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Genotype x Environment Interaction Studies in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Fourteen genotypes of chickpea were studied under different growing situations (October to December sowing) to characterize stability for seed yield and it's components. The analysis of variance for stability parameters showed that, major portion of genotype x environment interaction was linear in nature for all the characters. Stability for seed yield expressed on the basis of mean performance($\overline{X}$), regression coefficient (bi) and deviation from regression (S^2di) indicated that, the genotypes Phule G-171103, Phule G-171105, Phule G-1107-27-5, Phule G-1131-31-4, Digvijay, Phule Vikram and Phule Vikrant were average stable for seed yield i.e. suitable for all environments which indicated their suitability for wider cultivation. The variety Phule G-1131-31-4 has showed above average stability for pods per plant character i.e. better adaptable to poor environment or stress environment.

Keywords *Stability, Genotype x Environment interaction, chickpea*

Crop variety developed should show stable performance under different environments, especially in India where wide range of environmental conditions are prevailing. It is a need to develop genotypes with high degree of adaptability levels over a wide range of eco-geographical conditions for successful exploitation of its inherent potential. A variety is said to be stable, which can adjust its phenotypic and genotypic status in response to changing environment. The stability analysis study is important as crop improvement. Under such circumstances, it is desirable to have a stable genotype for commercial exploitation over a wide range of environments. The present investigations were therefore under taken to identify stable genotypes under different growing situations (4st Oct, 24th Oct, 4th Dec) for seed yield and it's contributing characters.

MATERIAL AND METHODS

The field experiment was conducted to evaluate fourteen genotypes of chickpea *viz*. Phule G 171101, Phule G 171103, Phule G 171104, Phule G 171105, Phule G 171113, Phule G 1107-27-5, Phule G 1115-13-16, Phule G 1131-31-4, Phule G 1131-31-9, Phule G 1131-31-18 and check varieties Vijay, Digvijay, Phule Vikram and Phule Vikrant under three environments *viz*., E_1 (4st October, 2018), E_2 (24th October, 2018), E_3 (4st December, 2018) at Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during 2018-19 in a Randomized Block Design with three replications. Each genotype was represented by six rows of four meter length with 30 x 10 cm spacing. A light irrigation was given after each sowing date to get good seed germination and plant stand. Field operations v*iz.*, irrigation schedule (1st at 30-35 days after sowing of each sowing date and 2nd at 60-65 days after sowing of each sowing date) was applied. Then weeding was carried out as and when required for each sowing date, so that the field was kept free from weeds. Recommended plant protection measures were adopted for control of pest i.e. *Heliothis armigera. The o*bservations were recorded on randomly selected five competitive plants in each genotype of each replication on the characters *viz*., days to 50% flowering, days to maturity, plant height, plant spread, primary branches per plant, secondary branches per plant, pods per plant, seeds per pod, 100 seed weight and seed yield per plant. The means of these characters were subjected to the stability analysis as per Eberhart and Russel (1966).

RESULTS AND DISCUSSION

The pooled analysis of variance (Table 1) showed that, mean sum of squares due to genotype and environment were highly significant indicating presence of variability among the genotypes and environment. The variance due to Genotype x Environment interaction were found to be significant for all the traits when tested against pooled error. Similar results were reported by Singh and Kumar (1993), Prudhvi Raj *et al.* (2015), Alemu *et al.* (2017) for majority traits in chickpea. Partitioning of G x E interaction showed that, G x E (linear) effect was significant for the characters *viz*., plant height, plant spread, primary

branches per plant, secondary branches per plant, pods per plant, 100 seed weight and seed yield per plant when tested against pooled error. G x E (linear) effect was also significant for the character pods per plant when tested against pooled deviation and pooled error, indicating the predictability of the performance of genotypes over environments.

Both linear and non-linear components of G x E interactions were significant for all the characters indicating that genotypes responded linearly to environmental changes in respect of these characters. The present results are in conformity with earlier reports of Sharma and Maloo (1989), Singh and Kumar (1993), Bhojane (2015), Naveed *et al.* (2016) for majority traits in chickpea.

Estimates of stability parameters for the characters under study are given in Table 2. As per the model suggested by Eberhart and Russel (1966), the genotypes having high mean than population mean, regression coefficient (bi) not deviating from unity and non significant and non significant deviation from regression (S^2di) are considered as stable genotypes or average stable. The genotypes having high mean than population mean, regression coefficient (bi) not deviating from unity but significantly greater than one and non significant deviation from regression (S^2di) are considered as below average stability or the genotype is suitable for favorable environment or rich environment. The genotypes having high mean than population mean, regression coefficient (bi) not deviating from unity but significantly less than one and non significant deviation from regression (S^2di) are considered as above average stability or the genotype is suitable for poor/stress environment. The genotypes with significant S^2di components are considered as highly unpredictable.

The genotypes Phule G-171104 (36.78 cm), Phule G-1131-31-18 (41.48 cm), Digvijay (38.81 cm) and Phule Vikram (42.20 cm) recorded higher mean than population mean (36.35 cm) for plant height with non significant bi value not deviating from unity (1.09, 1.12, 1.36 and 0.80 respectively) and non significant S^2di values (-0.09, 1.69, 0.48 and0.34 respectively) indicating its average stability for this trait i.e. suitable for all environments. The G x E interaction and pooled deviation (non linear component) were found significant for this trait. These results are in conformity with the results of Shafi *et al.* (2012), Chaturvedi *et al.* (2013), and Sharma *and* Johnson (2017).

The genotypes Phule G-1131-31-18 and Digvijay exhibited higher mean (19.46 cm and 22.55 cm respectively) than population mean (18.76 cm) for plant spread with non significant regression coefficient (bi) not deviating from unity (-0.1 and 0.37 respectively) and non-significant deviation from regression (S^2di= -0.19 and 0.11 respectively) indicating their average stability for all the environments. The genotype Phule Vikrant (24.50 cm) had higher mean than population mean (18.76 cm) with regression coefficient (bi= -0.54*) value significantly less than unity and non significant deviation from regression value (S^2di= -0.46) indicating its above average stability i.e. genotype is suitable for poor environment or stress environment for this character. The linear and non linear components of G x E interaction were significant. Chaturvedi *et al.* (2013) and Karpe *et al.* (2013) reported similar results in chickpea.

The genotypes Phule G-1131-31-4 and Phule Vikrant (4.22 and 4.18 respectively) exhibited superior mean than population mean (3.68) for primary branches per plant with non-significant regression coefficient (bi = 0.86 and -0.44 respectively) close to unity with non-significant deviation from regression (S^2di = 0.01 and 0.09 respectively) indicating their average stability for all the environment. The linear and non linear components of G x E interaction were significant. These results are in conformity with the results of Yadav *et al.* (2014), Bhojane (2015), Prudhvi Raj *et al.* (2015).

The genotypes Phule G-171103 (15.05), Phule G-1107-27-5 (14.31), Phule G-1131-31-18 (14.18), Vijay (14.75), Digvijay (14.51) and Phule Vikrant (15.80) recorded higher mean than population mean (13.87) for secondary branches per plant with non-significant regression coefficient (bi= 1.58, 1.61, 1.92, 1.09, 0.93, 0.81 and 1.34 respectively) close to unity and non-significant deviation from regression (S^2di= 0.62, 0.91, -0.22, 0.02, -0.17 and -0.19 respectively) values indicating their average stability for this trait. The linear and non linear components of G x E interaction were significant. Singh and Sandhu (2006), Yadav *et al.* (2014) and Prudhvi Raj *et al.*(2015) recorded similar results in chickpea.

The genotypes Phule G-171103, Phule G-171105, Phule G-1131-31-18, Phule Vikram and Phule Vikrant (39.38, 39.73, 37.46, 36.18 and 39.07 respectively)

Table 1 : ANOVA for stability as per Eberhart and Russell Model (1966) in Chickpea

Sr. No.	Sources/Characters	G	E	G x E	E+ G x E	E (L)	G x E (L)	P.D. (Pooled deviation)	P.E. (Pooled error)
1	Days to 50% flowering	8.64+**##	217.13++**##	3.92##	19.15+**##	434.26**##	5.78*##	1.92##	0.33
2	Days to maturity	74.09*##	577.57++**##	47.26##	85.14**##	1155.12**##	69.12*##	23.58##	0.73
3	Plant height (cm)	47.81++**##	219.65++**##	5.84##	21.11+**##	439.30**##	7.18##	4.18##	1.01
4	Plant spread (cm)	19.26*##	146.99++**##	10.12##	19.99+*##	293.97**##	12.04##	7.61##	0.48
5	Primary branches per plant(No.)	0.82++**##	0.53##	0.17##	0.19##	1.06*##	0.18##	0.15##	0.04
6	Secondary branches per plant (No.)	5.22++**##	37.53++**##	1.68##	4.24+**##	75.06**##	1.99##	1.27##	0.37
7	Pods per plant (No.)	62.18++**##	480.25++**##	21.23**##	54.02+**##	960.50**##	37.68**##	4.45##	0.93
8	Seeds per pod (No.)	0.023++*##	0.009#	0.008##	0.008##	0.017##	0.008##	0.007##	0.002
9	100 seed weight (g)	38.20++**##	15.92++**##	0.88##	1.96+**##	31.83**##	1.21##	0.52##	0.19
10	Seed yield per plant (g)	4.81++**##	35.59++**##	0.65##	3.14+**##	71.18**##	0.68##	0.56##	0.13

+, ++ = Significant at 5 and 1 % level of significance, respectively against G x E

*, ** = Significant at 5 and 1% level of significance, respectively against the pooled deviation (PD)

#, ## = Significant at 5 and 1% level of significance, respectively against the pooled error (PE)

Table 2 : Stability parameters of yield and yield components

SN	Geno-type	Plant height (cm)			Plant spread (cm)			No. of primary branches per plant			No. of secondary branches per plant			No. of pods per plant			100 seed weight (g)			Yield per plant (g)		
		Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di
1	Phule G 171101	34.74	1.95	1.51	17.25	1.96	3.15**	2.89	1.53	-0.03	13.43	0.12	2.33**	28.37	1.31	-0.75	20.12	1.29	-0.21	11.24	1.57*	-0.13
2	Phule G 171103	32.53	1.08	-1.30	18.55	2.10*	-0.47	2.88	1.63	0.23**	15.05	1.58	0.62	39.38	0.50	0.53	26.68	1.27	0.84*	13.51	0.66	0.27
3	Phule G 171104	36.78	1.09	-0.09	17.54	0.81	1.44*	3.48	2.70	0.02	12.56	1.59	-0.33	29.43	1.45	0.02	20.32	1.02	0.72	10.77	1.18	1.28**
4	Phule G 171105	39.60	0.94	11.53**	17.60	0.96	0.82	4.21	0.30	0.05	14.51	-0.07	-0.10	39.73	0.83	-0.62	27.44	1.41	-0.19	13.78	0.77	0.25
5	Phule G 171113	38.11	0.85	7.38*	17.43	0.79	0.09	3.06	0.56	-0.03	11.27	1.37	4.85**	25.75	0.36	13.98**	20.74	1.05	0.09	11.15	1.29	0.85**
6	Phule G 1107-27-5	32.15	0.84	2.79	16.00	0.58	4.43**	3.46	2.25	0.17*	14.31	1.61	0.91	34.23	0.47	-0.75	27.56	1.02	-0.17	13.14	0.97	-0.09
7	Phule G-1115-13-16	36.12	0.85	12.16**	14.86	1.13	-0.45	3.86	-2.77	0.93**	11.91	0.73	2.91**	32.87	2.30	11.09**	20.70	1.12	0.26	11.14	1.47	1.44**
8	Phule G -1131-31-4	40.60	-0.18	4.53*	20.62	1.42	44.48**	4.22	0.86	0.01	14.37	1.92	0.46	40.12	0.86*	-1.01	27.52	1.39	0.22	13.88	0.63	0.32
9	Phule G-1131-31-9	30.03	1.33	-0.35	17.51	1.49	5.69**	3.17	0.31	-0.03	12.60	0.57	1.22*	33.32	2.44	10.88**	20.42	1.10	-0.01	11.36	1.44	0.53*
10	Phule G -1131-31-18	41.48	1.12	1.69	19.46	-0.10	-0.19	4.21	1.98	0.11*	14.18	1.09	-0.22	37.46	1.09	-0.77	27.46	0.94	-0.16	14.10	0.42	1.23**
11	Vijay(Ch)	30.65	1.34	-0.51	19.21	1.71	25.58**	3.61	2.79	0.09	14.75	0.93	0.02	31.47	1.08	-0.50	20.20	1.31	-0.18	10.85	1.16	-0.02
12	Digvijay (Ch)	38.81	1.36	0.48	22.55	0.37	0.11	3.97	-0.13	-0.001	14.51	0.81	-0.17	35.54	-0.38	14.26**	27.47	1.43	-0.17	12.72	0.56	0.15
13	Phule Vikram (Ch)	42.20	0.80	0.34	19.60	1.28	15.71**	4.27	2.39	-0.03	14.90	0.35	0.48	36.18	0.99	2.36	22.03	-1.46	2.95**	13.44	1.02	0.009
14	Phule Vikrant (Ch)	35.14	0.59	-1.13	24.50	-0.54*	-0.46	4.18	-0.44	0.09	15.80	1.34	-0.19	39.07	0.64	-0.67	28.01	1.06	-0.10	12.93	0.79	-0.04
	Mean	36.35			18.76			3.68			13.87			34.50			24.05			12.43		
	S.E.±	1.44	0.36		1.95	0.60		0.27	1.41		0.79	0.48		1.49	0.25		0.51	0.47		0.53	0.33	

bi = Regression coefficient, S2di =Deviation from regression, * = Significant at 5 % level, ** = Significant at 1 % level

Table 3: Estimation of environment index (Ij) under different environments

Sr. No.	Characters	Environmental index (Ij)		
		E1	E2	E3
1	Days to 50 % flowering	-3.06	1.39	4.44
2	Days to maturity	-6.92	1.15	5.77
3	Plant height (cm)	-2.90	-1.61	4.51
4	Plant spread (cm)	-0.80	3.57	-2.77
5	Primary branches/plant	-0.17	-0.04	0.21
6	Secondary branches/plant	-1.66	1.62	0.04
7	Pods/plant	-5.46	6.19	-0.73
8	Seeds/pod	0.03	-0.01	-0.02
9	100 seed weight (g)	-1.10	1.03	0.07
10	Seed yield /plant (g)	-1.81	1.18	0.63

recorded high mean than population mean (34.50) for pods per plant with non significant bi values (0.50, 0.83, 1.09, 0.99 and 0.64 respectively) and non significant S^2di values (0.53, -0.62, -0.77, 2.36 and -0.67 respectively) indicating average stability for the given character. The genotype Phule G 1131-31-4 (40.12 cm) had higher mean than population mean (34.50 cm) with regression coefficient (bi= 0.86*) value significantly less than unity and non significant deviation from regression value (S^2di= -1.01) indicating its above average stability i.e. genotype is suitable for poor environment or stress environment for this character. These results are in conformity with the results of Yadav *et al.* (2014), Prudhvi Raj *et al.* (2015) and Desai *et al.* (2016).

The genotypes Phule G-171105, Phule G-1107-27-5, Phule G-1131-31-4, Phule G-1131-31-18, Digvijay and Phule Vikrant recorded high mean (27.44, 27.56, 27.52, 27.46, 27.47 and 28.01 g respectively) performance than population mean (24.05 g) for 100 seed weight with non-significant regression coefficient value (bi= 1.41, 1.02, 1.39, 0.94, 1.43 and 1.06 respectively) and non-significant deviation from regression (S^2di= -0.19, -0.17, 0.22, -0.16, -0.17 and -0.10 respectively) indicating their average stability for this character. The linear and non linear components of G x E interaction were significant. Karpe *et al.* (2013), Qureshi *et al.* (2015), Sharma and Johnson (2017) and Varma *et al.* (2019) reported similar results in chickpea.

The genotypes Phule G-171103 (13.51), Phule G-171105 (13.78), Phule G-1107-27-5 (13.14), Phule G-1131-31-4 (13.88), Phule Vikram (13.44), Phule Vikrant (12.93) and Digvijay (12.72) recorded high mean performance than population mean (12.43 g) for seed yield per plant with non-significant regression coefficient value (bi= 0.66, 0.77, 0.97, 0.63, 1.02, 0.79 and 0.56 respectively) and non-significant deviation from regression (S^2di= 0.27, 0.25, -0.09, 0.32, 0.009, -0.04 and 0.15 respectively) indicating their average stability for this character. The linear and non linear components of G x E interaction were significant. Desai *et al.*(2016), Tolga *et al* (2018) and Varma *et al* (2019) reported similar result in chickpea.

Estimates of environmental indices

Estimates of environmental indices (Ij) are presented in Table 3, which revealed that environment E_1 (04th October) was favourable for characters under study *viz*., day to 50% flowering, days to maturity and seeds per pod. Environment E_2 (24th October) was favourable for the characters *viz*., plant spread, secondary branches per plant, pods per plant, 100 seed weight and seed yield per plant. Environment E_3 (04th December) was favourable for the characters *viz*., plant height, primary branches per plant, secondary branches per plant, 100 seed weight and seed yield per plant.

In general environment E_2 (24th October) was most favourable for yield and yield contributing characters.

LITERATURE CITED

Alemu, B. and Lule, D. 2017. Genotype by environment interactions and grain yield stability of released and advanced Desi type chickpea (*Cicer arietinum* L.) genotypes in western Ethiopia. *International Journal of Biotechnology and Molecular Biology Research*. **8**(3) : 30-37.

Bhojane, S. B. 2015. Stability analysis for yield and yield contributing characters in chickpea (*Cicer arietinum* L.). M.Sc. (Agri) thesis submitted to College of Agriculture, Badnapur, VNMKV, Parbhani.

Chaturvedi S.K., Aski Murleedhar, Nadarajan N., Mishara Neelu 2013. Stability analysis of elite chickpea (*Cicer arietinum* L.) lines for yield and yield attributes under rainfed condition. *Journal of Food Legumes* **26** : 1-2

Desai, K., Tank, C.J., Gami, R.A. and Patel, A.M. 2016. G x E Interaction and stability analysis in chickpea (*Cicer arietinum* L.). *International Journal of Agriculture, Environment and Biotechnology Citation: IJAEB*: **9**(4): 479-484.

Eberhart, S.A. and Russell, W.L. 1966. Stability parameters for comparing varieties. *Crop Sci.*, **6** : 36-40.

Karpe, P. G. 2013. Stability analysis in chickpea (*Cicer arietinum* L.). M.Sc. (Agriculture) thesis submitted to Post Graduate Institute, Mahatma Phule Krishi Vidyapith, Rahuri.

Naveed, M., Shafiq, M., Rafiq, Ch.M., Naeem, M.K. and Amin, M. 2016. Grain yield stability of newly evolved desi chickpea strains under rainfed Conditions. *The Journal of Animal and Plant Sciences*, **26** (2): 481-486.

Prudhvi Raj V., Gaytonde, V., Jaiswal, D. K. and Shinde, S.R. 2015. Effect of different sowing dates on primary characters of chickpea (*Cicer arietinum* L.) genotypes. *Trends in Biosciences*, **8**(19): 5417-5420.

Qureshi, S.T., Yasmeen, A., Abassi. A.R., Qureshi, A.S., Gafoor, A., Memon, M.N. and Soomro, N. 2015. Evaluation of chickpea genotypes under different environments for stability of quantitative traits. *Sindh University Research Journal* (Sci. Ser.), **47**(3): 559-562.

Shafi, A., Ghulam, S., Zahid, A., Talat, M., Bakhsh, A. and Noorka, I.R. 2012. Stability analysis for yield and yield components in chickpea (*Cicer arietinum* L.) genotypes across three rainfed locations of Pakistan. *Pakistan Journal of Botany*, **44**(5): 1705-1709.

Sharma, P.P. and Maloo, S.R. 1989. Phenotypic stability in chickpea (*Cicer arietinum* L.). *Madras Agric. J.*, **76**(7) : 400-405.

Sharma, R. N. and Johnson, P. L. 2017. Genotype x Environment interaction and stability analysis for yield traits in chickpea (*Cicer arietinum* L.) *Electronic Journal of Plant Breeding*, **8**(3): 865-869.

Singh, O. and Kumar, S. 1993. Phenotypic stability of yield and related characters in desi gram (*Cicer arietinum* L.). *Indian J. Agril. Sci.* **64** (12) : 815- 820.

Singh Amandeep and Sandhu J.S. 2006. Genotype x Environment interaction in chickpea. *Crop Improvement*, **33**(1): 67-69.

Tolga, K., Aybegun, T., Adem, E. 2018. Genotype x Environment interaction and stability analysis for the yield and yield components in winter chickpea (*Cicer arietinum* L.). Fresenius Environmental Bulletin. September 2018.

Varma, P., Punia, S. S. and Kumar, R. 2019. Stability analysis in chickpea (*Cicer arietinum* L.) for higher productivity and sustainability in south eastern Rajasthan. *International Journal of Agriculture Sciences* 11(7): 8196-8197.

Yadav A, I. S. Yadav and C.K. Yadav 2014. Stability analysis of yield and related traits in chickpea. *Legume Res.*, **37** (6) : 641-645.

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