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Yield Stability in Chickpea Varieties Under Three Environments

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Abstract

Large environmental influence has been observed on grain yield resulting in yield instability in chickpea. The present study evaluates fifteen chickpea varieties for stability of grain yield and its components following Eberhart and Russell's (1966) model of stability under three different environments (normal sowing at main campus and new research campus and late sowing at main campus) at ICAR-IIPR, Kanpur. The pooled analysis of variance showed that mean square due to genotypes was significant for plant height and primary branches per plant while mean square due to environment was significant for days to pod initiation, plant height, primary branches per plant and grain yield (kg/ha). Days to 50% flowering showed non-significant effect due to varieties, environments and their interaction indicating stable predictable component. Among varieties, Annigeri 1 and BG 372 were environment specific for days to 50% flowering while BG 372 was environment specific for days to pod initiation. BG 372, CSG 8962, DCP 92-3 and RSG 888 were linearly predictable in terms of grain yield because of non-significant deviation from regression. Among these, BG 372, DCP 92-3 and RSG 888 showed regression coefficient around unity indicating their stability across environment whereas CSG 8962 showed regression coefficient less than unity indicating its suitability to unfavourable environment. Most of stable varieties showed yield compensation across environment except RSG 888 which expressed relatively higher mean yield (1720 Kg/ha). Therefore, RSG 888 can be utilised as an agronomic base to develop widely acceptable and stable chickpea varieties.

Chickpea is the most important pulse crop in India. It is cultivated in more than 9.5 M ha in the country with over 10 MT production recorded during 2018-19 (Anonymous, 2019). It is cultivated in a wide range of environments from relatively cooler northern states to warm and harsh conditions of southern states. Large variation is observed in average yield of different states varying from 619 Kg/ha in Karnataka to 1516 Kg/ha in Telangana (APY data). The fluctuation in chickpea production may be attributed to environmental changes and use of varieties that are not adapted to wide range of diversified environments. Stability analysis provides good estimates of genotype (G) and environment (E) main effects and genotype x environment interaction (GxE) effects which are relevant to cultivar evaluation. Higher G x E interaction masks actual genotypic potential leading reduction in genetic gain due to selection. Presence of large genotype x environment (G x E) interaction in chickpea has led to yield instability over years making the crop less lucrative than other rabi cereals like wheat. The presence of G x E interaction has been studied by many workers in chickpea (Bakhsh et al. 2006, Prakash 2006, Atta and Shah 2009, Choudhary and Haque 2010, Ozdemir 2011). The present study evaluates fifteen chickpea varieties for stability of grain yield and its components following

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Eberhart and Russell's (1966) model of stability under three different environments.

Materials and Methods

The material for current study consists of 15 chickpea varieties released for cultivation in India viz., Annigeri 1, Avrodhi, BG 372, C 235, CSG 8962, DCP 92-3, GNG 469, GPF 2, HC 1, JAKI 9218, JG 315, KWR 108, Pant G 114, RSG 888 and RVG 203. The experiment was laid in randomized block design with three replications at ICAR-IIPR, Kanpur. The material was raised under three environments viz., normal sowing at main campus and new research campus and late sowing at main campus at ICAR-IIPR, Kanpur. Observations were recorded on days to 50% flowering, days to pod initiation, plant height (cm), primary branches/ plant and yield (Kg/ha). Each genotype was grown in 4 m long 4 rows on sandy loam soil. Row to row spacing was maintained at 30 cm and plant to plant distance at 10 cm within the row. Standard agronomic practices were followed to raise the crop. Data were recorded on plot basis for phenological traits (days to flowering and maturity) and randomly selected five competitive plants from each genotype per replication for plant height and primary branches/plant. Stability of grain yield and its components was analyzed following Eberhart and Russell's (1966) model of stability.

Results and Discussion

Analysis of Variance: The pooled analysis of variance (Table 1) showed that mean square due to genotypes was significant for plant height and primary branches per plant while mean square due to environment was significant for days to pod initiation, plant height, primary branches per plant and grain yield (kg/ha). Days to 50% flowering showed non-significant effect due to varieties, environments and their interaction indicating stable predictable component. Primary branches per plant appeared to be a non-predictable trait. Similar findings in chickpea were also reported by Rao, (2011), Gupta and Sharma (2009), Ahmad Bakhsh *et al*. (2011) Shivani and Sreelakshmi (2015), Tilahun *et al.* (2015a), Tilahun *et al.* (2015b), Yadav *et al.* (2010), Yadav *et al.* (2014) and Rao and Rao (2004) for yield and yield attributing traits.

Table 1. Pooled analysis of variance for different characters

Source of Variations	df	Mean square				
		Days to 50% flowering	Days to pod initiation	Plant height (cm)	Primary branches/ plant	Yield (Kg/ha)
Varieties	14	72.04	25.26	69.86**	0.55**	245226
Environments	2	96.28	683.28**	95.28*	13.42**	9131186**
Var.* Env.	28	27.02	50.83	21.53	0.42**	141722
Env.+ (Var.* Env.)	30	31.64	93	26.45	1.29**	741019**
Environments (Lin.)	1	192.57*	1366.57**	190.55**	26.84**	18262371**
Var.* Env.(Lin.)	14	11.07	22.99	27.01	0.71**	134092
Pooled Deviation	15	40.11**	73.43**	14.99**	0.12**	139395**
Pooled Error	84	0.04	0.04	0.03	0.0004	6556

Stability Parameters: A stable variety shows unit regression coefficient (bi=1) with zero deviation from regression ($S^2di=0$). Accessions with bi values significantly higher than 1 and non-significant deviation from regression perform better in the favourable environments. Accessions with bi values significantly lower than 1 and non-significant deviations from the regression are more suited to low yielding environments. Those which have both bi and deviation from regression significant are unstable. The pooled stability results are described in Figure 1. Among varieties, Annigeri 1 and BG 372 were

environment specific for days to 50% flowering while BG 372 was environment specific for days to pod initiation. BG 372, CSG 8962, DCP 92-3 and RSG 888 were linearly predictable in terms of grain yield because of non-significant deviation from regression. Among these, BG 372, DCP 92-3 and

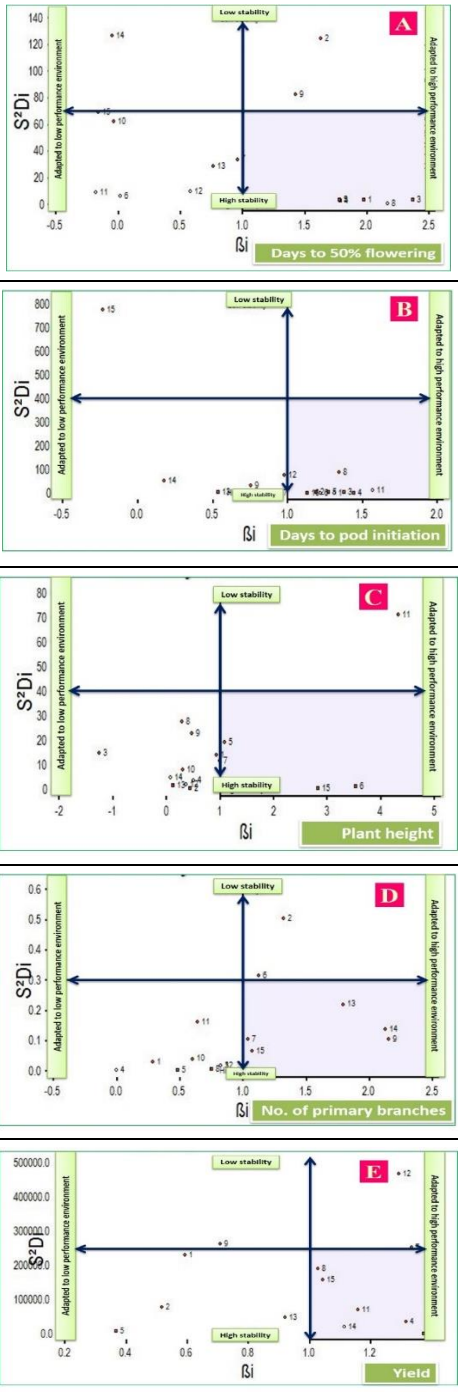

Figure 1. Pooled stability analysis for different traits in chickpea

Codes:- 1: Annigeri 1, 2: Avrodhi, 3: BG 372, 4: C 235, 5: CSG 8962, 6: DCP 92-3, 7: GNG 469, 8: GPF 2, 9: HC 1, 10: JAKI 9218, 11: JG 315, 12: KWR 108, 13: Pant G 114, 14: RSG 888, 15: RVG 203

RSG 888 were stable across environment whereas CSG 8962 showed regression coefficient less than unity indicating its suitability to unfavourable environment. Most of stable varieties showed yield compensation across environment except RSG 888 which expressed relatively higher mean yield (1720 Kg/ha). RSG 888 can be utilised as an agronomic base to develop widely acceptable and stable chickpea varieties.

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