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PHENOTYPIC STABILITY OF ADVANCE GENERATION POPULATIONS OF CHICKPEA FOR YIELD AND ITS COMPONENTS

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ABSTRACT

Nineteen advance generation populations of chickpea and a standard check var. Avarodhi were evaluated at three locations and stability parameters were studied for grain yield, seeds/pod, and harvest index. Significant differences were observed among the genotypes and environments. No genotype showed average stability for all the traits. Cv. G 105 was observed to have stable performance for grain yield and harvest index, and G 104 for pods/plant and harvest index. Cv. G 107 for grain yield and G 101 were stable genotypes for pods/plant with numerically better yield and significantly more pods/plant, respectively. The environmental conditions at Bharari were the best for the expression of all the traits except harvest index.

Key words: Phenotypic stability, chickpea, yield, harvest index.

Chickpea (*Cicer arietinum* L.) varieties show a wide range of fluctuations in their performance when grown under varied agroclimatic conditions. Some genotypes perform well over a wide range of environments, while others require specific environmental conditions to express their full genetic potential. Since Uttar Pradesh is a state of varied agroclimatic conditions and Bundelkhand covers 33.8% of total chickpea area of the State, a variety possessing reasonable stable yield is desirable. Significant improvement in crop productivity may be possible by breeding stable varieties. Although studies have been made on the released cultivars, the information is scanty on the stability of promising genotypes in advance generations. With this objective, a group of high yielding advance generation lines were evaluated over three environments (locations) to (i) assess the amount and nature of genotype-environment interaction, (ii) evaluate and identify the potential genotypes giving consistent performance, and (iii) select genotypes exhibiting good performance under a given specific environment.

MATERIALS AND METHODS

The experimental material comprised 19 advance generation (F_6 to F_8) populations of chickpea from different crosses: ICC x-7301-70—F_3 x ICC x-730062—F_5 (G 101), JG 74 x ICCC 9 (G 102), HMS 4 x Annigeri (G 103), JG 74 x Phule G 4 (G 104), ICCL 78043 x BDN-9-3 (G 105), Annigeri x ICC-9 (G 106), ICCL 78043 x BDN-9-3 (G 107), JG 74-x Annigeri (G 108), JG 74 x BDN-9-3 (G 109), ICCL 78004 x BDN-9-3 (G 110), ICCL 78005 x Annigeri (G 111), ICCC 22 x Phule G 7 (G 112), K 850 x ICCL 80074 (G 113), K 850 x ICCL 80074 (G 114), P 324 x ICC 9 (G 115), Annigeri x Phule G 5 (G 116), (Annigeri x JG 74) x Annigeri) x Annigeri (G 117), Annigeri x P 436-2 (G 118), Annigeri x P 436-2 (G 119), and a standard check variety Avarodhi grown at three diverse agroclimatic locations, viz. Kanpur, Deegh and Bharari in randomized block design with three replications during rabi 1988–89. The observations were recorded for grain yield and pods per plant, seeds per pod, and harvest index.

The analyses proposed by Eberhart and Russell [1] and Perkins and Jinks [2] were used to study both the linear and nonlinear parameters of phenotypic stability.

RESULTS AND DISCUSSION

Pooled analysis of variance (Table 1) for grain yield and its component traits revealed that the mean differences among genotypes and environments were significant for all the traits, indicating that there was large variability among the genotypes as well as

Table 1. Analysis of variance pooled over three environments as per models of [1, 2]

Source	d.f.	Mean squares			
		grain yield	pods per plant	seeds per pod	harvest index
Genotypes$^+$	19	28.4**	195.1**	0.01*	22.3*
Environments/joint regression$^+$	2	29.2**	67.7*	0.13**	186.9**
Genotypes x environments$^+$	38	4.3**	19.0**	0.01**	18.3**
Env. (genotype x env.)$^+$	40	7.1**	21.4**	0.01**	373.8**
Env. (linear)	1	118.4**	135.4**	0.26**	373.8**
Genotype x env. (linear) heterogeneity between regression	19	1.4	2.8**	0.00	3.9**
Pooled deviation	20	0.3*	0.8	0.01	1.8
Remainder$^+$	19	0.3*	0.8	0.01	1.9
Pooled error	120	0.2	0.8	0.01	1.4

+ As per the model of Perkins and Jinks [2].

*P = 0.05, **P = 0.01.

environments. The highly significant genotype x environment (G x E) interaction showed variable response of genotypes to environments. Similar results have also been reported earlier [3–5]. The combined environment and varieties x environment interaction was significant for all the traits, indicating that the genotypes interacted considerably with environmental conditions that existed at the three locations. Significant linear component of variation observed for all the traits indicated that the differences among the regression coefficients pertaining to various genotypes on the environmental mean were real. However, nonsignificant pooled deviation and remainder mean square for all the traits, except grain yield, revealed that the major component of the differences in stability was the linear regression and not the deviation from the linear function. Significant variances due to pooled deviation (nonlinear) for grain yield reflect considerable genetic diversity in the material. Such nonlinear deviation may also be of practical value to construct and test the utility of multiple regression models to know more critically the complex mechanism of adaptations. The heterogeneity between regression was highly significant for pods/plant and harvest index, and nonsignificant for grain yield and grains/pod, indicating high predictability and unpredictability, respectively, of the genotypes.

None of the genotypes tested showed average stability for grain yield and all its component traits (Table 2). However, G 105 gave stable performance for grain yield and harvest index and G 104 for pods/plant and harvest index. The stability for these traits is important because they have substantial indirect contribution to yield. G 107 for grain yield, G 101 for pods/plant, and G 117 for seeds/pod were stable genotypes with numerically better yield and significantly more pods per plant. The genotypes identified suitable for favourable environmental conditions were G 101, G 113 and Avarodhi for grain yield; G 115 for pods/plant; G 102 for seeds/pod; and G 110 and G 111 for high harvest index. G 104, G 111 and G 118 exhibited above average stability for grain yield, G 108 for pods per plant; and G 101 and G 116 for harvest index. The genotypes G 102, G 108, G 110, G 114 and G 116 for grain yield; G 103 and G 114 for pods/plant; G 105, G 106, G 114 and G 119 for seeds/pod; and G 112, G 113 and G 117 for harvest index had significant regression coefficient and nonsignificant squared deviation depicting predominance of linear interaction and predictable performance. G 113 gave the highest grain yield, whereas G 107 and G 117 produced highest number of pods per plant, grains per pod, and had high harvest index. The existence of large variation in regression coefficient for yield contributing traits indicated that genotypes had different degrees of environmental responses.

The values of environmental index (Table 3) indicated the best environment at Bharari for the expression of grain yield and its two components, i.e. pods/plant and seeds/pod, whereas Kanpur was the best location for the expression of high harvest index. Grain yield is a polygenic trait and depends on many characters, the most important being pods/plant and harvest index. Luthra et al. [6] proposed that stability of yield in a variety is determined,

Table 2. Estimates of stability parameters using two models for grain yield, pods per plant,

Genotype	Grain yield				Pods per plant			
	μi	$b^{E}i$	$\beta^{P}i$	$\bar{s}^2_d$	μi	$b^{E}i$	$\beta^{P}i$	$\bar{s}^2_d$
G 101	18.0**	0.81	–0.19	0.70	87.9**	1.15	0.15	–1.57
G 102	18.2**	1.68*	0.68*	0.04	77.4	0.56	–0.43	–7.59**
G 103	18.2**	0.50	–0.50	12.68**	85.8**	0.23*	–0.77*	1.86
G 104	10.9	0.72	–0.28	–0.70	72.3	1.04	0.04	–1.30
G 105	17.2	1.37	0.37	–0.79	71.3	1.82*	0.82*	61.07**
G 106	14.9	1.89**	0.89**	6.25**	73.0	1.61	0.61	–106.65**
G 107	16.9	1.14	0.14	3.48	92.7**	1.60	0.60	0.73
G 108	16.6	1.79*	0.79*	3.01	80.6*	0.71	–0.29	–0.89
G 109	16.0	1.98**	0.98**	12.45**	84.4**	1.36	0.36	7.47**
G 110	14.2	1.99**	0.99**	–1.01	63.0	–0.49**	–1.49**	–6.58**
G 111	13.5	0.52	–0.48	–1.03	74.6	1.16	0.16	–7.47**
G 112	20.8**	1.08	0.08	24.74**	84.1**	1.62	0.62	1.11
G 113	29.9**	0.74	–0.26	–0.91	88.1**	0.65	–0.35	59.22**
G 114	14.4	0.14**	–0.86**	3.28	74.0	0.11*	–0.89*	2.44
G 115	15.5	1.47	0.47	–0.11	81.3**	1.22	0.22	1.76
G 116	19.1**	–1.14**	–2.14**	–0.11	83.6**	1.68	0.68	1.83
G 117	17.3	1.20	0.20	12.96**	76.2	0.28**	–0.97	–8.37**
G 118	10.7	0.62	–0.38	–0.21	64.5	1.23	0.23	–0.95
G 119	18.6**	0.93	–0.06	5.38*	87.9**	1.63	0.63	1.49
Avarodhi (ch)	20.0**	0.54	–0.46	1.12	82.9**	1.05	0.05	–7.41**
Population mean	16.7	1.00	—	—	79.3	1.00	—	—
SE ±	0.4	0.22	—	—	0.6	0.34	—	—
CD 5%	0.8	—	—	—	1.2	—	—	—
CD 1%	1.0	—	—	—	1.6	—	—	—

*P = 0.05. **P = 0.01. E—Eberhart and Russell [1], P—Perkins and Jinks [2] models.

to a great extent, by the relative stabilities of different components. Genotypes stable for yield or adaptable to specific environment were also stable or adapted to specific environment for other characters. Grafius [7] suggested that selection for stable genotypes could be augmented through selection for stability of individual yield components.

seeds per pod, and harvest index in chickpea

Grain yield				Pods per plant			
μi	$b^{E}i$	$\beta^{P}i$	$\bar{s}^2_d$	μi	$b^{E}i$	$\beta^{P}i$	$\bar{s}^2_d$
1.17	0.70	–0.23	0.001	42.0	0.88	–0.12	2.83
1.24	1.34	0.34	0.004	44.1^{*}	1.54	0.54	–3.08
1.25	1.03	0.01	0.104^{**}	44.4^{*}	0.60	–0.39	1.37
1.11	0.38	–0.61	0.006	40.0	1.08	0.08	–2.83
1.13	-0.21^{**}	-1.22^{**}	0.007	43.8	1.04	0.04	–3.31
1.17	1.97^{*}	0.97^{*}	0.004	37.3	0.85	–0.15	3.79
1.19	0.64	–0.35	0.002	38.0	1.41	0.41	2.81
1.18	1.04	0.04	0.054^{**}	44.2^{**}	0.13	–0.87	8.94^{*}
1.29^{**}	0.16	–0.84	0.003	46.2^{**}	0.44	–0.56	27.79^{**}
1.21	0.60	–0.40	0.002	43.6	1.14	0.14	5.25
1.20	1.95^{*}	0.95^{*}	-0.043^{**}	40.0	1.12	0.12	4.76
1.17	1.79^{*}	0.79^{*}	0.026^{**}	40.1	1.70^{*}	0.70^{*}	–2.66
1.18	1.33	0.33	-0.014^{**}	44.4	1.79	0.79^{*}	2.93
1.08	-0.05^{*}	-1.05^{*}	–0.001	38.5	0.49	–0.51	6.43
1.29^{**}	1.68	0.68	0.021^{**}	43.3	0.53	–0.47	12.40^{**}
1.21	1.17	0.17	-0.011^{*}	42.6	0.74	–0.26	4.06
1.35^{**}	1.20	0.29	–0.001	47.1^{**}	-0.09^{**}	-1.09^{**}	–0.04
1.19	0.97	–0.03	0.049^{**}	40.6	1.76	0.76	16.23^{**}
1.14	0.12^{*}	-0.88^{*}	0.004	40.0	1.46	0.47	–0.86
1.31^{**}	0.38	–0.62	0.003	43.3	1.40	0.40	70.79^{**}
1.20	1.00	—	—	42.2	1.00	—	—
0.03	0.39	—	—	1.0	0.31	—	—
0.06	—	—	—	1.9	—	—	—
0.08	—	—	—	2.5	—	—	—

Both the models used in the analysis in the present study are associated with each other so that mean and squared deviation from regression ($\bar{s}^2_d$) are similar and regression coefficient of the Perkins and Jinks model is equivalent to b^E-1. The index b^E is the regression coefficient of the Eberhart–Russell's model. Consequently, the ranking pattern of the genotypes under the Perkins–Jinks model will be similar to the pattern under the Eberhart–Russell model. The results of the present investigation show that both the models used can be equally applied for selecting stable genotypes under different environments.

Table 3. Mean genotypic performance over different environments (μi) and environment indices (Ij) for various traits

Character	Kanpur		Deegh		Bharari	
	μi	Ij	μi	Ij	μi	Ij
Grain yield/plant	16.3	–0.39	15.2	–1.49	18.6	1.88
Pods/plant	77.3	–1.94	79.5	–0.22	81.0	1.72
Seeds/pod	1.1	–0.07	1.2	–0.02	1.3	0.09
Harvest index (%)	45.6	3.34	41.1	–1.05	39.8	–0.39

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