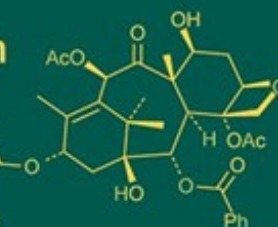
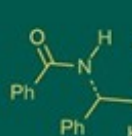


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Genetic variability and selection potential in F_3 , F_4 and BIP F_2 populations of Kranti $\times$ PC-6 in mustard (*Brassica juncea* L.)

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ABSTRACT

The present study was conducted to assess the magnitude of genetic variability and selection potential in F_3 , F_4 and biparental F_2 populations of the cross Kranti $\times$ PC-6 in Indian mustard (*Brassica juncea* L.). The field experiment was conducted during Rabi 2025–26 at the Research Field of AICRP (Linseed and Mustard), College of Agriculture, Nagpur, in a randomized block design with two replications. Observations were recorded for days to first flowering, days to maturity, plant height, number of branches plant⁻¹, number of siliques plant⁻¹, silique density, powdery mildew incidence and seed yield plant⁻¹. Analysis of variance revealed highly significant differences among plants for all the characters in F_3 , F_4 and BIP F_2 , indicating substantial variability within the populations. Considerable variation was observed in mean performance and range, particularly for yield and yield-associated traits. GCV and PCV were comparatively higher for number of branches plant⁻¹, number of siliques plant⁻¹, silique density and seed yield plant⁻¹. Moderate to high heritability coupled with appreciable genetic advance for these characters indicated greater scope for selection and genetic improvement in the Kranti $\times$ PC-6 segregating populations.

Keywords: *Brassica juncea*, Kranti $\times$ PC-6, Genetic variability, GCV, PCV, Heritability, Genetic advance, Biparental population

Introduction

Indian mustard (*Brassica juncea* L.) is an important oilseed crop cultivated widely in India and contributes substantially to the country's edible oil production. Improvement in productivity and adaptation of mustard depends largely on the identification and utilization of desirable genetic variability for yield and its associated traits. Since seed yield is a complex quantitative trait influenced by several component characters and environmental factors, effective selection requires an understanding of the extent and nature of genetic variability present in segregating populations.

Segregating generations derived from biparental crosses provide an opportunity to generate and exploit genetic variation for economically important traits. Evaluation of successive generations such as F_3 and F_4 facilitates the identification of superior segregants, while biparental mating can further broaden variability through recombination. Estimation of genotypic and phenotypic coefficients of variation, heritability and genetic advance provides useful information regarding the relative contribution of genetic variation and the expected response to selection.

The cross Kranti $\times$ PC-6 represents a useful genetic combination for evaluating variability in mustard. However, information on the magnitude of variability and the selection potential of its F_3 , F_4 and biparental F_2 populations is essential for determining the effectiveness of selection for yield and associated traits. Therefore, the present investigation was undertaken to assess the analysis of variance, mean performance, range and genetic variability parameters in F_3 , F_4 and BIP F_2 populations of Kranti $\times$ PC-6 for yield and related traits under Nagpur conditions.

Materials and Methods

The experiment was conducted during Rabi 2025–26 at the Research Field of AICRP (Linseed and Mustard), College of Agriculture, Nagpur. F_3 , F_4 and BIP F_2 populations derived from the cross Kranti $\times$ PC-6 were evaluated in a randomized block design with two replications. Observations were recorded on days to first flower (DFF), days to maturity (DM), plant height (PH), number of branches plant⁻¹ (NBP), number of siliques plant⁻¹ (NSP), silique density (SDP), powdery mildew incidence (PMI) and seed yield plant⁻¹ (SYP). Analysis of variance was performed following Punse and Sukhatme (1961) [1]. GCV and PCV were estimated following Burton and Devane (1953), broad-sense heritability according to Hanson *et al.* (1956) [2],

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and genetic advance according to Robinson *et al.* (1949) [3]. GCV and PCV values below 10%, 10–20% and above 20% were considered low, moderate and high, respectively.

Results and Discussion

Significant variation among plants was observed for most of the characters in the three generations of Kranti × PC-6. The genotype mean squares for days for first flower were 26.79, 20.08 and 24.11 in F₃, F₄ and BIP F₂, respectively, while those for days to maturity were 57.33, 21.89 and 20.65. Plant height also showed highly significant variation, with genotype mean squares of 726.20, 704.23 and 881.62, respectively. Similar significant variation was observed for number of branches plant⁻¹, number of siliquae plant⁻¹ and siliquae density plant⁻¹. For powdery mildew incidence, genotypic differences were significant in F₃ and BIP F₂ but non-significant in F₄. Seed yield showed highly significant genotypic variation in all three generations,

with genotype mean squares of 95.12, 121.36 and 100.70, respectively.

The mean and range further demonstrated substantial segregation within the Kranti × PC-6 populations. Days to first flower ranged from 39–54 days in F₃, 40–55 days in F₄ and 41–51 days in BIP F₂, with means of 44.40, 43.42 and 45.88 days, respectively. Days to maturity showed relatively narrower variation, with means of 109.90, 114.10 and 114.78 days. Plant height exhibited a comparatively wider range, from 137–193 cm in F₃, 150–199 cm in F₄ and 134–199 cm in BIP F₂.

For yield-associated traits, number of branches plant⁻¹ averaged 5.03, 4.73 and 4.45 branches plant⁻¹ in F₃, F₄ and BIP F₂, respectively. Number of siliquae plant⁻¹ showed substantial segregation, ranging from 141–356, 149–352 and 171–362 siliquae plant⁻¹, with corresponding means of 239.23, 232.42 and 246.90. Siliqua density ranged from 0.31–0.92, 0.35–0.98 and 0.42–0.98, respectively. Seed yield ranged from 2.65–29.40 g in F₃, 4.30–31.60 g in F₄ and 5.40–29.40 g plant⁻¹ in BIP F₂.

Table 1. Analysis of variance for Kranti x PC-6 cross of mustard

Sources of variation		DFF		DM		PH		NBP		NSP		SDP		PMI		SYP	
		DF	MSS	DF	MSS	DF	MSS	DF	MSS	DF	MSS	DF	MSS	DF	MSS	DF	MSS
F ₃	Replication	1	0.01	1	0.01	1	2550.25	1	0.01	1	139.24	1	0.005	1	15.21	1	0.01
	Selected plants	49	26.79**	49	57.33**	49	726.2**	49	1.06**	49	3339.57**	49	0.03**	49	367.44**	49	95.12**
	Error	49	0.07	49	0.13	49	123.63	49	0.23	49	543.89	49	0.01	49	52.9	49	8.18
F ₄	Replication	1	1.66	1	0.6	1	40.01	1	0.81	1	2220.41	1	8E-04	1	1.06	1	19.61
	Selected plants	29	20.08**	29	21.89**	29	704.23**	29	2.1**	29	5090.46**	29	0.03**	29	295.85	29	121.36**
	Error	29	0.25	29	0.11	29	100.67	29	0.54	29	367.69	29	0.007	29	203.75	29	10.79
BIP F ₂	Replication	1	0.02	1	0.22	1	1.22	1	0.02	1	168.1	1	0.01	1	42.02	1	15.46
	Selected plants	19	24.11**	19	20.65**	19	881.62**	19	1.6**	19	2952.02**	19	0.03**	19	291.13**	19	100.7**
	Error	19	0.18	19	0.17	19	69.17	19	0.23	19	504.36	19	0.004	19	19.44	19	6.08

** Significant at 1% level.

DFF=Days to first flower; DM=Days to maturity; PH=Plant height; NBP=Number of branches plant⁻¹; NSP=Number of siliquae plant⁻¹; SDP=Siliquae density plant⁻¹; PMI=powdery mildew incidence; SYP=Seed yield plant⁻¹.

DF=degree of freedom; MSS= mean sum of squares

Powdery mildew incidence showed considerable variation, ranging from 16–85% in F₃, 28–75% in F₄ and 5–66% in BIP F₂. The mean incidence decreased from 40.10% in F₃ and 51.12% in F₄ to 31.62% in BIP F₂. Thus, the BIP F₂ population contained individuals with rela-

tively lower disease incidence, providing useful material for selection for reduced powdery mildew susceptibility. The frequency distribution also showed individuals occurring in the lower disease-incidence classes in BIP F₂.

Table 2. Mean and range for different characters in F₃, F₄ and BIP F₂ populations of Kranti x PC-6 cross of mustard

Characters	Generations	Mean ± S. E	Range
Days to first flower	F ₃	44.40 ± 0.34	39.00 - 54.00
	F ₄	43.42 ± 0.48	40.00 - 55.00
	BIP F ₂	45.88 ± 0.50	41.00 - 51.00
Days to maturity	F ₃	109.90 ± 0.28	105.0 - 116.0
	F ₄	114.10 ± 0.42	108.0 - 120.0
	BIP F ₂	114.78 ± 0.45	110.0 - 120.0
Plant height (cm)	F ₃	167.48 ± 1.29	137.0 - 193.0
	F ₄	176.43 ± 1.62	150.0 - 199.0
	BIP F ₂	176.05 ± 2.56	134.0 - 199.0
Number of branches plant ⁻¹	F ₃	5.03 ± 0.10	3.00 - 8.00
	F ₄	4.73 ± 0.14	3.00 - 8.00
	BIP F ₂	4.45 ± 0.13	3.00 - 6.00

(continued on next page)

Characters	Generations	Mean $\pm$ S. E	Range
Number of siliquae plant ⁻¹	F ₃	239.23 $\pm$ 3.73	141.0 - 356.0
	F ₄	232.42 $\pm$ 5.10	149.0 - 352.0
	BIP F ₂	246.90 $\pm$ 5.31	171.0 - 362.0
Siliqua density plant ⁻¹	F ₃	0.61 $\pm$ 0.01	0.31 - 0.92
	F ₄	0.62 $\pm$ 0.02	0.35 - 0.98
	BIP F ₂	0.67 $\pm$ 0.02	0.42 - 0.98
Powdery mildew incidence (%)	F ₃	40.10 $\pm$ 1.39	16.00 - 85.00
	F ₄	51.12 $\pm$ 1.56	28.00 - 75.00
	BIP F ₂	31.62 $\pm$ 2.61	5.00 - 66.00
Seed yield plant ⁻¹ (g)	F ₃	16.05 $\pm$ 0.53	2.65 - 29.40
	F ₄	15.28 $\pm$ 0.69	4.30 - 31.60
	BIP F ₂	14.90 $\pm$ 0.74	5.40 - 29.40

The estimates of genetic parameters revealed distinct differences among characters and generations. Days to first flower showed low GCV and PCV, ranging from 6.95–7.81% and 7.03–7.85%, respectively, with high heritability of 97.51–99.47% and genetic advance as percentage of mean of 14.13–16.05%. Days to maturity showed low variability, with GCV and PCV ranging from 2.60–4.60% and 2.62–4.61%, respectively, although heritability remained high (98.34–99.54%).

Plant height showed moderate variability in BIP F₂, where GCV and PCV reached 13.34 and 14.43%, respectively, with heritability of 85.45% and genetic advance of 25.40%. number of branches plant⁻¹ showed moderate to high variability, with GCV ranging from 15.10–19.04% and PCV from 18.88–24.75%; heritability ranged from 59.18–74.39%, while genetic advance as percentage of mean ranged from 24.86–30.78%. NSP also showed moderate GCV and PCV, with the highest values in F₄ (16.06 and 17.27%) accompanied by high heritability (86.53%) and genetic advance (30.78%).

Table 3. Genetic variability parameter estimates for different characters in F₃, F₄ and BIP F₂ generations of Kranti x PC-6 cross of mustard

Characters	Populations	GCV %	PCV %	h ² (bs) %	GA (% of mean)
Days to first flower	F ₃	7.81	7.83	99.47	16.05
	F ₄	6.95	7.03	97.51	14.13
	BIP F ₂	7.79	7.85	98.49	15.92
Days to maturity	F ₃	4.6	4.61	99.54	9.45
	F ₄	2.69	2.7	98.93	5.50
	BIP F ₂	2.6	2.62	98.34	5.30
Plant height	F ₃	10.37	12.32	70.9	17.99
	F ₄	10.4	12	74.99	18.54
	BIP F ₂	13.34	14.43	85.45	25.40
Number of branches plant ⁻¹	F ₃	15.1	18.88	63.92	24.86
	F ₄	19.04	24.75	59.18	30.17
	BIP F ₂	17.32	20.08	74.39	30.78
Number of siliquae plant ⁻¹	F ₃	13.81	16.28	71.99	24.15
	F ₄	16.06	17.27	86.53	30.78
	BIP F ₂	12.57	14.94	70.82	21.80
Siliqua density	F ₃	16.84	23.83	49.93	24.51
	F ₄	19.82	24.46	65.67	33.09
	BIP F ₂	16.08	18.75	73.53	28.40
Seed yield plant ⁻¹	F ₃	34.88	38.03	84.16	65.92
	F ₄	37.81	41.12	84.54	71.62
	BIP F ₂	31.23	33.18	88.6	60.56

Siliqua density exhibited moderate to high variability, with GCV ranging from 16.08–19.82% and PCV from 18.75–24.46% in Kranti × PC-6. Heritability ranged from 49.93–73.53%, while genetic advance as percentage of mean ranged from 24.51–33.09%. Seed yield plant⁻¹ showed high variability in all three generations, with GCV values of 34.88, 37.81 and 31.23% and PCV values of 38.03, 41.12 and 33.18% in F₃, F₄ and BIP F₂, respectively. Heritability was high (84.16–88.60%) and genetic advance as percentage of mean ranged from 60.56–71.62%.

The close association between high heritability and substantial genetic advance for number of branches plant⁻¹, number of siliquae plant⁻¹, siliqua density plant⁻¹ and seed yield plant⁻¹ indicate considerable scope for selection in the Kranti × PC-6 populations. Seed

yield showed high GCV, PCV, heritability and genetic advance in all three generations, indicating substantial heritable variation for this trait. The results agree with earlier reports of genetic variability and heritability for yield and yield-associated traits in Indian mustard.

Conclusion

The F₃, F₄ and BIP F₂ populations of Kranti × PC-6 exhibited considerable genetic variability for yield and associated traits. Significant genotypic differences were observed for most characters, while substantial phenotypic ranges indicated the presence of diverse segregants. Low variability was observed for flowering and maturity, whereas number of branches plant⁻¹, number of siliquae plant⁻¹, sili

quae density plant-1 and particularly seed yield plant-1 showed greater variability. High heritability coupled with appreciable genetic advance for these traits indicated good prospects for selection. The presence of lower powdery mildew incidence classes in BIP F₂ also provides useful material for further selection. Overall, the Kranti × PC-6 segregating populations offer useful genetic material for selection and advancement of superior mustard genotypes.

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