

Comparison of induced and recombinational variability for improving productivity in urdbean

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ABSTRACT

Eleven F_2/F_2M_2 urdbean progenies comprising four irradiated single, four single, two three-way and one double cross progenies generated by involving parents for seed index and pods per plant were compared for genetic variability parameters. Higher range was observed for plant height, pods per plant, 100-seed weight and seed yield per plant in the irradiated single cross progenies. Three-way and double cross progenies had higher values for pod length and number of seeds per pod. Variability generated by irradiation of single cross had supplemented hybridization for number of clusters per plant and pod length. Hybridization involving more than two parents resulted in sufficient variability for remaining traits under study. High heritability value (>90%) was estimated for 100-seed weight in all the progenies wherever large seeded parent was used as a donor. Creation of desirable variability depended on the trait under consideration, selection of parental lines and methodology advocated generating variability.

Key words: Induced variability, Recombination breeding, Urdbean, *Vigna mungo*

Breeding high yielding short duration varieties with resistance to key pests and diseases forms the foremost strategy for breaking the yield plateau. Amongst various pulses, urdbean (*Vigna mungo* L. Hepper) is an important crop grown in different seasons across the country. Lack of sufficient genetic variability for economically important traits is one of the reasons attributed for slow improvement in urdbean (5). To widen the genetic base of urdbean, extensive hybridization involving parents of diverse origin has been advocated. However, crossing between diverse genotypes may also result in appearance of high proportion of parental types in segregating generations on account of conserved linkage blocks. In such complex situations, mutagenesis in association with recombination breeding offers a viable option to improve locally adapted varieties and release the variability hidden in the conserved gene blocks. Systematic efforts have not been made so far to combine recombination and mutation in urdbean to generate desirable variability. Hence, in the present investigation, an attempt was made to compare variability generated through different mating schemes and combination of mating and irradiation to improve productivity of existing recommended varieties.

MATERIALS AND METHODS

The experimental material was generated by crossing four genotypes in the different fashions. Manikya and TAU 1 are genetically diverse but locally adapted varieties which lack optimum seed size and number of pods per plant, respectively. Two lines, No. 169, a donor for high pod number, and No. 216, a donor for seed size, were involved to generate four single crosses (TAU 1 x No. 169, TAU 1 x No. 216, Manikya x No. 169 and Manikya x No. 216), two three-way crosses [(TAU 1 x No. 169) x No. 216 and (Manikya x No. 216) x No. 169] and one double cross [(TAU-1 x 169) x (Manikya x 216)]. These cross combinations were advanced to F_2 generations. The seeds of the single crosses were also irradiated with 20 kr gamma rays and advanced to generate F_2M_2 progenies. All 11 populations (four single cross F_2 s, four irradiated single cross, two three-way crosses and one double cross) along with parents and F_1 s were evaluated in a randomized block design with three replications at University of Agricultural Sciences, Dharwad during 2002-03. Observations were recorded on five randomly selected plants for plant height, number of clusters per plant, number of pods per plant, pod length, number of seeds per pod, 100-seed weight and seed yield per plant. The data were subjected to standard statistical procedure to assess the variability.

RESULTS AND DISCUSSION

The results showed significant variation for the characters studied among the populations (Table 1). The range of variation for the traits studied was compared with the reported range among 268 strains of urdbean (6), and it was much higher in the present populations for number of clusters and pods per plant, pod length, number of seeds per pod, 100-seed weight and seed yield per plant. Among the populations studied, irradiated single cross (F_2M_2) progenies had wider range for plant height, number of pods per plant, 100-seed weight and seed yield per plant whereas three-way and double cross progenies had wider range for clusters per plant, pod length and number of seeds per pod.

The mean performance of F_2 and F_2M_2 progenies indicated higher values for gamma irradiated progenies for plant height, pods/plant and seed yield/plant. The results showed positive shift in mean values due to irradiation. Similar

Table 1. Means and range for yield and yield traits in F_2 and F_2M_2 progenies of urdbean

Progenies	n	Plant height (cm)		Clusters per plant ¹		Pods per plant ¹		Pod length (cm)		Seeds per pod		100-seed weight (g)		Seed yield per plant ¹ (g)	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Single crosses (SC)															
TAU 1 x No. 169	199	45.64	36.2-56.4	26.74	17-34	55.87	24-84	4.97	4.25-5.55	6.86	6.2-7.6	4.80	4.01-5.21	21.85	13.63-27.94
TAU 1 x No. 216	199	50.79	33.4-63.3	20.63	16-25	51.44	22-78	5.27	4.30-5.85	6.93	6.1-7.8	5.16	4.52-5.64	19.22	11.33-26.66
Manikya x No. 169	194	39.05	32.8-51.6	20.28	11-30	49.46	20-75	4.97	4.50-5.65	6.85	6.0-7.5	4.76	3.93-5.42	18.76	10.40-27.10
Manikya x No. 216	199	30.15	30.3-41.5	16.40	9-25	45.98	20-68	4.41	4.12-5.30	6.59	5.9-7.3	4.68	4.06-5.38	16.03	10.51-23.45
Overall mean		41.42		20.44		50.70		4.90		6.81		4.85		18.97	
SC(Irradiated)															
TAU 1x No. 169	300	58.16	42.1-68.6	20.01	18-29	54.96	25-85	5.10	4.50-5.35	6.97	5.9-7.5	4.76	4.11-5.61	28.52	16.30-38.23
TAU 1x No. 216	297	50.24	40.3-60.8	23.24	16-32	55.32	23-87	4.97	4.40-5.64	6.99	6.2-7.9	5.12	4.63-5.79	23.81	14.13-29.80
Manikya x No. 169	300	48.97	39.4-58.2	20.06	12-29	51.88	20-82	4.80	4.15-5.20	6.80	6.3-7.7	4.56	4.03-5.15	20.32	13.42-27.04
Manikya x No. 216	294	42.68	37.1-54.5	19.68	10-30	46.18	22-71	4.83	4.24-5.16	6.89	6.0-7.6	4.92	4.56-5.27	16.37	10.37-23.67
Overall mean		50.05		20.74		52.10		4.93		6.91		4.84		22.28	
Three-way cross															
TAU 1 x No. 169) x No. 216	341	48.08	40.3-60.1	24.88	17-34	49.48	24-79	5.63	4.25-5.98	6.93	6.0-7.9	4.28	4.01-4.90	25.82	14.32-34.60
(Manikya x No. 394	43.32	38.6-51.2	20.28	14-32	42.87	22-65	5.01	4.15-5.65	7.06	6.2-8.0	4.72	4.24-5.28	16.28	11.22-22.17	
216) x No. 169			22.41		45.94		5.30		7.00		4.52		20.71		
Overall mean		45.28		22.41		45.94		5.30		7.00		4.52		20.71	
Double cross															
(TAU 1 x No. 169) x (Manikya x No. 216)	497	52.82	43.5-64.7	26.73	16-38	38.35	19-60	5.79	4.44-5.98	7.12	6.1-8.1	4.84	4.36-5.43	20.03	11.28-29.71
Overall mean		52.82		26.73		38.35		5.79		7.12		4.84		20.03	

n=Number of progenies

observations have been reported earlier for plant height and number of pods per plant (1, 8), number of seeds per pod (7, 8) and seed yield per plant (2). There was no change in the mean values of number of clusters per plant, seeds per pod and pod length consequent to irradiation of single crosses. Mean value of 100-seed weight values did not change appreciably either in irradiated or other populations.

There were large differences in the variances of the most of the traits under study and majority of single cross irradiated F_2 progenies recorded higher variance for plant height, clusters per plant¹, pods per plant¹ and seed yield per plant¹ than corresponding F_2 progenies. F_2 progenies of three-way and double crosses exhibited higher variance for pod length, seeds per pod¹ and 100-seed weight. The increased variability in irradiated population was mainly due to cumulative effect of hybridization and mutation (9). However, consequent to irradiation, there was reduction in the variance for plant height and clusters/plant in the cross TAU 1 x No. 169 for pods and number of seeds per pod in the cross Manikya x No. 169.

Phenotypic and genotypic coefficients of variation were significant for most of the traits except pod length and pods per plant. The difference in the magnitude of PCV and GCV values which reflects environmental coefficient of variation was more for clusters per plant, pods per plant and seed yield per plant, and low for remaining traits. In general, irradiated populations exhibited higher PCV and GCV values for clusters and pods per plant, indicating greater scope for improvement through selection. Similar results have been reported earlier in mutagen treated progenies of urdbean.

Among F_2 populations involving more than two parents, the highest PCV and GCV values were observed for plant height and 100-seed weight in three-way cross [(TAU 1 x No. 169) x No. 216] and for number of seeds per pod and seed yield per plant in [(Manikya x No. 216) x No. 169] and for number of pods per plant in double cross progenies [(TAU 1 x No. 169) x (Manikya x No. 216)]. Variability realized in the present study by irradiation appeared to add to the recombination variability for two characters such as clusters per plant and pod length. For remaining traits, hybridization involving more than two parents generated sufficient variability and obviously mutagenesis of F_1 hybrids had no greater advantage. Similar findings were also reported in mustard (3). The variability generated depended to a large extent on the parental genotypes and traits under study than the method of generation of variability. Similar findings were also reported in safflower (4).

It is the extent of heritable variation which matters most for achieving gains in the selection programme. Most of the characters exhibited low to moderately high heritability in all the segregating populations. High heritability (> 90%) was estimated for 100-seed weight in all the segregating populations wherever the donor parent for seed weight (No. 216) was involved as parent in cross combination. Heritability estimates for seed yield and other yield components such as pods per plant and seeds per pod were low to moderate irrespective of method used for generation of variability.

The extent of improvement in different traits can be

Table 2. Estimates of components of variance, heritability (broad-sense), and genetic advance over mean (%) for yield and yield traits in F₂ and F₂M₂ progenies of urdbean

Population	Plant height (cm)		Number of clusters per plant		Number of pods per plant		Pod length (cm)		Number of seeds per pod		100-seed weight (g)		Seed yield per plant (g)															
	PCV	GA	PCV	GA	PCV	GA	PCV	GA	PCV	GA	PCV	GA	PCV	GA														
Single crosses(SC)																												
TAU 1x No. 169	23.99	13.27	30.59	15.12	38.82	24.97	41.38	33.10	30.93	10.56	11.66	7.43	19.71	16.10	67.00	27.36	12.28	7.29	35.21	8.89	18.63	10.83	33.75	12.92	59.68	13.70	17.94	11.99
TAU 1x No. 216	19.35	7.37	14.50	5.79	39.38	23.07	34.33	27.87	35.97	15.86	19.45	14.41	11.85	8.27	48.72	11.76	12.07	6.29	27.14	6.78	70.62	68.79	94.88	137.98	46.30	10.43	12.56	7.91
Manikya x No. 169	27.94	20.46	53.63	30.88	41.08	25.43	38.32	32.45	36.75	23.75	41.76	31.62	16.09	10.65	43.73	14.49	11.77	6.85	33.85	8.18	20.58	12.78	38.54	16.39	49.08	6.72	5.70	3.46
Manikya x No. 216	28.65	11.88	17.20	10.15	33.11	12.53	14.31	9.76	30.57	11.05	13.06	8.22	13.99	6.41	21.62	6.12	13.32	9.23	48.05	13.20	62.81	60.70	93.40	120.94	39.90	8.04	11.13	5.49
SC(I)																												
TAU 1x No. 169	17.37	6.59	14.40	5.16	49.50	26.84	29.40	29.94	32.04	8.48	26.47	17.47	18.91	14.14	55.91	21.76	12.26	6.09	24.66	6.17	23.77	17.83	56.25	27.52	25.19	13.31	27.90	14.48
TAU 1x No. 216	21.46	6.87	10.23	4.52	39.02	23.42	36.02	28.96	34.31	12.45	13.17	9.31	13.04	7.25	30.95	8.25	12.47	7.29	34.21	8.73	62.01	61.33	97.82	125.00	29.26	20.17	47.50	28.64
Manikya x No. 169	22.51	16.42	53.23	24.67	49.40	34.08	47.59	48.45	33.29	22.95	47.54	32.59	17.55	11.22	40.85	14.79	12.22	4.88	15.94	3.97	23.21	13.87	35.71	17.11	31.14	19.37	38.68	24.80
Manikya x No. 216	26.30	16.93	41.43	22.45	36.85	21.41	33.78	25.66	31.83	12.89	16.38	10.74	13.26	6.55	24.39	6.63	12.23	6.16	25.34	6.39	53.93	52.45	94.04	105.08	22.58	7.99	12.52	5.80
Three way cross																												
TAU 1 x No. 169) x No. 216	27.04	17.45	41.64	23.19	36.45	17.72	23.64	11.77	33.85	14.25	17.72	12.35	17.13	12.56	53.76	19.01	13.54	7.36	29.56	8.23	80.40	78.99	96.54	159.81	27.44	15.68	32.66	18.47
(Manikya x No. 216) x No. 169	23.79	12.20	26.31	12.88	42.03	22.99	29.91	25.89	38.59	21.79	31.90	25.36	18.94	13.54	51.11	39.92	14.02	8.26	34.60	10.06	76.74	75.20	96.04	151.91	42.61	30.17	50.14	43.98
Double cross																												
(TAU 1 x No. 169) x (Manikya x No. 216)	20.55	11.56	31.61	13.37	30.89	15.03	23.68	15.08	46.12	23.06	24.99	23.73	16.92	13.38	62.50	21.76	12.72	7.43	34.15	8.99	77.09	75.77	96.62	153.51	31.29	17.38	30.86	19.87

predicted based on genetic advance. A high genetic gain along with high heritability suggests suitable conditions for making effective selection. The genetic advance was high for 100-seed weight and clusters per plant coupled with high to moderate heritability in almost all the progenies of crosses involving No. 216 as donor parent for seed weight. When different progenies were compared based on their genetic advance as percent mean, irradiated single cross and three-way cross progenies exhibited higher values for seed yield per plant, whereas three-way and double cross progenies were superior to other progenies for pod length.

The present study revealed that hybridization followed by irradiation increased variability for major yield attributes like clusters and pods per plant. However, the methodology to be adopted depends on the trait to be improved and parental lines to be selected. Therefore, it is quite possible to generate high variability for most of yield contributing traits rather than handling large number of cross progenies for genetic improvement of urdbean by careful selection of parental genotypes and dosage of mutagen.

LITERATURE CITED

1. Bandyopadhyay, B. and Bose, S. 1983. Mutation induced by pre-irradiation treatment with ethyl methane sulphonate in blackgram. *Genetica Iberica* 35:107-113.
2. Chinchest, A. and Nakceraks, P. 1990. Mutation breeding of black gram. In: *Proceedings of Mungbean Meeting*, Chang Mai, Thailand, Feb 23-24, 1990..
3. Mahla, S.V.S., Mor, B.R. and Yadava, J.S. 1991. Mutagen induced polygenic variability in some mustard (*Brassica juncea* L.) varieties and their hybrids. *Oil Seeds Research* 8:173-177.
4. Meghannavar, R.D. 1997. Variability and correlation studies in segregating generations derived from hybridization and combination of hybridization and irradiation in safflower (*Carthamus tinctorius* L.). M.Sc. Thesis, University of Agricultural Sciences, Dharwad.
5. Ramanujam, S. 1975. Genetic diversity, stability and plant type in pulse crops. In: *Proceedings of International Workshop on Grain Legumes, ICRISAT*, Hyderabad, pp.167-176
6. Sandhu, T.S., Bhullar, B.S., Cheema, H.S. and Brar, J.S. 1978. Grain protein, yield and its components in urdbean. *Indian Journal of Genetics and Plant Breeding* 38(3): 410-415.
7. Sarwar, G., Malik, I.A., Alam, K. and Rajput, M.A. 1987. Studies on the effect of gamma irradiation in *Vigna radiata* (L) Wilczek and *Vigna mungo* (L) Hepper species II. Yield and Yield Components. *Nucleus* (Pakistan) 24(3-4): 35-38.
8. Singh, R.K., Raghuvanshi, S.S. and Dhan Prakash. 1987. Induced vine mutant in *Vigna mungo*. *Plant Breeding* 99 (1): 27-29.
9. Virk, D.S., Saini, S.S. and Gupta, V.P. 1978 Gamma radiation induced polygenic variation in pure breeding and segregating genotypes of wheat and rice. *Environmental and Experimental Botany* 18: 185-191.