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Analysis of Genetic Variability parameters for Seed Yield and its attributing Traits of *desi* Chickpea (*Cicer arietinum* L.) under different Environments in West Bengal

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ABSTRACT

Twenty two promising *Desi* chickpea genotypes were grown in RBD with two replications under normal and late sown high temperature conditions with objective to estimate genetic variability for seed yield and its attributing traits to identify potential genotypes for heat tolerance. The maximum genotypic and phenotypic coefficients of variability (GCV and PCV) were observed for number of seeds per pod, 100-seed weight and seed yield per plant under both environments, whereas number of primary branches per plant recorded minimum in late planting conditions. The high heritability coupled with high genetic advance as per cent of mean (GAM) was observed for all traits except days to maturity, plant height and number of pods per plant under both environments but the harvest index recorded moderate heritability coupled with low GAM in late planting conditions. This implies the presence of more additive gene effects for potential crop improvement. On the basis of mean performance for important economic traits under both environments, the genotypes ICCV 92944, Annigeri-1, JG-6, RSG-888, RSG-945 and ICCV-10 were identified as best performer for the number of pods per plant, 100-seed weight, seed yield per plant and harvest index, as well as these genotypes were identified as heat tolerant for the respective traits. The genotype ICCV 10 had stable for yield and yield related traits over both environments, therefore it could be tested over locations for stability verification and for further use in breeding program.

Keywords: Chickpea, Genetic variability, Environments (normal and late sown), Heat tolerance.

INTRODUCTION

Among the pulses, Chickpea (*Cicer arietinum* L.) is a major food legume and an important source of protein in many countries specifically in Asia and Africa. The crop is mainly grown under rainfed conditions either on stored soil moisture in subtropical environments with summer dominant rainfall or on current rainfall in winter-dominant Mediterranean-type environments. In both environments, a water shortage and high temperature as the plant enters its reproductive phase induces the end of reproductive development (Siddique *et al.*, 2000; Turner 2003, 2004; Turner *et al.*, 2006). This end-of-season drought is termed "terminal heat stress". However, the crop productivity continues to be low in the country and West Bengal with a productivity of 840 kg per ha and 1073 kg per ha respectively (Anonymous 2016). Hence, there is an urgent need to enhance its productivity in order to meet protein requirement of India. In the state of West Bengal, it is mainly cultivated under rainfed receding soil moisture condition immediately preceded by rice crop. The state is experiences high night temperature (25^{0}C) (Anon, 2015) during the peak reproductive stage (January) of chickpea and is an important factor for limiting yield in chickpea. Thus, there is a need to investigate the effect of high temperature on yield and its attributing characters in chickpea.

Furthermore, crop improvement depends upon the magnitude of genetic variability and the extent to which desirable characters are heritable. Genetic variability for yield and yield components is essential in the base population for successful crop improvement (Allard, 1960). Genetic parameters such as genotypic, phenotypic coefficient of variability (GCV and PCV) are useful in detecting the amount of variability present in the available genotypes. Heritability and genetic advance helps in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection (Robinson *et al.* 1949). Genetic variability for pod development imposed by high temperature conditions has been studied by Meshram *et al.* (2014). Mirzaei *et al.* (2010) reported that seed weight, seed yield, biological yield and harvest index were reduced with delay in planting date under dry conditions. But still there is much effort is needed to study the genetic variability for heat tolerance in chickpea.

Hence, the present investigation was undertaken to elucidate the genetic variability, heritability and genetic advance for different quantitative characters in chickpea under normal and late sown high temperature conditions of West Bengal.

MATERIALS AND METHODS

The present investigation was undertaken at the District Seed Farm (AB Block), Kalyani under Bidhan Chandra Krishi Viswavidyalaya during winter season of 2014-15 in upland situation. The farm is situated at approximately 22° 56′ N latitude and 88° 32′ E longitude with an average altitude of

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9.75 m above mean sea level (MSL). Whereas, the air temperature varied from 7.5°C being minimum in January and more than 35.5°C being maximum in April. Therefore, the month of April is highly suitable for screening the heat tolerant genotypes under natural field conditions.

An experimental material comprised of twenty two genotypes of chickpea (*Cicer arietinum* L.). The genotypes were diverse with respect to morphological and important economical traits. Among the genotypes, WBG 39/2 and Pusa-256 were considered as local checks. List of genotypes is given in Table 1. The genotypes were sown on 18th November 2014 (as normal sown) and 1st January 2015 (as late sown) and laid out in Randomized Complete Block Design (RCBD) with two replications. Each entry was accommodated in a row length of two meter, keeping plant to plant distance of 10 cm and row to row distance of 30 cm.

The recommended agronomical and plant protection practices were adopted for good crop growth. Observations were recorded on five randomly selected plants in each entry for ten characters *viz.*, days to 50 per cent flowering, days to maturity, number of primary branches per plant, plant height, number of pods per plant, number of seeds per pod, biological yield per plant (gm), 100-seed weight (gm), seed yield per plant (gm), and harvest index (%) and their mean values were used for the statistical analysis. The genotypic and phenotypic coefficient of variability (GCV and PCV) were estimated as per the formulae suggested by Burton (1952), while, heritability in broad sense was calculated by using the formulae suggested by Allard (1960).

Table 1: Pedigree information of 22 genotypes of chickpea (*Cicer arietinum* L.) analysed in the present study.

Sl. No.	Name of the genotypes	Release name	Pedigree
1	RSG-963	Aadhar	RSG 524 x PDG 84-10
2	WBG 39/2 (Check)	Anuradha	Mahamaya 1 x Radhey
3	PUSA-372	BG 372	P 1231 x P 1265
4	RSG-888	RSG-888	RSG 44 x E 100 Y
5	Vaibhav	IG 9218	Selection from GP ICCV 91106
6	RSG-945	Asha	RSG 668 x RSG 817
7	JGG-1	JGG-1	Selection from germplasm
8	Phule G 81-1-1	VIJAY	P 127 X Annegeri 1
9	Pusa 256 (Check)	BG-256	(JG 62 x 850-3/27) x (L 550 X H 208)
10	ICCV 92944	JG-14	(GW-5/7 x P-326) x ICCL 83149
11	ICCV 96970	JG-16	(ICCC 42 x ICCV 88506) x (KPG 59 x JG 74)
12	ICCV-10	Bharati	P 1231 x P 1265
13	ICCV 93952	JAKI-9218	(ICCC 37 x GW 5/7) x ICCV 107
14	Chaffa	Chaffa	Selection from Niphad (MS)
15	JG-315	JG-315	Selection from WR 315
16	Phule G12	VIKAS	GW 5/7 x Ceylon 2
17	RSG-974	Abilasha	K-850 x RSG-515
18	PUSA-547	Pusa547	Mutant of BG 256
19	Annigeri-1	Annigeri -1	Selection from local germplasm
20	RSG-2	Kiran	Mutant of RS 10
21	JG-6	JG-6	(ICCV 10 X K 850)x (H208 X RS11)
22	Gujarat Gram 4	GCP105	ICCL 84224 x Annegeri

RESULTS AND DISCUSSION

In the present investigation, significant differences in crop phenology were observed among twenty two genotypes of chickpea under both environments (normal and late sown). This suggested the existence of sufficient genetic variability in the genotypes studied.

Table 2: Genotypic and phenotypic coefficient of variations, heritability and genetic advance expressed as per cent of mean for ten characters in normal and late sown genotypes of chickpea.

Characters		PCV (%)	GCV (%)	h^2% BS	GAM (%)
Days to 50 per cent flowering	NS	15.9	12.8	65.3	21.4
	LS	19.0	14.0	54.5	21.3
Days to maturity	NS	7.2	5.8	64.7	9.6
	LS	7.8	5.6	50.8	8.2
Number of primary branches per plant	NS	17.6	15.6	79.1	28.6
	LS	28.5	22.5	62.6	36.7
Plant height (cm)	NS	11.1	9.1	66.5	15.2
	LS	8.2	6.0	54.3	9.2
Number of pods per plant	NS	13.7	11.1	65.9	815
	LS	16.2	11.9	54.2	18.1
Number of seeds per pod	NS	40.2	36.9	84.2	69.8
	LS	47.7	40.6	72.4	71.1
Biological yield per plant (gm)	NS	18.0	16.2	80.6	30.0
	LS	18.6	14.9	64.0	24.5
100-seed weight (gm)	NS	22.0	19.6	79.3	35.9
	LS	28.3	24.9	77.3	45.1
Seed yield per plant (gm)	NS	22.8	21.1	85.8	40.3
	LS	30.9	25.7	69.3	44.1
Harvest Index (%)	NS	9.6	8.0	70.5	13.9
	LS	15.3	11.7	58.2	18.4

NS- Normal sown, LS- Late sown

Table 3: Mean performance of 22 genotypes of chickpea for 10 characters grown under normal and late sown high temperature conditions.

Genotype		Days to 50 per cent flowering		Days to maturity		Number of primary branches per plant		Plant height (cm)		Number of pods per plant		Number of seeds per pod		Biological yield per plant (gm)		100-seed weight (gm)		Seed yield per plant (gm)		Harvest Index (%)	
		NS	LS	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Annigeri-1		42.0	35.0	99.5	91.5	6.2	3.8	50.0	41.5	104.5	90.8	2.1	1.9	143.0	123.5	20.5	16.5	58.5	45.0	40.9	36.4
WBG 39/2 (Check)		55.5	48.0	114.0	102.0	4.9	2.2	48.0	40.0	76.5	66.5	1.9	1.2	106.0	88.5	21.5	17.0	40.5	27.5	38.2	31.1
JG-6		56.0	47.5	114.5	101.5	5.3	3.0	52.0	40.0	90.0	73.0	2.0	1.6	116.5	92.0	28.0	22.6	45.0	32.0	38.6	34.8
RSG-888		56.4	47.5	125.0	115.5	4.5	2.5	50.5	37.5	85.0	68.5	2.0	1.9	104.5	94.0	28.5	22.5	40.5	27.0	39.5	29.5
Pusa 256 (Check)		61.3	45.0	116.0	105.0	6.6	4.2	52.5	43.0	95.5	88.0	1.9	1.9	160.0	143.5	21.5	17.5	62.5	51.0	39.1	35.6
ICCV-10		38.4	37.0	94.0	88.0	7.5	5.0	48.5	40.0	103.5	93.0	3.9	3.8	158.5	140.0	25.8	20.5	75.0	62.5	47.4	44.7
Chaffa		50.5	48.5	110.0	101.0	4.9	2.8	51.0	41.0	84.5	67.5	1.8	1.3	121.5	99.5	21.0	13.5	42.0	30.0	34.8	30.5
Gujarat Gram 4		62.5	55.0	116.5	107.0	5.4	2.9	53.0	43.5	83.0	70.5	2.7	2.5	120.5	100.0	19.5	13.5	46.5	33.0	38.6	33.1
ICCV 93952		48.0	40.0	102.0	90.0	6.0	4.2	55.0	46.0	100.5	85.0	2.7	2.1	158.5	126.0	26.5	20.5	57.5	44.0	36.4	35.0
ICCV 92944		43.5	38.0	107.0	98.0	6.9	4.2	52.0	41.0	106.0	93.5	3.3	2.8	164.5	139.0	24.5	20.8	63.0	50.5	38.5	36.3
ICCV 96970		65.5	61.0	117.0	102.5	5.6	3.8	57.5	44.0	90.0	77.5	1.2	1.0	112.5	104.0	25.9	19.5	48.0	35.5	42.8	33.7
JG-315		58.5	53.5	120.5	110.0	5.0	3.3	62.5	48.0	79.0	67.0	1.8	1.3	106.5	94.5	18.5	12.5	44.5	31.0	41.9	32.8
JGG-1		57.5	49.5	113.0	106.0	4.2	2.2	44.0	39.0	71.0	62.0	1.3	1.0	100.0	93.5	12.5	9.5	32.5	20.0	31.5	22.5
Phule G12		65.0	62.0	112.0	104.0	5.9	3.3	52.5	43.0	72.5	63.0	2.7	2.0	139.0	110.0	25.5	18.0	51.5	38.5	37.0	35.1
PUSA-372		62.5	54.0	123.5	109.0	4.6	2.8	40.0	36.5	72.5	61.0	1.3	1.0	106.0	99.5	15.0	11.0	38.5	29.5	36.6	29.1
PUSA-547		62.5	50.5	118.5	106.5	5.9	4.1	59.5	44.5	80.0	64.0	2.2	1.9	128.0	114.0	22.5	17.8	52.0	39.5	40.8	34.8
RSG-2		63.8	54.5	115.5	99.5	4.4	2.6	43.0	39.0	73.0	65.0	1.0	1.0	107.0	87.5	18.0	11.0	37.5	24.0	35.0	27.5
RSG-945		49.5	42.0	117.5	91.5	7.2	5.2	51.5	38.5	94.5	77.0	2.1	1.2	160.0	133.5	16.5	10.8	70.5	55.0	44.0	41.2
RSG-963		67.0	64.8	115.5	107.0	6.7	5.1	52.5	43.0	88.0	71.5	1.4	1.4	148.5	129.0	19.5	12.5	62.5	47.5	42.1	36.8
RSG-974		62.0	60.5	116.0	106.5	5.5	3.4	49.0	40.5	86.0	68.0	1.4	1.0	117.5	95.5	15.5	10.8	48.5	36.0	41.3	37.9
Vaibhav		64.8	50.0	117.0	101.5	5.3	3.5	55.0	46.0	80.5	66.0	1.1	1.0	122.0	113.0	20.0	13.5	50.5	39.0	41.9	34.0
Phule G 81-1-1		59.5	57.0	119.0	105.0	5.2	2.9	46.5	38.5	86.5	70.5	1.2	1.0	112.0	93.0	18.0	13.5	45.0	33.0	40.2	34.4
Grand mean		56.9	50.0	113.8	102.2	5.6	3.5	51.2	41.5	86.5	73.1	1.9	1.6	127.8	109.7	21.1	15.7	50.6	37.8	39.4	33.9
Range	Min.	38.4	35.0	94.0	88.0	4.2	2.2	40.0	36.5	71.0	61.0	1.0	1.0	100.0	87.5	12.5	9.5	32.5	20.0	31.5	22.5
	Max.	67.0	64.8	125.0	115.5	7.5	5.2	62.5	48.0	106.0	93.5	3.9	3.8	164.5	143.5	28.5	22.6	75.0	62.5	47.4	44.7
Coefficient of variance (CV)		9.4	12.8	4.3	5.5	8.0	17.4	6.4	5.6	8.0	10.9	16.0	25.0	7.9	11.2	10.0	13.5	8.6	17.1	5.2	9.9
F- test		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S. Ed±		3.8	4.5	3.5	4.0	0.3	0.4	2.3	1.6	4.9	5.7	0.2	0.3	7.2	8.7	1.5	1.5	3.1	4.6	1.4	2.4
C. D. (P=0.05)		11.1	13.3	10.2	11.6	0.9	1.3	6.8	4.8	14.3	16.6	0.6	0.8	21.1	25.4	4.4	4.4	9.0	13.5	4.3	7.0

NS- Normal sown, LS- Late sown

Estimated genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV), broad sense heritability (h^2BS) and genetic advance as percent of mean (GAM) of the traits studied are presented in Table 2. In general, the PCV values were greater than GCV values while the differences were small in both environments. Whereas, narrow difference between the values of GCV and PCV indicated the environmental effect was small for the expression of these traits and are governed by additive gene action. The results are in confirmation with the findings of Mishra and Babbar (2011); Singh (2015).

The high phenotypic coefficient of variability (>20%) is because of wide range of variation and it was recorded for number of seeds per pod (40.2 % and 47.7 %) fallowed by seed yield per plant (22.8 % and 30.9 %) and 100 seed weight (22.0 % and 28.3 %) under both environments respectively. This indicates that there is a high degree of interaction of genotype with the environment (Kavita and Reddy 2002). Therefore, the simple selection can be relied upon and practiced for further improvement of these traits in development of heat tolerant genotypes. The similar results were reported by Devasirvatham (2012).

Perusal of results on heritability revealed high heritability estimates for all traits across both environments while the traits, days to 50 per cent flowering, days to maturity, plant height, number of pods per plant and harvest index recorded the heritability at moderate level under late planting conditions. This indicates that most likely the heritability is due to additive gene effects contributing to these traits (Panse and Sukhatme 1967). In addition, high heritability coupled with narrow differences among PCV and GCV for studied traits indicated that genotypes influenced more in the expression of these traits in both environments (Mohamed *et al.*, 2015). Devasirvatham (2012) also reported high heritability estimates for number of seeds per pod, number of filled pods, total number of pods and grain yield under high temperature conditions. Whereas, for days to flower initiation, seed yield, days to 50 per cent flowering, total and effective pods per plant in both normal and late sown *Desi* chickpea genotypes by Mishra and Babbar (2011).

Johnson *et al.* (1955) suggested that high heritability coupled with high genetic advance as percent of mean (GAM) is more useful than heritability alone in predicting the resultant effect during selection of best individual genotype. In the present experiment, high heritability coupled with high GAM was observed for all traits except days to maturity, plant heightand number of pods per plantacross both environments but the trait harvest index recorded moderate heritability coupled with low GAMunder late planting conditions.The similar findings were observed by Devasirvatham (2012) and Peerzada *et al.* (2015).

The performance results of ten different traits are shown in Table 3. On the basis of mean performance for important economic traits under both environments, the genotypes ICCV 92944, Annigeri-1 and ICCV-10 were identified as best performer for the number of pods per plant whereas, the genotypes JG-6 and RSG-888 were found best in 100-seed weight. The highest seed yield coupled with high harvest index was observed in genotypes ICCV-10, RSG-945 and ICCV 92944, as well as these genotypes were identified as heat tolerant (Chaitanya and Chandrika 2006) and can be utilized in chickpea breeding programme.

CONCLUSION

Thus, it is evident from the present finding that substantial genetic variability was envisaged for yield and its component traits under both environments, which gives an ample opportunity to plant breeder for simple phenotypic selection that ensures improvement of these traits for the development of heat tolerant genotypes. However, the genotypes used in this study showed different levels of stability across both environments. The genotype ICCV 10 had stable yield over both environments; therefore it could be tested over locations for stability verification and for further use in breeding program.

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