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Variability studies for yield in biparental and selfed progenies of chickpea (*Cicer arietinum* L.)

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ABSTRACT

In the present study, biparental progenies (BIP F_3) and their corresponding selfed (F_5) progenies generated from the cross JAKI 9218 X NBeG 776 were simultaneously evaluated for per se performance and extent of genetic variability using thirty genotypes for each population in chickpea. The *per se* performance of $BIPF_3$s was higher for various traits as compared to F_5 progenies. The range for different characters for $BIPF_3$ and F_5 also revealed that $BIPF_3$ has wider limits compared to F_5 progenies for plant height, number of pods, seed yield, 100 seed weight, and protein content. Phenotypic and genotypic coefficients of variation were high in both $BIPF_3$ and F_5 selfed for all the characters except for days to flowering and days to maturity in BIP F_3 and protein content in F_5. Except for days to flowering ($BIPF_3$ and F_5) and days to maturity (BIP F_3), all other traits showed high heritability with moderate to high genetic advance in $BIPF_3$ as well as in F_5. However, high heritability associated with low GAM% was observed for protein content in F_5 of this cross.

Keywords: *Biparental progenies, Chickpea, GCV, PCV and Selfed progenies.*

Chickpea (*Cicer arietinum* L.) is the foremost *rabi* pulse crop in India, accounting for 50% of the nation's total pulse production. This crop is vital for soil improvement due to its ability to fix nitrogen, thereby enhancing soil health. Additionally, chickpeas are a significant component of vegetarian diets, providing protein (12-31%), carbohydrates (48-67%), starch (41-50%), and fat (6%). During the 2022-23 agricultural year, there was significant progress in global chickpea production, achieving a record output of 18.0 million tons from 14.8 million hectares, reflecting a 14.0% increase compared to 2021-22 (FAOSTAT 2023). India remains the world's leading chickpea producer, contributing 11.58 million tons from 9.46 million hectares, with a productivity of 1,264 kg/ha (Third advance estimates, Agricultural Statistics Division, Directorate of Economics and Statistics, Dept. of Agriculture and Cooperation, 2023-24). Despite this robust production, India's chickpea output is insufficient to meet domestic demand, and dependent on imports for Desi chickpeas while simultaneously establishing itself as a significant exporter of Kabuli chickpeas over the past decade. Chickpeas are primarily self-pollinated, which contributes to slow breeding progress due to limited genetic diversity. In self-pollinated crops, the presence of linkage blocks and inverse relationships among correlated traits is common. Traditional breeding techniques, such as the pedigree method and its variations, face several limitations, including restricted parent participation, low genetic variability, reduced recombination, and rapid gene fixation due to self-fertilization (Clegg *et al*., 1972). Consequently, it has become crucial to explore new strategies for generating genetic variability in yield and its component traits. Biparental mating within appropriate segregating populations (such as F_2, F_3, or later generations) offers enhanced opportunities for recombination compared to selfing (Gill, 1987). This approach is particularly effective in breaking larger linkage blocks. When a lack of desired variation presents a significant barrier in crop improvement programs, breeders often turn to this method to rapidly generate variability. Although there have been contrasting opinions presented on the usefulness of the biparental strategy in self-pollinated

crops and has been a subject of strong disagreement still in many cases, such as wheat and safflower, it has proven to be beneficial. However, there is ample information on BIP's efficacy with chickpeas. The present investigation was thus, aimed to evaluate the performance of biparental progenies with the selfed generation in releasing genetic variability for yield and other important yield component traits.

MATERIAL AND METHODS

The experimental material was obtained from genetic stock of Chickpea breeding programmes of AICRP on Chickpea operating at RARS, Nandyal. Thirty biparental (BIP F_3s) and 30 selfed progenies (F_5s) of cross JAKI 9218 x NBeG 776 along with parental genotypes were sown in Compact family block design with two replications during *rabi*, 2023 at RARS, Nandyal. The parent JAKI 9218 is high yielding desi variety whereas NBeG 776 is high yielding machine harvestable desi genotype bred at RARS, Nandyal and released for commercial cultivation in Andhra Pradesh. In each replication every genotype was sown in one row of three-meter length with a spacing of 30 cm between rows and 10 cm between the plants within a row. The data was recorded on individual plant in BIP F_3s and F_5s for nine characters *viz*., days to 50% flowering, plant height, days to maturity, number of branches per plant, number of pods per plant, seed yield, harvest index,100 seed weight and protein content. The $BIPF_3$ progenies and F_5 progenies means and ranges with regard to each character were recomanded. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were calculated by the method suggested by Burton (1952). Heritability (h^2) in broad sense was calculated as suggested by Lush (1940) and expressed in percentage. Genetic advance and genetic advance as per cent of mean ware estimated by the method formulated by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The *per se* performance of $BIPF_3$s for various traits was superior in the JAKI 9218 × NBeG 776 cross compared to F_5 progenies, with the exception of plant height (Table 1). In $BIPF_3$ progenies, both additive and non-additive gene effects appear to have been effectively utilized. The enhanced performance of BIP F_3s relative to F_5 progenies can also be attributed to increased genetic variability resulting from the disruption of undesirable linkages. This suggests a greater potential for selection in BIP F_3 progenies, as the mean performance has improved in the desired direction. These results are also supported by the studies of Anuradha and Reddy (2004) in case of sesame, Jahagirdar (2005) in chickpea, Naik *et al*. (2009) in safflower. The ranges of plant height, number of pods, seed yield, 100 seed weight, and protein content of $BIPF_3$ progenies have larger limits than F_5 progenies. Additionally, in desiable direction the general shift in the range of expression was notedof several characters in the biparental mating in safflower by Naik *et al*. (2009).

Genetic variability parameters such as coefficient of variation (%), heritability, and genetic advance as per cent of mean in $BIPF_3$ and F_5 progenies of cross are presented in Table 2. The genetic variability studies revealed that PCV and GCV were high in both $BIPF_3$ and F_5 selfed for all the characters except for days to flowering and days to maturity in BIP F_3 and protein content in F_5. However, PCV (49.4%,10%) and GCV (44.8%,5%) estimates were high in $BIPF_3$ and low in F_5 for protein content. This may be due to the breakage of both coupling and repulsion phase linkages in BIPs. This suggests that, there is enhanced scope for improved selection response for higher protein content in BIP F_3 progenies. Except days to flowering ($BIPF_3$ and F_5), days to maturity (BIP F_3), all other traits showed high heritability with moderate to high genetic advance in $BIPF_3$ as well as F_5. The prevalence of additive gene effects is likely responsible for the anticipated genetic gains, indicating that selection could be effectively utilized in this cross across the populations to enhance yield and associated traits. However, the F_5 generation exhibited high heritability coupled with a low genetic advance as per cent of mean (GAM%) for protein content. In contrast, the BIP F_3 generation showed improvements in both heritability and genetic advance, demonstrating the efficacy of biparental mating in early segregating generations to increase genetic variability. This suggests that the potential gains from selection for protein content will be greater in BIP F_3 progenies compared to their selfed counterparts. High heritability with high genetic advance for important traits in BIP over selfed progenies was also reported in bread wheat (Yunus and Paroda, 1983;Verma *et al.,* 1979), barley (Prakash and Verma, 2006) and okra (Raju *et al*., 2010;Guddadamath *et al*., 2011). Kampli *et al*. (2002) reported enhanced estimates of heritability

Table 1. Mean and range of seed yield and yield equipment traits in BIP F_3 and F_5 progenies of chickpea crops JAKI 9218 × NBeG 776

	BIP F_3			F_5		
	Mean	Limits	Range	Means	Limits	Range
DFF	46	37.0-50.0	13	43.8	36.0-50.0	14
DM	81	70.0-83.0	11	81.6	72.0-90.0	14
PH	37.5	19.0-50.0	31	38.1	25.0-60.0	26
NBPP	16.5	3.0-31.0	28	14.1	4 -39.0	35
NPPP	46	8.0-87.0	79	41.4	13-92.0	79
SY	16.5	2.0-33.0	31	12.6	4-33.0	29
HI	58.1	20.0-60.0	40	52.2	19.5-68.7	49.2
HSW	28.9	15.0-33.0	18	28.2	17.0-35.7	17.5
PC	17.7	14.3-26.0	11.7	16.2	14.11-19.88	5.8

DFF= Days to 50% flowering*, PH= Plant height (cm), DMM= Days to maturity*, NBPP= Number of branches per plant, NPPP= No of pods per plant, SY= Seed yield (g), HI= Harvest index (%), HSW= 100 seed weight (g) *, PC= Protein content (%) * *Recorded on plot basis.

Table 2. Estimates of variability, heritability and genetic advance as per cent of mean for nine traits in BIP F_3 and F_5 progenies of chickpea crops JAKI 9218 × NBeG 776

Character	Population	PCV	GCV	h^2 (b) %	GA	GAM (%)
DF	BIP-F_3	16.61	5.07	30.5	1.73	3.77
	F_5	22.51	10.39	46.15	2.98	6.81
DM	BIP-F_3	10.12	3.95	39.02	2.3	2.84
	F_5	31.26	25.13	80.41	8.36	10.24
PH	BIP-F_3	43.76	22.99	52.53	4.38	11.69
	F_5	73.72	53.27	72.26	7.89	20.71
NBPP	BIP-F_3	112.97	88.12	78	6.94	42.07
	F_5	330.89	301.78	91.2	12.83	91.13
NPPP	BIP-F_3	282.02	185.07	65.62	15.4	33.47
	F_5	580.46	472.63	81.42	25.98	62.82
SY	BIP-F_3	100.73	80.73	80.14	6.74	40.82
	F_5	221.42	195.14	88.13	9.57	76.18
HI	BIP-F_3	206.08	155.06	75.24	16.96	29.2
	F_5	144.39	87.63	60.69	10.85	20.79
HSW	BIP-F_3	116.87	79.96	68.42	8.2	28.3
	F_5	73.01	35.07	48.03	4.49	15.93
PC	BIP-F_3	49.43	44.83	90.69	5.53	31.31
	F_5	10.09	5.09	50.43	1.33	8.18

DFF= Days to 50% flowering*, PH= Plant height (cm), DMM= Days to maturity*, NBPP= Number of branches per plant, NPPP= No of pods per plant, SY= Seed yield (g), HI= Harvest index (%), HSW= 100 seed weight (g) *, PC= Protein content (%)

* *Recorded on plot basis. PCV= Phenotypic coefficient of variation GCV=Genotypic coefficient of variation, h^2 (b) % = Heritability (broad sense), GA=Genetic advance, GAM%=Genetic advance as percent of mean.

and genetic advance in biparental progenies of chickpea, while Hasan and Deb (2023) observed greater genetic variability for quantitative traits in chickpea.

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