6.5	.761**	1.464**	18.8	0.791	0.605
SGM 84-120	5.9	.660**	1.872**	17.3	0.992	3.422*
SGM 84-154	5.1	0.870	0.109	17.5	1.042	0.077
BR 77	5.0	0.560*	1.104*	17.8	0.991	3.606
C 235	4.92	0.810	-0.022	16.2	0.829	-0.636
SG 2	5.8	1.080	-0.148	19.3	1.103	-2.437
Mean	5.4			17.8		

* and ** significant at 5 and 1 per cent probability level respectively.

Table 3. Correlations between stability parameters and between stability parameters of yield and its components

Characters	Correlations between				
	$\overline{X}$ vgbi	$\overline{X}$ Vs $S^{-2}d$	bi Vs $S^{-2}d$	bi of yield Vs bi of yield components	$S^{-2}d$ of yield Vs $S^{-2}d$ of yield components
No. of pods/plant	0.751**	-0.049	-0.128	-0.182	0.233
100-grain weight	0.802**	0.738**	0.659**	-0.362	0.200
Single plant yield	0.727**	0.094	0.097	0.198	0.526**
Grain yield	0.070	0.131	0.316	-	-

** Significant at 1% level.

84-120 had high mean, above average response but highly unstable for yield per plant. The highest yielding genotype SGM 84- 104 was found to have average response and highly stable. Another genotype IH 83-103 was high yielder having very high response and stable, thus this genotype is likely to perform better in all environments. Variety C 235 and SG 2 showed average response and were highly stable for yield per plant. Mehra and Ramanujam (1979) also reported that variety C 235 was stable for yield per plant with average response.

Grain yield/ha

Grain yield varied from 14.40 (IH 83-10) to 20.90 q/ha (SGM 84- 112). The genotype SGM 84-112, having highest yield was found unstable, however, the genotypes SGM 84-104, IH 83-6, and SG 2 which ranked second, third and fourth in respect of yield were found highly stable. Similar results were reported by Mehra *et al.* (1980) in gram. Considering the Sd^{-2} it was found that five genotypes were unstable for grain yield as they had significantly high Sd^{-2} values. Promising lines for grain yield which were found stable were SGM 84-117, IH 83-4, IH 83-19, and SGM 84-113. Variety C 235 showed below average yield but highly stable.

There was lack of general association between mean ($\overline{X}$) and stability (Sd^{-2}) and between responsiveness (bi) and stability (Sd^{-2}) for all characters except 100-grain weight (Table 3). This indicated that the separate genetic systems were perhaps involved in the control of those parameters. In contrast to this, there was positive and significant correlations between mean performance of the genotypes ($\overline{X}$) and responsiveness (bi) for number of pods/plant, 100-grain weight and single plant yield. It revealed that genotypes with high mean values for these attributes were, in general, better responsive. There was lack of association between responsiveness (bi) of yield and its components and between stability of (Sd^{-2}) yield and components. This indicated that yield components alone cannot be considered as index for the stability of yield. However, signle plant yield can be taken as index for the stability of yield as such which was indicated by positive and significant correlation between stability of yield per plant and yield per plot.

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