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PERFORMANCE OF GENETIC VARIABILITY EXISTING IN CHICKPEA POPULATION UNDER DROUGHT STRESS AND NON-STRESS CONDITIONS

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ABSTRACT

The present investigation entitled "Performance of genetic variability existing in chickpea population under drought stress and non-stress conditions" was carried out during the year 2013-2014 at the Research Farm, All India Co-ordinated Research Project for Dryland Agriculture, Indore (M.P.). The experimental material was comprised of nine genotypes of chickpea (*viz.* Ujjain 21, JAKI-9218, IG-593, JG-6, JG-16, JG-130, JG-412, JG-11 and KAK-2) were evaluated under drought stress and non-stress situations. These genotypes were sown in Randomized Complete Block Design with three replications. Observations were recorded on the basis of five random competitive plants selected from each genotype separately for physiological and yield contributing traits were evaluated as per standard procedure. The material was sown on November 14, 2013 with row to row distance of 40 cm and plant to plant 10 cm. All recommended package of practices were followed during the conduction of experiment to harness the maximum potential of the genotypes under study.Out of nine genotypes; genotypes KAK-2, JG-16, JG-6 and IG-593 exhibited minimum reduction in seed yield due to moisture stress condition. Further it also maintained highest seed yield along with minimum drought index, high drought tolerance efficiency and least drought susceptibility index. Therefore, it is revealed that these genotypes will be suitable for enhancing seed yield under drought stress condition.

Key words : *Chickpea, genotypes, phenotypic and genotypic coefficients of variation, physiological characters and yield characters.*

Chickpea (*Cicer arietinum* L.) belongs to genus *Cicer*, tribe *cicerace*, family Fabaceae and subfamily papillionaceae. Chickpea has been recognized as a valuable source of protein (25.2-28.9%), vitamins (mainly C) and minerals (P and Ca) in the human diet and occupy a very important place in human nutrition in many developing countries. On an average, chickpea seed contains 23% protein, 64% total carbohydrate, 47% starch, 5% fat, 6% crude fibre, 6% soluble sugar &3% ash. Being a leguminous crop possessing root nodules; it maintains the soil fertility as it enriches the soil through symbiotic nitrogen fixation. The deep penetrating root systems of chickpea enable it to utilize the limited available moisture more efficientlyand contribute substantially to the loosening up of soil.India is the largest producer of chickpea with about 8 million tons accounting of about 70% of total world production. In India, it is being grown under 9.51 Mha area with production of 8.83 Mt and productivity 929 kg/ha (2012-13). Madhya Pradesh covers 3128.70 thousand ha area with 3551.20 thousand tons production and productivity 1135 kg/ha (2012-13) (1).

Drought or moisture stress being the one of the most detrimental constraints causing its low production. Drought tolerance improvement is one of the most challenging objectives of plant breeding programme. Water resource is an important factor affecting partitioning of biomass and there by its seed yield, as the availability of water for agriculture is becoming limiting factor day by day. Thus, it becomes necessary to identify chickpea genotypes tolerant to drought stress.

MATERIALS AND METHODS

The present investigation entitled "Performance of genetic variability existing in chickpea population under drought stress and non-stress conditions" was carried out during the year 2013-2014 at the Research Farm, All India Co-ordinated Research Project for Dryland Agriculture under the edaphic and climatic conditions of Indore is situated at $22^0$43' North latitude and $75^0$66' East longitude with an altitude of 555.7 meter above the mean sea level in Malwa plateau of western Madhya Pradesh.This region belongs to sub–tropical semi-arid region with an average annual rainfall of 954.5 mm. The total rainfall received during the crop season 2013-14 was 50.2 mm with 7 rainy days, the maximum temperature range from 19.68^{0}C to 34.58^{0}C and minimum temperature range from 8.87^{0}C to 22.50^{0}C and relative humidity 50.42 to 90.71%.

The experimental material was comprised of two sets of nine chickpea genotypes (*viz.* Ujjain 21, JAKI-9218, IG-593, JG-6, JG-16, JG-130, JG-412, JG-11 & KAK-2) were evaluated under drought stress (rainfed) and non-stress (irrigated) conditions. These genotypes were sown in Randomized Complete Block Design with three replications. Observations were recorded on the basis of five random competitive plants selected from each genotype separately for physiological and yield contributing traits were evaluated as per standard procedure.The material was sown on November 14, 2013 with row to row distance of 40 cm and plant to plant 10 cm. All recommended package of practices were followed

during the conduction of experiment to harness the maximum potential of the genotypes under study.Two irrigations were given at the time of branch formation and pod formation stage in second set of experiment non stress conditions.The formulas of different parameters are as follows:

Relative leaf water content

$$RLWC\ \% = \frac{FW - DE}{TW - DW} \quad 100$$

Where, FW=Fresh weight (g), TW=Turgid weight (g), DW= Dry weight (g)

Phenotypic and Genotypic Coefficients of Variation : (2)

Phenotypic Coefficients of Variation (PVC)

$$= \frac{\sqrt{\text{Phenotypic variance}}}{\text{Mean}} \quad 100$$

Genotypic Coefficients of Variation (GVC)

$$= \frac{\sqrt{\text{Genotypic variance}}}{\text{Mean}} \quad 100$$

RESULTS AND DISCUSSION

Analysis of Variance : The mean differences due to genotypes were highly significant for all the characters except number of seeds pod^{-1} under stress condition (Table-1) where as highly significant difference among genotypes under non-stress condition (Table 2).The findings of Shauket *et al.* (2002) are similar to the present study.

Genetic variability

Physiological characters : Relative water content at flowering stage ranged from 74.19% (JAKI-9218) to 85.43% (JG-130) and 85.80% (JAKI-9218) to 91.33% (JG-130) in stress and non-stress situations; respectively. The overall mean performance of 81.60% and 88.83% were recorded under stress and non-stress situations; respectively. The maximum relative water content 85.43% and 91.33% were observed in genotypes JG-130 at stress and non-stress situations; respectively. While, it's were recorded minimum 74.19% and 85.80% in JAKI-9218 at both situations; respectively.

Relative water content per cent at pod formation stage varied from 65.07% (Ujjain-21) to 83.76% (IG-593) and 72.63% (Ujjain-21) to 86.50% (IG-593) and overall mean performance of 76.06% and 80.29% were recorded at stress and non-stress situations; respectively. The genotype viz. IG-593 exhibited the maximum 83.76% and 86.50% relative water content per cent at pod formation stage under stress and non-stress situations, while genotype Ujjain-21 showed minimum mean 65.07% and 72.63% under stress and non-stress situations; respectively for the same.

W.S.D. at flowering stage varied from 14.57% (JG-130) to 25.81% (JAKI-9218) and 8.67% (JG-130) to 14.20% (JAKI-9218) with an overall mean performance of 18.39% and 11.16% under stress and non-stress situations; respectively. The significantly maximum 25.81% and 14.20% W.S.D. at flowering stage was observed in genotype JAKI-9218, while the minimum (14.57 and 8.67%) W.S.D. was recorded in JG-130 under stress and non-stress situations; respectively.

W.S.D. at pod formation stage varied from 16.24% (IG-593) to 34.93% (Ujjain-21) and 13.50% (IG-593) to 27.37% (Ujjain-21) with an overall mean performance of 23.93% and 19.48% under stress and non-stress situations; respectively. The maximum W.S.D. at pod formation stage was observed in Ujjain-21(34.93% and 27.37%); while it was observed minimum in IG-593 (16.24% and 13.50%) under stress and non-stress situations; respectively.

The mean for days to flower initiation was 45.14 days and it ranged from 40.0 to 50.67 days. Maximum days to flower initiation were noted in JG-6 (50.67 days) and it revealed earliest days to flower initiation in genotype JG-412 (40.0 days) under stress situations. It was ranged from 39.33 (KAK-2) to 66.0 days (IG-593) and over all mean performance of 58.44 days be observed at non-stress situations.

The mean for days to 50% flowering was 56.81 days and it ranged from 49.67 to 61.33 days. Maximum days to 50% flowering were noted in JG-6 (61.33 days) and it revealed earliest days to 50% flowering in genotype JG-412 (49.67 days) under stress situations. It was ranged from 56.00 (KAK-2) to 82.0 days (IG-593) and over all mean performance of 70.81 days be observed at non-stress situations.

Days to maturity ranged between 104.0 to 116.0 days and the mean for all genotype was 111.85 days. Genotype KAK-2 recorded considerably maximum (116.0) days, while genotype JG-16 expressed minimum (104.0) days under stress situations. At non-stress situations, it was ranged from 118.33 to 127.0 days with an overall mean of 121.92 days. Genotype KAK-2 recorded considerably maximum (127.0) days, while genotype JG-16 expressed minimum (118.33) days.

Vegetative phase varied from 40.33 to 57.0 days with average of 47.37 days. The genotype JG-412 recorded maximum vegetative phase, while genotype KAK-2 exhibited 40.33 days was least under stress situations. At non-stress situations, it was ranged from

Table-1 : Analysis of variance for various physiological and yield contributing traits of chickpea under drought stress condition (mean square).

Characters	Source of variation		
	Replications	Genotypes	Error
d.f.	2	8	16
Physiological traits			
R.W.C. at flowering stage	1.765	50.048**	3.505
R.W.C. at pod formation stage	4.875	109.527**	5.082
W.S.D. at flowering stage	1.773	50.048**	3.503
W.S.D. at pod formation stage	4.878	109.527**	5.083
Days to flower initiation	2.480	56.259**	1.523
Days to 50% flowering	13.812	67.342**	3.731
Days to maturity	6.703	49.092**	4.578
Vegetative phase (days)	17.371	47.120**	10.661
Reproductive phase (days)	11.257	140.398**	1.634
Days to pod initiation	9.593	47.925**	4.425
Yield contributing traits			
Plant height at maturity (cm)	28.321	55.620**	1.024
Number of branches/plant	0.259	11.731**	2.884
Number of pods/plant	10.111	201.666**	45.152
Number of seeds/pod	0.037	0.0648	0.0787
Biological yield/plant (g)	19.878	228.525**	0.432
Test weight (g)	4.703	137.717**	5.234
Harvest index (%)	119.946	84.495**	13.555
Seed yield/plant (g)	32.383	78.603**	1.521

No asterisk : Non-significant, * : Significant, ** : Highly significant

Table-2 : Analysis of variance for various physiological and yield contributing traits of chickpea under non-stress condition (mean square).

Characters	Source of variation		
	Replications	Genotypes	Error
d.f.	2	8	16
Physiological traits			
R.W.C. at flowering stage	1.162	10.139*	2.770
R.W.C. at pod formation stage	15.251	69.190**	2.221
W.S.D. at flowering stage	1.240	10.160*	2.769
W.S.D. at pod formation stage	23.574	65.862**	3.715
Days to flower initiation	8.444	179.750**	8.986
Days to 50% flowering	26.925	155.092**	10.092
Days to maturity	3.370	23.314**	4.162
Vegetative phase (days)	10.333	151.416**	10.375
Reproductive phase (days)	3.814	134.564**	8.648
Days to pod initiation	41.592	220.759**	23.384
Yield contributing traits			
Plant height at maturity (cm)	19.507	31.180**	0.432
Number of branches/plant	12.259	14.481**	0.217
Number of pods/plant	21.925	154.898**	0.300
Number of seeds/pod	0.066	0.166**	0.310
0Biological yield/plant (g)	27.011	176.948**	1.499
Test weight (g)	19.564	200.918**	0.460
Harvest index (%)	36.384	131.588**	0.865
Seed yield/plant (g)	30.522	65.643**	0.996

No asterisk : Non-significant, * : Significant, ** : Highly significant

Table-3 : Mean performance of physiological contributing traits of chickpea under drought stress and non-stress condition.

Genotypes		R.W.C. at flowering stage	R.W.C. at pod formation stage	W.S.D. at flowering stage	W.S.D. at pod formation stage	Days to flower initiation	Days to 50% flowering	Days to maturity	Vegetative phase (days)	Reproductive phase (days)	Days to pod initiation
JG-130	S	85.43	73.90	14.57	26.10	48.33	60.33	107.67	48.33	59.33	60.67
	NS	91.33	84.33	8.67	15.67	57.33	69.33	119.67	57.33	62.33	83.00
IG-593	S	85.25	83.76	14.75	16.24	45.00	59.67	114.67	45.00	69.67	59.33
	NS	87.60	86.50	12.40	13.50	66.00	82.00	122.00	66.00	56.00	87.00
JG-6	S	84.37	81.50	15.63	18.50	50.67	61.33	109.00	50.67	58.33	61.00
	NS	89.13	82.43	10.87	15.57	61.00	74.00	121.00	61.00	60.00	83.33
JAKI-9218	S	74.19	75.80	25.81	24.20	42.00	55.67	113.00	42.00	71.00	54.67
	NS	85.80	78.70	14.20	21.30	64.33	76.33	125.67	54.67	71.00	77.33
KAK-2	S	81.97	82.77	18.03	17.23	40.33	50.33	116.00	40.33	75.67	51.67
	NS	90.27	86.03	9.73	13.97	39.33	56.00	127.00	61.67	65.33	58.00
JG-16	S	83.60	74.44	16.40	25.56	49.00	60.67	104.00	49.00	55.00	59.33
	NS	90.10	78.67	9.90	21.33	60.67	71.00	118.33	60.67	57.67	78.33
Ujjain-21	S	78.46	65.07	21.54	34.93	49.67	60.67	113.00	49.67	63.33	61.00
	NS	87.40	72.63	12.60	27.37	61.33	73.33	120.33	40.67	79.67	80.00
JG-11	S	76.94	70.63	23.06	29.37	41.33	53.00	114.67	50.33	64.33	55.67
	NS	87.47	77.67	12.53	20.53	57.33	67.67	121.00	57.33	63.67	85.67
JG-412	S	84.27	76.73	15.73	23.27	40.00	49.67	114.67	57.00	57.67	51.00
	NS	90.40	75.67	9.60	24.10	58.67	67.67	122.33	56.67	65.67	79.67
SEm ±	S	1.08	1.30	1.08	1.30	0.71	1.11	1.23	1.88	0.73	1.21
	NS	0.96	0.86	0.96	1.11	1.73	1.83	1.17	1.85	1.69	2.79
C.D. at 5% level	S	3.23	3.90	3.23	3.90	2.13	3.34	3.70	5.65	2.21	3.64
	NS	2.88	2.58	2.88	3.33	5.18	5.49	3.53	5.57	5.09	8.37

S:Drought stress condition NS:Non-stress condition

40.67 to 66.0 days with an overall mean of 57.33 days. Genotype IG-593 recorded considerably maximum (66.0) days, while genotype Ujjain-21 expressed minimum (40.67) days.

Reproductive phase (days) varied from 55.0 to 75.67 days with average of 63.92 days. The genotype KAK-2 recorded long reproductive phase (75.67 days), while genotype JG-16 exhibited short reproductive phase (55.0 days) under stress situations. Similarly genotype Ujjain-21 recorded long reproductive phase (79.67 days), while genotype IG-593 exhibited short reproductive phase (56.0 days) under non stress situations.

Days to pod initiation ranged between 51.0 to 61.0 and average was calculated to be 57.14. The maximum (61.0) days to pod initiation was noted in JG-6 and Ujjain-21, while it was observed minimum (51.0) in the genotypes JG-412 under stress situations. Similarly genotype IG-593 was recorded maximum (87.0) days to pod initiation, while, genotype KAK-2 exhibited minimum (58.0) days under non-stress situations.

Yield characters : Plant height ranged from 40.67 to 55.60 cm and 55.0 to 65.87 cm and overall mean performance in 46.36 and 60.13 cm were recorded under stress and non-stress situations; respectively. The maximum plant height 55.60 cm and 65.87 cm were observed in genotypes IG-593 under stress and non-stress situations; respectively. While it's were recorded minimum 40.67 cm and 55.0 cm in JG-11 under stress and non-stress situations; respectively.

Number of branches/plant ranged between 5.33 to 10.0 and 6.0 to 11.67 and average was calculated to be 7.40 and 8.07 cm at stress and non-stress situations; respectively. The maximum branches/plant was noted in KAK-2 (10.0 and 11.67), while it was observed minimum (5.33 and 6.0) in the genotype JG-130 at stress and non-stress situations; respectively.

Number of pods/plant ranged between 41.33 to 63.0 and 43.67 to 63.67 pods with an overall mean performance of 50.33 and 54.07 pods at stress and non-stress

Table-4 : Mean performance of yield contributing traits of chickpea under drought stress and non-stress condition.

Genotypes		Plant height at maturity (cm)	Number of branches / plant	Number of pods/ plant	Number of seeds/ pod	Biological yield/ plant (g)	Test weight (g)	Harvest index (%)	Seed yield/ plant (g)
JG-130	S	44.47	5.33	54.67	1.00	33.70	24.67	49.16	16.55
	NS	62.33	6.00	56.33	1.00	50.60	25.17	53.97	26.87
IG-593	S	55.60	8.33	45.67	1.33	31.93	35.33	47.50	15.21
	NS	65.87	7.00	48.00	1.00	46.20	37.00	50.10	21.67
JG-6	S	42.67	5.67	57.00	1.00	34.33	32.50	41.38	14.28
	NS	59.33	7.00	61.00	1.00	49.13	34.67	39.20	19.97
JAKI-9218	S	47.20	6.00	42.33	1.00	37.99	26.83	41.02	15.60
	NS	60.33	11.00	48.33	1.00	41.70	26.33	49.10	24.47
KAK-2	S	47.00	10.00	63.00	1.00	50.93	38.17	52.70	26.72
	NS	61.00	11.67	63.67	1.67	55.67	44.33	54.33	29.23
JG-16	S	44.67	9.67	58.67	1.00	28.80	19.83	52.35	15.20
	NS	56.00	7.33	59.33	1.33	41.67	21.50	51.87	20.33
Ujjain-21	S	45.67	6.33	41.33	1.00	23.13	18.00	37.44	11.05
	NS	60.67	6.00	43.67	1.00	29.67	18.67	39.10	19.50
JG-11	S	40.67	9.67	48.67	1.33	23.63	24.67	43.56	10.30
	NS	55.00	10.00	58.67	1.00	41.58	24.67	42.93	16.20
JG-412	S	49.33	5.67	41.67	1.00	25.07	28.83	47.67	9.41
	NS	60.67	6.67	47.67	1.00	51.33	28.00	38.47	15.03
SEm ±	S	0.58	0.98	3.87	0.16	0.37	1.32	2.12	0.71
	NS	0.37	0.26	0.31	0.10	0.70	0.39	0.53	0.57
C.D. at 5% level	S	1.75	2.93	11.63	N.S.	1.13	3.96	6.37	2.13
	NS	1.13	0.80	0.94	0.30	2.11	1.17	1.61	1.72

S : Drought stress condition, NS : Non-stress condition

situations; respectively. The maximum 63.0 and 63.67 pods/plant were recorded in genotype KAK-2, while it was recorded least in genotype Ujjain-21 (41.33 and 43.67) at stress and non- stress situations; respectively.

Number of seeds/pod ranged between 1.0 to 1.33 and 1.0 to 1.67 seeds/pod, while the average, was 1.07 and 1.11 seeds/pod at stress and non-stress situations; respectively. The maximum 1.33 seeds/pod was observed in genotypes IG-593 and JG-11 and it was found in least 1.00 in remaining genotypes under stress situations. Similarly under non stress situations, the maximum 1.67 and 1.33 seeds/pod was observed in genotypes KAK-2 and JG-16 and remaining genotypes exhibited 1.0 seeds/pod.

This trait ranged between 23.13 to 50.93 g and 29.67 to 55.67 g with an overall mean of 32.16 g and 45.29 g at stress and non-stress situations; respectively. Genotypes KAK-2 was recorded maximum 50.93 and 55.67 g biological yield but it was minimum in genotype Ujjain-21(23.13 and 29.67 g) at stress and non-stress situations; respectively.

Test weight varied from 18.0 to 38.17 g and 18.67 to 44.33 g with an overall average weight of 27.64 and 28.92 g at stress and non- stress situations; respectively. The genotype KAK-2 exhibited maximum 38.17 and 44.33 g test weight, while genotype Ujjain-21 recorded minimum 18.0 and 18.67 g test weight.

Harvest index varied from 37.44% to 52.70% and 39.10% to 54.33% with an overall mean performance of 45.86% and 46.56% at stress and non-stress situations; respectively. Genotype KAK-2 was recorded maximum (52.70% and 54.33%) harvest index, while it was recorded lowest in genotypes Ujjain-21 (37.44% and 39.10%) at stress and non-stress situations; respectively.

Maximum seed yield/plant was recorded in KAK-2 (26.72 and 29.23 g) and minimum in Ujjain-21 (9.41 and 15.03 g) at stress and non- stress situations; respectively. It was varied from 9.41 to 26.72 g and 15.03 to 29.23 g and overall mean performance of 14.92 g and 21.47 g at stress and non-stress situations; respectively.

The findings were quite similar to the finding of (3, 4) for seeds/pod, (4, 5, 6) for number of pods/plant, (4, 5, 6) for seed yield/plant, (4, 6) for test weight and biological yield/plant.

Coefficient of variation

Drought stress situations : The highest phenotypic coefficient of variation was observed for seed yield/plant (34.95) followed by number of branches/plant (32.61), biological yield/plant (27.18), W.S.D. at pod formation

Table-5 : Genetic parameters in different characters of chickpea under drought stress and non- stress condition.

Characters		Grand Mean	Range		Coefficient of variations	
			Min.	Max.	Phe.	Gen.
R.W.C. at flowering stage	S	81.60	74.19	85.43	05.34	04.83
	NS	88.83	85.80	91.33	02.57	01.76
R.W.C. at pod formation stage	S	76.06	65.07	83.76	08.30	07.76
	NS	80.29	72.63	86.50	06.17	05.88
W.S.D. at flowering stage	S	18.39	14.57	25.81	23.71	21.42
	NS	11.16	08.67	14.20	20.49	14.06
W.S.D. at pod formation stage	S	23.93	16.24	34.93	26.39	24.65
	NS	19.48	13.50	27.37	25.37	23.36
Days to flower initiation	S	45.14	40.00	50.67	09.85	09.46
	NS	58.44	39.33	66.00	13.89	12.91
Days to 50% flowering	S	56.81	49.67	61.33	08.76	08.10
	NS	70.81	56.00	82.00	10.79	09.82
Days to maturity	S	111.85	104.00	116.0	03.94	03.44
	NS	121.92	118.33	127.00	02.66	02.07
Vegetative phase (days)	S	47.37	40.33	57.00	10.08	07.36
	NS	57.33	40.67	66.00	13.21	11.96
Reproductive phase (days)	S	63.92	55.00	75.67	10.83	10.64
	NS	66.59	56.00	79.67	10.68	09.73
Days to pod initiation	S	57.14	51.00	61.00	07.61	06.66
	NS	79.14	58.00	87.00	11.93	10.25
Plant height at maturity (cm)	S	46.36	40.67	55.60	09.46	09.20
	NS	60.13	55.00	65.87	05.44	05.32
Number of branches/plant	S	07.40	05.33	10.00	32.61	23.18
	NS	08.07	06.00	11.67	27.62	27.01
Number of pods/plant	S	50.33	41.33	63.00	19.60	14.35
	NS	54.07	43.67	63.67	13.31	13.28
Number of seeds/pod	S	01.07	01.00	01.33	25.34	06.33
	NS	01.11	01.00	01.67	24.90	19.10
Biological yield/plant (g)	S	32.16	23.13	50.93	27.18	27.10
	NS	45.29	29.67	55.67	17.10	16.89
Test weight (g)	S	27.64	18.00	38.17	25.42	24.04
	NS	28.92	18.67	44.33	28.36	28.26
Harvest index (%)	S	45.86	37.44	52.70	13.30	10.60
	NS	46.56	39.10	54.33	14.32	14.18
Seed yield/plant (g)	S	14.92	09.41	26.72	34.95	33.96
	NS	21.47	15.03	29.23	22.11	21.62

S : Drought stress condition, NS : Non-stress condition

stage (26.39), test weight (25.42), number of seeds/pod (25.34) and W.S.D. at flowering stage (23.71). Days to maturity (3.94), R.W.C. at flowering stage (5.34), days to pod initiation (7.61), R.W.C. at pod formation stage (8.30), days to 50% flowering (8.76), plant height at maturity (9.46), days to flower initiation (9.85), vegetative phase (10.08) and reproductive phase (10.83) showed the low estimate of PCV under stress condition.

Moderate phenotypic coefficient of variation was recorded for harvest index (13.30) and number of pods/plant (19.60).

The highest genotypic coefficient of variation was observed for seed yield/plant (33.96) followed by biological yield/plant (27.10), W.S.D. at pod formation stage (24.65), test weight (24.04) number of branches/plant (23.18) and W.S.D. at flowering stage (21.42); whereas days to maturity (3.44), R.W.C. at flowering stage (4.83), number of seeds/pod (6.33), days to pod initiation (6.66), vegetative phase (7.36), R.W.C. at pod formation stage (7.76), days to 50% flowering (8.10), plant height at maturity (9.20) and days to flower initiation (9.46) showed the low estimate of GCV under stress condition.

Moderate genotypic coefficient of variation was recorded for harvest index (10.60), reproductive phase (10.64) and number of pods/plant (14.35) in Table-5.

Non-stress situations : The phenotypic coefficient of variation was highest for test weight (28.36) followed by number of branches/plant (27.62), W.S.D. at pod formation stage (25.37), number of seeds/pod (24.90), seed yield/plant (22.11) and W.S.D. at flowering stage (20.49); However R.W.C. at flowering stage (2.57), days to maturity (2.66), plant height at maturity (5.44), and R.W.C. at pod formation stage (6.17) showed the low estimate of PCV under non-stress condition.

Moderate phenotypic coefficient of variation was recorded for reproductive phase (10.68), days to 50% flowering (10.79), days to pod initiation (11.93), vegetative phase (13.21), number of pods plant^{-1} (13.31), days to flower initiation (13.89), harvest index (14.32) and biological yield/plant (17.10).

The genotypic coefficient of variation was highest for test weight (28.26) followed by number of branches/plant (27.01), W.S.D. at pod formation stage (23.36) and seed yield/plant (21.62); while R.W.C. at flowering stage (1.76), days to maturity (2.07), plant height at maturity (5.32), R.W.C. at pod formation stage (5.88), reproductive phase (9.73) and days to 50% flowering (9.82) showed the low estimate of GCV under non-stress condition.

Moderate genotypic coefficient of variation was recorded for, days to pod initiation (10.25), vegetative phase (11.96), days to flower initiation (12.91), number of pods/plant (13.28), W.S.D. at flowering stage (14.06), harvest index (14.18), biological yield/plant (16.89) and number of seeds/pod (19.10).

The difference between PCV and GCV was less for days to flower initiation, days to 50% flowering, days to maturity, reproductive phase, plant height at maturity and biological yield/plant under stress condition, however the difference between PCV and GCV was less for number of branches/plant, number of pods/plant, test weight and harvest index under non-stress condition.

The findings are in close harmony with the result of (7, 8) for test weight, (9, 10) for number of branches/plant, (11) for number of seeds/pod, (8, 10) for seed yield/plant, (12) for biological yield/plant, (7) for days to maturity, and (13) for harvest index.

CONCLUSION

Out of nine genotypes, KAK-2, JG-16, JG-6 and IG-593 exhibited minimum reduction in seed yield due to drought stress condition. Thus, it reveals that these genotypes will be suitable for enhancing crop productivity under drought stress condition.

REFERENCES

1. Singh N.P. (2014). Project Co-ordinator's Report : All India Co-ordinated Research Project on chickpea, IIPR, Kanpur. *Indian Institute of Pulses Resarch,* Kanpur, pp: 23-26.
2. Burton G.W. (1952). Quantitative inheritance in grasses, *Proc. Sixth Int. Grassland Congr; 1:* 277-283.
3. Chauhan M.P. and Singh I.S. (2000). Variability estimation and identifying chickpea genotypes for yield and yield contributes in salt affected soil. *Legume Res., 23(3):* 199-200.
4. Kumar S., Arora P.P. and Jeena A.S. (2001a). Genetic variability studied for qualitative traits in chickpea. *Agri. Sci. Digest., 21(4):* 263-264.
5. Shaukat Ali, Maher A.B., Anwar M. and Haqqani A.M. (2002). Exploitation of genetic variability for grain yield improvement in chickpea. *Int. J. Agric. Bio., 4(1):* 148-149.
6. Lokare Y.A., Patil J.V. and Chauhan U.D. (2007).Genetic analysis of yield and quality traits in kabuli chickpea. *J. Food Legumes, 20(2):* 147-149.
7. Meena H.S., Kumar J. and Deshmukh P.S. (2006). Genetic variability and correlation studies for traits related to drought tolerance in chickpea (*Cicer arietinum* L.). *Indian J. of Genetic and Plant Breeding, 66(2)*: 140.
8. Akhtar L.H., Pervz M.A. and Nasim M. (2011). Genetic divergence and inter-relationship studies in chickpea (*Cicer arietinum* L.). *Pak. J. of Agril. Sci., 48(1):* 35-39.
9. Durga K.K., Murthy S.S.N., Rao Y.K. and Reddy M.V. (2007). Genetic studies on yield and yield components of chickpea. *Agricultural Science Digest., 27(3):* 201-203.
10. Sreelakshmi C., Shivani D. and Sameer C.V.K. (2010). Genetic divergence, variability and character association studies in bengal gram (*Cicer arietinum* L.). *Electronic Journal of Plant Breeding, 1(5):* 1339-1343.
11. Babbar A., Prakash V., Tiwari P. and Iquebal M.A. (2012). Genetic variability for chickpea (*Cicer arietinum* L.) under late sown season. *Legume Res., 35(1):* 1-7.
12. Jeena A.S., Arora P.P. and Upreti M.C. (2005). Divergence analysis in chickpea. *Legume Res., 28(2):* 152-154.
13. Yadav J.K., Singh H.L. and Kumar R. (2003). Determining selection components in chickpea (*Cicer arietinum* L.). *Plant Archi., 3(1):* 125-128.

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