Original Research Article

Stability in phonological, yield and yield attributes ofchickpea (*Cicer arietinum* L.) Genotypes under various temperature conditions

ABSTRACT

An experiment was conducted with a set twenty-five genotypes of desi and Kabuli chickpeas to estimate stability parameters in Randomized Block Design with two replications under four environments (1st November 2018 (normal), 21st November 2018 (optimum), 15th December 2018 (late) and 15th January 2019 (extremely late) conditions during Rabi-2018-19. The analysis of variance showed a significant connection among genotypes, environment (linear), and genotype environment (linear) in all the traits in investigation.The JG-11, JAKI-9218, RVG-201 and RVSSG-54 thesegenotypes suitable for high seed yield withlate and very-late sown conditions.

Key words: Chickpea, heat stress, Stability analysis

Introduction

Pulses, also known as food legumes, are a staple crop belonging to the *Fabaceae* family and are the second-largest producer of protein and vitamins worldwide after cereals. Particularly for vegetarians, who make up a huge part of our Indian population, they are a significant and affordable source of nutritional protein. Minerals including calcium, phosphorus, iron, and a few important amino acids are abundant in pulses. Therefore, consuming too few pulses could have detrimental effects on one's health. A key source of protein,chickpeas are a cool-season crop.Chickpea is a food legume grown primarily in arid and semi-arid zones in India, where it is frequently subjected todrought and high temperatures during the reproductive stage. Chickpea flowering and podding are highly sensitive to changes in the external environment, with drastic reductions in seed yields reported when plants are exposed to high temperatures (Bahuguna *et al.* 2012). Chickpeas are well tailored for growth and pod filling in a range of temperatures 30-15°C (Basu*et al.* 2011). Chickpeas should be planted in the mid of October in dry land areas and in the first week of November in semi-arid areas. Since the post reproductive crop stage is exposed to high temperatures (>35°C), a delay in sowing results in a dramatic reduction in yield.Due to the chickpea's inclusion in innovative cropping systems and intensive sequential cropping techniques that cause chickpea to spend a prolonged amount of time in high temperatures during the growing season, primarily during the reproductive period, the area of chickpea under late sown conditions has increased over the last decade, especially in northern and central India. The effect of high temperatures on crops is determined by the timing of heat stress with sensitive stages of crop growth. Chickpea flowering and podding are extremely sensitive to changes in the external climate, and when plants are exposed to high temperatures, seed yields are drastically reduced (Krishnamurthy *et al.*, 2011, Devasirvatham*et al.*, 2012). Berger *et al.*, (2011) used climate analysis and current production patterns to characterise the general chickpea

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distribution. According to the climate studied, the current chickpea growing area is threatened by rising temperatures, and production can shift to cold areas. Chickpea grain yield decrease by 53 kg per ha. in UP (India) and 30 kg per ha. in Haryana (India) with each 1°C rise in seasonal temperature in north India (Kalra *et al*., 2008). Plants reactions to high temperatures vary. Respiration, seed quality, membranestability,photosynthesis,f ertilization, fruit maturation, and nutrient absorption are all harmed by high temperatures (Basu*et al*., 2011).These studies were used to do a variance stability study on seed yield and its correlated traits using Eberhart and Russell's (1966) model for phenotypic stability of genotypes. Three factors make up the Eberhart and Russell (1966) model: (a) mean yield across locations or seasons; (b) regression coefficient; and (c) deviation from regression. A stable variation, in accordance with this concept, is one that has a regression coefficient of unity (b=1) and the least amount of departure from the regression line (s2d=0). According to their description, a breeder would typically want to create a variety that has a high mean yield and meets the aforementioned criteria for stability (Pundan and Narayanan, 2004).The present investigation was undertaken to identify chickpea genotypes for cultivation in mid-late and very late irrigated sown conditions.

Materials and methods

25 genotypes of desi and Kabuli chickpea were used as the experimental material for the ongoing study. The exploratory study was conducted at the Rafi Ahmad Kidwai (RAK) College of Agriculture in Sehore(M.P.) during the *rabi* seasons of 2018–19 using a randomised complete block design (RCBD) with two replications. Inter-row spacing on the research plot was 30.0 cm, and intra-row spacing was 10.0 cm. To successfully cultivate the crop, the recommended agronomical methods were put into operation.Chickpea genotypes were grown in four environments (1st November 2018 (early), 21st November 2018 (optimum), 15th December 2018 (late) and 15th January 2019 (very-late). Five modest evocative plants are selected at random from the plot in each replication for recording the further quantitative observations on yield and its contributing traits. The observations were recorded on fourteen Phonological traits. The data were collected ondays to 50 per cent flowering, days to first pod initiation, pollen fertility (per cent), vegetative period, reproductive period, days to maturity,plant height (cm), number of pods per plant, number of empty pods per plant, number of seeds per plant, Biological yield per plant (g), hundred seed weight (g), harvest index (per cent), Seed yield per plant (g)were recordedeach of the four environments separately.

Results and Discussion

The stability analysis of variance for seed yield and its component characters pooled over four sown conditions presented in Table-I. For all the characters, the variance analysis showed significant differences between genotypes. The mean square sum was highly significant for all the characters due to the environment (linear). It showed that the environment varies significantly from one another. For all the characters significant except first pod initiation, pollen fertility (%), vegetative period, reproductive period, and seeds per plant for genotype × environment (linear) interaction is acquired when checked against pooled error.The stability response didn't are same for all of the qualities but was also particular for certain genotypes' attributes (Yadav et al. 2014).The stability parameters were estimated for all the traits of each genotype and presented in table 2. According to 'Eberhart and Russell' (1966) model which considered both linear (bi) and non-linear (S^2di) component of genotypesx environment interaction to predict genotype performance, the regression coefficient (bi<1) and insignificantly deviated from regression (S^2di=0) with high mean performance over the population would be the ideally suitable for the normal sown environment [optimum (E-II) & early (E-I)] with high yield. The (bi >1) value,which is lower than the average population indicates that it is below average stability and expected to be appropriate for the late sown environment [very-late (E-IV) &late (E-III)]with low yields. However, if the less than the unity (bi<1) with a low mean yield, it indicated that these genotypes stable in early and optimum sown environments [optimum (E-II) and early (E-I)] with low mean yield. However, if bi value greater than a unit (bi>1) with a high mean value, hence, these genotypes perform better under late and very-late sown environments [very-late (E-IV) and late (E-III)] and recommended for high seed yield.

Table 1 Stability analysis of variance for seed yield and its contributing characteristics under four different environmental conditions.

Source of Variation	**Variety**	**Env.**	**Var. X Env.**	**Env + Var X Env.**	**Env (Linear)**	**Var. X Env. (Lin)**	**Pooled Deviation**	**Pooled Error**	**Total**
DF	**24**	**3**	**72**	**75**	**1**	**24**	**50**	**96**	**99**
Character									
CH1	50.06**	2,351.2**	5.8**	99.6**	7053.1**	8.8**	4.2**	1.9	
CH2	133.5	1268.2	9.8	60.2	3804.7	6.7	10.9	1	
CH3	5.2	1035.9	3.5	44.8	3107.8	7.2	1.7	1.1	
CH4	147.4	625	6.1	30.8	1875	8.3	4.7	0.72	
CH5	68.5	1118.8	12	56.3	3356.4	11.9	11.6	2.3	
CH6	140.3**	838.1**	8.5**	41.7**	2514.5**	10.6**	7.2**	1.6	
CH7	95.7**	389**	6.1**	21.4**	1166**	10.8**	3.6**	1.4	
CH8	296.2**	1,900**	36.0**	110.5**	5700.**	73.0**	16.8**	8.2	
CH9	9.3**	27.1**	2.1**	3.1**	81.4**	1.4*	2.3**	0.93	
CH10	356.5**	1952**	55.5**	131.4**	5855**	2.9	30.6**	10.4	
CH11	23.5**	876.6**	6.1**	40.9**	2,629.8**	5.0**	6.3**	1.7	
CH12	353.7**	53.1**	5.1**	7.0**	159.4**	8.9**	3.0**	0.7	
CH13	88.0**	915.9**	37.9**	73.0**	2747.8**	83.6**	14.4**	4.4	
CH14	9.1**	131.9**	1.9**	7.1**	395.9**	2.8**	1.4**	0.38	

Note: * and ** significant at 5% and 1% level of probability, respectively against pooled deviation and pooled error

CH1-Days to 50 % flowering, CH2-Days to 1st pod initiation, CH3-Pollen fertility (%) CH4-Vegetative period, CH5-Reproductive period, CH6-Days to maturity, CH7-Plant height (cm), CH8-Number of pods per plant, CH9-Number of empty pods per plants, CH10-Number of seeds per plant, CH11-Biological yield per plant (g), CH12-100 seed weight (g), CH13-Harvest index (%), CH14-Seed yield per plant (g)

The stability parameters for seed yield and its contributing traits under 25 chickpea genotypes in four environments and presented in table II. The genotypesJG-14, RVG-202, JGK-5 had regression coefficient having less than one with high mean than population mean. It indicated that these genotypes perform better under normal sowing conditions and recommended for high seed yield. The genotypes JG-11, JAKI-9218, RVG-201 and RVSSG-54 had regression coefficient was greater than one with a high mean thanpopulation mean and deviation from regression around to zero. Therefore, these genotypes could be recommended the bestsuitable genotypes for late and very late shown condition because their higher yield performance were recorded in late as well as very late sowing Conditions.

Table 2 Stability parameters for seed yield and its contributing characteristic over four environmental conditions in 25 genotypes of chickpea.

Seed Yield Per Plant (G)				
S. No.	**Genotype**	**mean ($\bar{X}$)**	**Bi**	**S^2_{di}**
1	**JG-6**	6.87	0.495	2.76**
2	**JG-11**	8.33	1.766	-0.07
3	**JG-14**	6.82	0.356	1.29
4	**JG-16**	5.94	0.725	1.67*
5	**JG-63**	6.27	1.333	4.03**
6	**JAKI-9218**	7.99	1.12	0.2
7	**RVG-201**	7.3	1.2	-0.02
8	**RVG-202**	6.5	0.73	0.05
9	**RVG-203**	7.05	1.46	2.50**
10	**RVG-204**	6.98	1.13	1.92**
11	**ICCV-10**	4.43	0.3	0.09
12	**RSG-888**	6.15	1.56	1.57*
13	**VIJAY**	4.8	1.12	-0.1
14	**JG-74**	5.17	1.17	-0.15
15	**RVSSG-54**	9.02	1.41	0.13
16	**JG-315**	6.18	1.52	6.77**
17	**RVG-205**	4.1	0.712	0.66
18	**BGD-112**	3.12	0.43	0.2
19	**ICC-4812**	2.8	0.32	0.27
20	**KAK-2**	5.57	0.86	0.05
21	**JGK-5**	5.98	0.67	0.44
22	**RVKG-101**	5.55	1.15	0.78
23	**JGK-3**	4.85	1.09	0.11
24	**RVKG-151**	5.54	1.47	2.96**
25	**RVKG-111**	4.49	0.81	4.19**
	General Mean (GM)	5.92	1	
	SE Mean	0.7	0.3	

Note: * and ** are significant against pooled deviation at 5 per cent and 1 per cent likelihood levels, respectively.

Five stable genotypes RVG-205, KAK2, ICC-4812, ICCV-10 and BGD-112 had regression coefficient having less than one with less mean than grand mean. Therefore, thesegenotypes had above average stability but is not suitable for cultivation due to poor seed yield recorded in normal sowing condition [optimum (E-II) & early (E-I)]. The genotypes VIJAY, JG-74, RVKG-101 and JGK-3 had regression coefficient higher than one with lower mean value than grand mean and deviation from regression around zero. it indicates that it is below average stability and expected to be appropriate for the late and very-late environment with low mean yield.

Conclusions

According to the stability parameters, the genotypes JG-14, RVG-202, and JGK-5 were recommended forcultivation in early and optimum sown conditions with high means yield. Genotypes JG-11, JAKI-9218, RVG-201, and RVSSG-54 were performed stable in late and very-late planting conditions and identified for high seed yield.

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