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Impact of row spacing in chickpea genotypes (*Cicer arietinum L.*)

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ABSTRACT
Chickpea, to compare the production potential of six desi chickpea genotypes , (JG 16, JG 315, PhuleG 405, JG 36, NBeG 452 and RVG 203) at Row spacing 30 cm and 45 cm. The experiment was laid out in randomized block Design with three replication and 5.0m x 3.6 m plot size. The soil of the experimental field was medium clay loam (vertisol), low in available nitrogen, medium in phosphorus and medium in available potash with pH 6.9. Various growth and yield attributing characters were studied. Genotypes differed significantly in growth parameters like plant height, number of branches per plant at all crop growth stages except 90 DAS and maturity in case of number of branches per plant. The crop growth rate varied significantly in different genotypes. Seed and straw yields differed according to genotypes and highest values were obtained from PhuleG 405 (1547kg/ha seed and 1745kg/ha straw yield).
Keywords: *Genotypes, Yield Characters, Chickpea, Variability.*

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INTRODUCTION

Chickpea (*Cicer aritinum L.*) the premier pulse crop of Indian sub-continent, is predominantly consumed as a pulse; dry chickpea is also used in preparation of a variety of snacks, sweets and condiment and green fresh chickpea are commonly consumed as a vegetable. It is one of the most important pulse crop grown in semi-arid and tropical climate. It is rich source of proteins, vitamins and minerals containing 17-22% protein, 60-64% carbohydrate and 3-4% fat. India is the largest chickpea producer as well as consumer in the world[1]. During 2015-16 India grows chickpea on about 81.71 lakh ha area producing 59.40 lakh tonnes, productivity 727kg/ha (DACNET,2015). In M.P. chickpea was grown in 26.21 lakh ha area producing 22.97 lakh tonnes, productivity 877 kg/ha. The major area of chickpea in Madhya Pradesh is under rainfed conditions. Proper germination and better establishment of the plants for normal plant population is an important factor responsible for getting an optimum yield.

Row spacing is one of the important characters which can be manipulated to attain the maximum production from per unit land area [3]. The optimum row spacing with proper geometry of planting is dependent on variety, its growth habit and agro climatic condition. The seed yield of chickpea is highly dependent on plant population. Seed yield increases with decreased row spacing up to an optimum limit which changes according to genotypes[4].

MATERIAL AND METHODS

The experiment was laid out in randomized block Design with 12 treatments and each treatment was replicated three times. The details of layout plan and treatments are given as follows:

Design	:	Randomized Block Design
Treatments	:	12
Replications	:	3
Total number of plots	:	36
Gross plot size	:	5.0 m × 3.6 m
Net plot size	:	4.5 m × 2.7 m

Distance between replications	:	1.0m
Distance between plots	:	0.50 m
Crop	:	Chickpea
Seed rate	:	80 kg/ha
Distance between rows	:	As per treatment
Fertilizer dose	:	20:60:20:20 (N:P:K:S kg/ha)

Treatment details:

A. Genotypes (6):

V1: JG-16
V2: JG-315
V3: PhuleG-405
V4: JG-36
V5: NBeG-452
V6: RVG-203

B. Row spacing (2):

S1: 30 CM
S2: 45 CM

Treatment combinations:

1	JG – 16,	30 CM	1	JG – 16	45 CM
2	JG – 315	30 CM	2	JG – 315	45 CM
3	PhuleG – 405	30 CM	3	PhuleG – 405	45 CM
4	JG – 36	30 CM	4	JG – 36	45 CM
5	NBeG – 452	30 CM	5	NBeG – 452	45 CM
6	RVG – 203	30 CM	6	RVG – 203	45 CM

In this investigation the crop growth rate was worked out with the help of following formula; as proposed by Watson (1952):

$$CGR = \frac{W_2 - W_1}{P\,(t_2 - t_1)}$$

Where,

P is ground area ($1m^2$);

W_1 and W_2 are plant dry weight at time t_1 and t_2, respectively.

The mean relative growth rate over a time interval from t_1 and t_2 was calculated with the help of following algebraic expression as proposed by Fisher (1921).

$$RGR = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1}$$

Where,

W_1 and W_2 are the dry weight (g) at time t_1 and t_2, respectively and Log_e is natural Log.

In case of "F" test was significant, standard error and critical differences were calculated by formula.

Genotypes:

$$S.E_m \pm = \frac{EMS}{R * S}$$

$$C.D.at5\% = S.E_m \pm \sqrt{t_{(22df)}}\,at5\%$$

$$C.V.\% = \frac{\sqrt{EMS}}{GM} * 100$$

Where:

T = Number of treatments
R = Number of replication
D.F. = Degree of freedom
S.Em ± = Standard error of mean
C.D. = Critical difference
C.V. = Coefficient of variance
MSS = Mean Sum of square
SS = Sum of square
EMS = Error mean square

RESULT AND DISCUSSION

Plant height as a measure of growth was recorded at successive stages of crop growth i.e. 30,60, 90 DAS and at maturity. It revealed that the genotypes and row spacing caused significant differences in the plant height at all the stages of the crop growth. Amongst the six genotypes PhuleG 405 recorded relatively tallest plant than JG 315, JG 36, JG 16 and NBeG 452 throughout the growth span and was near to equal to that of RVG 203. The genotypes JG 16 and JG 315 did not record any measurable difference in plant height at 30, 60 and 90 DAS. At 80 DAS and at maturity genotypes Phule G 405 recorded significantly more number of branches per plant than rest of genotype except RVG 203. While at 40 DAS & 60 DAS, number of branches / plant was also significantly higher in PhuleG 405 but it was statically similar with NBeG 452 and RVG 203. At 60 DAS and at maturity genotype PhuleG 405 recorded significantly more root length per plant than all other genotype vig. RVG 203, JG 16, JG 36, JG 315 and NBeG 452, but it was at par with RVG 203 and NBeG 452 at 30 DAS. The root length per plant increased significantly as the row spacing decreased from 45 to 30 cm at all crop growth stages[4][5][6]. The dry weight per plant as a measure of crop growth was recorded at successive stages of crop growth i.e. 30, 60, 90 DAS and maturity. The variety PhuleG 405 gave maximum dry weight per plant (1.58, 5.94, 8.97 and 11.75) which was significantly superior than RVG 203, NBeG 452, JG 16, JG 36 and JG 315 at all the growth stages of crop. The minimum plant dry weight (g) was recorded under the variety JG 315 (1.38, 5.43, 8.56 and 11.56 g) at all the growth stages of crop viz 30, 60, 90 DAS and at maturity respectively. The variation in number of root nodules by different genotypes was significant at all the stages of observation except at 60 DAS. The maximum number of root nodules per plant were found significant in genotype PhuleG 405, which was at par with RVG 203 at both the stages at 30cm and 45 cm However, the maximum number of root nodules (19.32) were recorded at 60 DAS in PhuleG 405 followed by NBeG 452, RVG 203, JG 16, JG 36 and JG 315. Crop growth rate for different genotypes varied significantly at most of the periods of the crop growth stages.

It was observed that highest CGR (0.401 and 0.314 g/m2/day) of chickpea was recorded at 30-60 and 60-90 DAS period respectively in PhuleG 405 which was at par with RVG 203 and JG 16 at both the period of observations. Relative growth rate for different genotypes varied significantly at most of the periods of the crop growth stages.

It was observed that highest RGR (0.00198 and 0.00673 g/g/day) of chickpea was recorded at 30-60 and 60-90 DAS period respectively in PhuleG 405 which was followed by RVG 203 and JG 16 at both the period of observations. Genotypes PhuleG 405 produced significantly higher number of pods per plant than other genotypes. While it was at par with RVG 203[6][7][8]. However, genotypes NBeG 452, JG 16, and JG 36 produced significantly more number of pods per plant as compared to JG 315. Number of seeds per pod did significantly influenced by genotypes and row spacing. However, it varied from 1.68 to 1.31 in respect of genotypes and row spacing (Table 4.14 fig 10 and appendix VI). The seeds per pod was significantly superior in PhuleG 405 (1.68) than other genotypes except RVG 203. Seed yield per plant of chickpea significantly varied due to different genotypes and row spacing data indicated that the genotypes PhuleG 405 gave significantly higher yield/plant than by RVG 203, NBeG 452, JG 16 , JG 36 and JG 315. The significant variation in seed index due to different genotypes and row spacing was recorded. Among genotypes phuleG 405 established its superiority over JG 315 and produced statistically equal 100 seed weight to that produced by RVG 203, NBeG 452, JG 16 and JG 36. Among the genotypes PhuleG 405 established its superiority over rest of the genotypes[9][10]. The maximum seed yield of 1.88 kg/plot was obtained with PhuleG 405 and minimum of 1.33 kg/plot with JG 315. Genotype RVG 203, NBeG 452, JG 16, JG 36 occupied the second, third, fourth and fifth place. It was observes that highest biological yield per plot of chickpea was recorded in PhuleG 405 followed by RVG 203 ,NBeG 452, JG 16, JG 36 and JG 315. Among the genotypes PhuleG 405 established its superiority over rest of the genotypes. The maximum seed yield of 1547 kg/ha was obtained with PhuleG 405 and minimum of 1094 kg/ha with JG 315. Genotype RVG 203, NBeG 452, JG 16, JG 36 occupied the second, third, fourth and fifth place. It was observed that highest straw yield of chickpea was recorded in PhuleG 405 while minimum in JG 315. It was observes that highest biological yield of chickpea was recorded in PhuleG 405 followed by RVG 203 ,NBeG 452, JG 16, JG 36 and JG 315[11][12].

Table-1: Plant height (cm) as influenced by genotypes and row spacing

A Variety : 6	30 DAS	60 DAS	90 DAS	Maturity
V1 JG-16	14.22	30.00	38.05	45.21
V2 JG-315	13.91	28.39	35.50	43.50
V3 Phule G-405	15.53	33.44	40.55	46.05
V4 JG-36	14.05	29.33	37.78	44.39
V5 NBeG-452	14.40	31.22	38.66	45.61
V6 RVG-203	15.05	32.93	39.33	45.78
S.E.m±	0.30	0.67	0.90	0.53
CD5%	0.87	1.96	2.64	1.57
B. Spacing : 02				
S1 : 30 cm	15.02	31.84	39.89	46.09
S2 : 45 cm	14.03	29.92	36.74	44.09
S.E.m±	0.17	0.39	0.52	0.31
CD at 5%	0.50	1.13	1.53	0.91
C. V × S				
S.E.m±	0.528	1.157	1.260	0.883
CD at 5%	NS	NS	NS	NS

Table-2: Number of branches per plant as influenced by genotypes and row spacing

A Variety : 6	40 DAS	60 DAS	80 DAS	Maturity
V1 JG-16	2.48	7.55	8.77	8.77
V2 JG-315	2.33	7.00	8.33	8.33
V3 Phule G-405	2.83	8.05	9.72	9.72
V4 JG-36	2.44	7.11	8.55	8.55
V5 NBeG-452	2.55	7.72	8.05	8.05
V6 RVG-203	2.72	7.78	9.50	9.50
S.E.m±	0.11	0.23	0.25	0.25
CD5%	0.33	0.67	0.73	0.73
B. Spacing : 02				
S1 : 30 cm	2.68	7.76	9.29	9.29
S2 : 45 cm	2.44	7.31	8.68	8.68
S.E.m±	0.06	0.13	0.14	0.14
CD5%	0.19	0.39	0.42	0.42
C. V × S				
S.E.m±	0.157	0.319	0.396	0.396
CD5%	NS	NS	NS	NS

Table-3 Root length/plant (cm) as influenced by genotypes and row spacing

A Variety : 6	30 DAS	60 DAS	Maturity
V1 JG-16	8.12	11.05	13.22
V2 JG-315	7.98	10.83	12.94
V3 Phule G-405	8.51	11.83	15.44
V4 JG-36	8.02	10.88	13.11
V5 NBeG-452	8.22	11.11	13.83
V6 RVG-203	8.25	11.16	13.98
S.E.m±	0.11	0.20	0.18
CD5%	0.31	0.57	0.53
B. Spacing : 02			
S1 : 30 cm	8.38	11.57	14.47
S2 : 45 cm	7.98	10.72	13.03
S.E.m±	0.06	0.11	0.10
CD5%	0.18	0.33	0.30
C. V × S			
S.E.m±	0.148	0.277	0.253
CD5%	NS	NS	0.948

Table- 4: Dry weight / plant (g) as influenced by genotypes and row spacing

A Variety : 6	30 DAS	60 DAS	90 DAS	Maturity
V1 JG-16	1.54	5.50	8.67	11.62
V2 JG-315	1.38	5.43	8.56	11.56
V3 Phule G-405	1.58	5.94	8.97	11.75
V4 JG-36	1.44	5.49	8.62	11.61
V5 NBeG-452	1.56	5.63	8.75	11.64
V6 RVG-203	1.57	5.78	8.94	11.70
S.E.m±	2.29	4.47	4.88	4.03
CD5%	6.531	13.11	14.32	11.18
B. Spacing : 02				
S1 : 30 cm	1.56	5.74	8.85	11.71
S2 : 45 cm	1.47	5.51	8.66	11.58
S.E.m±	1.29	2.58	2.82	2.33
CD5%	3.77	NS	8.27	6.82
C. V × S				
S.E.m±	3.14	6.31	6.90	5.69
CD5%	11.80	23.66	25.87	21.35

Table-5: Root nodules/plant (No.) as influenced by genotypes and row spacing

A Variety : 6	30 DAS	45 DAS	60 DAS
V1 JG-16	10.83	15.60	18.74
V2 JG-315	10.41	15.15	18.50
V3 Phule G-405	11.50	17.80	19.32
V4 JG-36	10.50	15.50	18.68
V5 NBeG-452	11.28	14.75	19.18
V6 RVG-203	11.00	17.60	18.95
S.E.m.	0.24	0.61	0.16
CD5%	0.69	1.79	NS
B. Spacing : 02			
S1 : 30 cm	10.50	15.15	18.65
S2 : 45 cm	11.34	17.14	19.14
S.E.m±	0.14	0.38	0.23
CD5%	0.40	1.11	NS
C. V × S			
S.E.m±	0.389	0.674	0.861
CD at 5%	NS	NS	NS

Table 6: Dry weight of root nodules (mg/plant) as influenced by genotypes and row spacing

A Variety : 6	30 DAS	45 DAS	60 DAS
V1 JG-16	43.77	50.76	61.01
V2 JG-315	41.22	49.71	58.52
V3 Phule G-405	50.08	59.92	65.19
V4 JG-36	42.83	50.16	60.42
V5 NBeG-452	46.47	55.68	63.09
V6 RVG-203	45.13	51.97	62.22
S.E.m±	0.94	1.73	0.53
CD5%	2.94	5.07	NS
B. Spacing : 02			
S1 : 30 cm	43.95	48.56	59.30
S2 : 45 cm	45.88	57.51	64.18
S.E.m±	0.54	1.00	0.74
CD5%	2.94	2.92	2.18
C. V × S			
S.E.m±	1.381	1.597	2.34
CD at 5%	NS	NS	NS

Table 7: Crop growth rate (g/m²/day) as influenced by genotypes and row spacing

A Variety : 6	**30-60 DAS**	**60-90 DAS**
V1 JG-16	0.396	0.292
V2 JG-315	0.354	0.277
V3 Phule G-405	0.401	0314
V4 JG-36	0.359	0.289
V5 NBeG-452	0.352	0.276
V6 RVG-203	0.397	0.301
S.E.m±	0.08	0.07
CD5%	0.024	0.022
B. Spacing : 02		
S1 : 30 cm	0.444	0.440
S2 : 45 cm	0.309	0.330
S.E.m±	0.04	0.04
CD5%	0.013	0.012
C. V × S		
S.E.m±	0.011	0. 010
CD5%	NS	NS

Table 8: Relative growth rate (RGR) as influenced by genotypes and row spacing

A Variety : 6	**30-60 DAS**	**60-90 DAS**
V1 JG-16	0.00178	0.00625
V2 JG-315	0.00173	0.00573
V3 Phule G-405	0.00198	0.00673
V4 JG-36	0.00175	0.00585
V5 NBeG-452	0.00183	0.00651
V6 RVG-203	0.00196	0.00671
S.E.m±	0.0046	0.00192
CD5%	0.0134	0.0564
B. Spacing : 02		
S1 : 30 cm	0.00188	0.00653
S2 : 45 cm	0.00179	0.00613
S.E.m±	0.00260	0.00111
CD5%	0.0780	0.0326
C. V × S		
S.E.m±	0.0027	0.0064
CD5%	NS	NS

CONCLUSION

Genotypes differed significantly in growth parameters like plant height, number of branches per plant at all crop growth stages except 90 DAS and maturity in case of number of branches per plant. At maturity plant height and branches /plant were maximum in PhuleG 405 followed by RVG 203, NBeG 452, JG 16 and JG 36 while minimum in JG 315. Genotypes did differ in number and dry weight of nodules per plant at all stages of observations. except 60 DAS. The crop growth rate varied significantly in different genotypes. PhuleG 405 recorded significantly higher crop growth rate over rest of the genotypes except RVG 203 and JG 16, Relative growth rate differ significantly among the genotypes. The genotypes PhuleG 405 had highest number of pods per plant and seed yield per plant as well as seed index was found highest in PhuleG 405 followed by RVG 203, NBeG 452, JG 16 and JG 36. Minimum value of all the yield attributing characters was obtained in JG 315. The seeds /pod influence significantly due to genotypes. Seed and straw yields differed according to genotypes and highest values were obtained from PhuleG 405 (1547kg/ha seed and 1745kg/ha straw yield). Harvest index for different genotypes did vary significantly.

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