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Research Article

Inheritance of seed yield and its components in chickpea (*cicer arietinum*)

Krishna D. Dahake Anant R. Mali and Balawant S. Mundhe
Department of Agricultural Botany,
M.P.K.V., Rahuri, Maharashtra- 413 722, INDIA.
Email: armali.333@gmail.com

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Abstract
Present investigation was undertaken to unravel the genetics of seed related attributes in chickpea (*Cicer arietinum*) at Pulse Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. Three crosses (Phule G 96006 x Phule G 5, Phule G 96006 x Phule G 9426-2 and Phule G 5 x Phule G 9426-2) along with its parental seed, F_2, BC_1 and BC_2 were put into generation mean analysis. The characters *viz.,* days to maturity, plant height, branches per plant, pods per plant, harvest index and seed yield per plant were subjected to generation mean analysis to assess the gene effects controlling these traits. The analysis of variance revealed that significant differences among generations in most of the characters studied in all the three crosses, except branches per plant and plant height, indicating considerable variability in the experimental material. The scaling tests (A, B, C and D) indicated that appreciable amount of epistasis was present in different characters of three crosses under study. Generation mean analysis revealed that different gene effects were responsible for the inheritance of the same trait in different crosses and for different traits in the same cross. Hence, specific handling of individual cross in segregating generations would be advantageous for improvement of these traits

Key words
Chickpea, Gene action, Generation mean analysis, Seed yield.

Introduction

Chickpea is a cool season grain legume of exceptionally high nutritive value and most versatile food for human. It is mostly grown under rain fed conditions in arid and semi-arid areas around the world. Chickpea is known to have eight annual and 34 perennial species (Van der Maesen, 1987). Among them *Cicer arietinum* (2n = 16) is most widely cultivated and *Cicer soongaricum* (2n = 16) cultivated in Western temperate and Alpine regions (9000-15000 feet in altitude) of Himalaya. West Asia and Iran is known to be a genetic diversity centre and rich in both landraces and wild relatives of chickpea (Singh and Ocampo, 1997). Modern plant breeding and agricultural systems have narrowed the genetic base of cultivated chickpea (Robertson *et al.,* 1997).

Though, there is a wide range of genetic variability available in India, not much attention has been given to the genetical studies and crop improvement. Despite growing demand and high yield potential, chickpea yield is unstable and productivity is stagnant at unacceptably low level. The estimation of genetic parameters is needed to understand the genetic architecture of yield and yield contributing components. Information about type of gene action for yield and yield contributing components would be of immense help for a plant breeder to decide about the proper breeding procedure to be adopted. The present study was envisaged to ascertain the inheritance of yield and yield component characters essential in formulating a suitable breeding programme.

Material and method

The present investigation was undertaken to unravel the genetics of seed yield and its related attributes in chickpea (*Cicer arietinum*) at Pulse Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. Three crosses (Phule G 96006 x Phule G 5, Phule G 96006 x Phule G 9426-2 and Phule G 5 x Phule G 9426-2) made during *Rabi*- 2005 were grown along with its three promising parents (Phule G 96006, Phule G 5 and Phule G 9426-2) to make the F_2, BC_1 and BC_2 generations during *Rabi*- 2006 by hand pollination. Therefore, the material for the present investigation consisting complete set of six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) for generation mean analysis. The experiment was laid out in a Randomized Block Design with three replications. The parents, F_1, BC_1 and BC_2 were sown in single row of 3 m length with 30 x 15 cm inter and intra row spacing, while, F_2 was assigned with 32 rows for each cross in each replication. Recommended agronomic practices and necessary plant protection measures were timely adopted successfully for raising the crop. The observations were recorded for the characters *viz.,* days to maturity (DM), plant height (PH), branches per plant (BP), pods per plant (PP), seed yield per plant (SY) and harvest index (HI) on five randomly selected plants for all the generations in each replications. The data were subjected to analysis of variance for Randomized Block Design following Fisher (1950). The scaling test as described by Haymen and Mather (1955) was used to check the adequacy of the additive dominance model for different characters in each cross. Generation mean analysis was performed as per Hayman (1958).

Result and discussion

The analysis of variance for individual character was carried out for each of the three crosses for seed yield per plant and its component traits (Table I). The analysis of variance revealed that all the characters under study exhibited highly significant differences among the genotypes except branches per plant and plant height. The crosses that showed significant differences among their respective generations for various characters were considered for studying gene action.

Scaling tests: The scaling tests for individual traits among three crosses revealed that A, B, and C were significant for all the characters except days to maturity (C II), branches per plant (C-II), plant height (C- III), pods per plant (C- I, III), harvest index (C- I) and yield per plant (C- I). This suggested the failure of a simple genetic model to explain the genetic system controlling the traits in three crosses studied and need for consideration of epistasis in all traits while the planning breeding programmes in chickpea (Table 2).

*Days to maturity:*There was a significant difference for this character in all the three crosses. The highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generations differed from each other with respect to days to maturity. The estimation of gene effects revealed that in cross C- I and C- II, additive, dominance and all three types of interactions *viz.*, additive x additive (i), additive x dominance (j) and dominance x dominance (l) were present. The dominance (h) and dominance x dominance (l) effects were having opposite signs, indicating the duplicate gene action in inheritance of days to maturity (Bajaj *et al.* 1983 and Malhotra and Singh, 1989). Hence, recurrent selection method would be effective for improvement in this character. The cross C- III revealed that additive and additive x additive (i) effects were significantly influencing this character, which indicate the predominant role of selection in breeding for this character.

*Branches per plant:*There was a significant difference for this character in all the three crosses. Highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generations differed from each other with respect to branches per plant. The cross C- I shows presence of additive, dominance and all three types of interactions *viz.* additive x additive (i), additive x dominance (j) and dominance x dominance (l) gene effects. The dominance (h) and dominance x dominance (l) effects were having opposite signs and this indicate the presence of duplicate gene action in inheritance of this character. Hence, recurrent selection would be effective in improvement of this character. While, in cross C- II, duplicate gene action and cross C- III, dominance x dominance (l) gene interactions were influencing this character and this indicate that heterosis breeding would be effective for improvement of branches per plant (Singh and Sindhu, 1994 and Jeena and Arora, 2001).

*Plant Height:*The significant difference was found for this character in C I and C II. The highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generations differed from each other with respect to plant height. The estimates of gene effect for plant height revealed that cross C- I shows presence of additive, dominance and all three types of interactions *viz.*, additive x additive (i), additive x dominance (j) and dominance x dominance (l) gene effects. The dominance (h) and dominance x dominance (l) effects were having opposite signs, indicating the duplicate gene action in inheritance of this character (Malhotra and Singh, 1989 and Miah and Bahl, 1989), indicating recurrent selection would be effective in improvement of this character. For cross C- II, additive (d) and dominance x dominance (l) and C- III, additive x additive (i) and dominance x dominance (l) interactions were observed.

Pods per plant: All the three crosses showed the significant differences for this character. Highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generations differed from each other with respect to pods per plant. In crosses C- II and C- III, additive, dominance and all three types of interactions *viz.*, additive x additive (i), additive x dominance (j) and dominance x dominance (l) were present. The dominance (h) and dominance x dominance (l) effects were having opposite signs and this indicate the presence of duplicate gene action in inheritance of pods per plant. Hence, recurrent selection for improvement of this character (Patil *et al.* 1998 and Shivkumar *et al.* 2001). The cross C- I shows presence of additive (d), dominance (h), additive x additive (i) and additive x dominance (j), indicating predominance of additive gene effects in governing this character.

*Harvest index:*There was a significant difference for this character in all the three crosses. Highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generations differed from each other with respect to harvest index. All three crosses shows the presence of additive, dominance and all three types of interactions *viz.,* additive x additive (i), additive x dominance (j) and dominance x dominance (l) gene effects. The dominance (h) and dominance x dominance (l) effects were having opposite signs and this indicate the presence of duplicate gene action in inheritance of this character. Hence, recurrent selection would be effective in improvement of this character (Mandal, 1992).

*Seed yield per plant:*The crosses CII and CIII showed the significant differences for this character. The highly significant values of 'm' from the generation mean analysis in all the three crosses showed that the six generation differed from each other with respect to seed yield per plant. All the three crosses showed significant additive (d) gene effects and dominance effects among crosses C- I and C- III. All three types of interactions were present in cross C- II, while in cross C- III, additive x additive (i) and additive x dominance (j) were found to be predominant. It would be beneficial to adopt recurrent selection method and heterosis would be effective to some extent in the improvement of this trait (Shinde and Deshmukh, 1991, Annigeri *et al.* 1996, Sarode *et al.* 2001 and Girase *et al.* 2002).

These findings illustrated the importance of duplicate epistasis in genetic consideration of different characters studied in chickpea. From the present investigation, it can be concluded that appreciable amount of epistasis was present in different characters of three crosses under the study. Breeding methods *viz.,* biparental mating, recurrent selection and diallel selective mating, which take care of both additive and non-additive gene action will be more promising for the improvement of various characters studied.

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Table 1. Analysis of variance of generation means of three crosses for various characters in chickpea.

Source	df	Cross		
		I	**II**	**III**
		Days to maturity		
Replications	2	0.046	1.09	0.06
Generations	5	25.11	12.51*	34.96**
Error	10	7.55	3.05	2.77
		Branches per plant		
Replications	2	16.51	22.37	33.46
Generations	5	11.003	6.66	15.93
Error	10	4.27	9.59	18.70
		Plant height		
Replications	2	17.01	2.13	68.55
Generations	5	13.84	7.25	15.76
Error	10	11.29	6.77	14.21
		Pods per plant		
Replications	2	73.00	89.66	861.25
Generations	5	1304.53**	1545.48**	361.8*
Error	10	209.50	113.27	106.93
		Harvest Index		
Replications	2	26.51	18.46	19.47
Generations	5	32.87*	63.93*	53.95**
Error	10	8.99	12.14	1.60
		Seed yield per plant		
Replications	2	22.28	3.41	26.16
Generations	5	54.15	18.71	103.10**
Error	10	19.31	10.04	3.23

*, ** significant at 5% and 1% level, respectively.

Table 2. Estimation of scaling tests and gene effects for different characters in chickpea

Crosses	Scales			Gene Effects					
	A	B	C	m	d	h	i (A x A)	j (A x D)	l (D x D)
					Days to maturity				
I	9.22**	6.47**	5.65**	122.31**	2.86**	4.24*	10.04**	1.37*	-25.73**
II	6.00**	1.55	-10.85**	119.29**	2.80**	19.94**	18.41**	2.22**	-25.97**
III	3.94**	4.00**	13.55**	128.42**	2.84**	-0.18	-5.60**	-0.03	-2.35
					Branches per plant				
I	-1.77*	6.71**	-10.13**	20.00**	-4.07**	15.94**	15.07**	-4.24**	-20.01**
II	-3.49	-5.00**	5.89*	24.02**	1.01	-13.14*	-14.39**	0.75	22.89**
III	-7.94**	-7.37**	-16.58**	19.79**	0.91	4.04	1.27	-0.28	14.05**
					Plant height				
I	2.55*	-4.09*	-11.44**	36.02**	3.23**	6.27**	9.91**	3.32**	-8.36**
II	-2.53*	-4.57**	-6.73**	37.06**	2.11**	2.35	-0.36	1.01	7.47*
III	5.80*	-0.12	-4.15	39.38**	0.46	6.02	9.84**	2.96	-15.52*
					Pods per plant				
I	26.59**	-5.31	56.67**	126.30**	39.40**	-52.84**	-35.39**	15.95**	4.11
II	17.91**	-17.20**	-64.20**	101.84**	40.89**	41.97**	64.95**	17.55**	-65.65**
III	-14.86*	11.22	79.14**	125.82**	-9.13*	-68.32**	-82.78**	-13.04**	86.42**
					Harvest index				
I	-12.39**	-1.29	15.06**	41.21**	-3.38**	-30.68**	-28.74**	-5.55**	42.42**
II	22.79**	7.79**	6.68**	36.48**	3.92**	19.44**	23.90**	7.50**	-54.49**
III	-9.57**	-16.86**	9.77**	41.67**	4.39**	-37.92**	-36.21**	3.64**	62.65**
					Yield per plant				
I	2.81	3.63	7.79*	32.25**	4.80**	-7.27**	-1.34	-0.40	-5.11
II	9.36**	0.20	5.14**	30.67**	5.58**	0.55	4.41*	4.58**	-13.97**
III	-18.43**	2.77*	-35.31**	31.10**	-5.13**	29.05**	19.64**	-10.60**	-3.98