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Short Communication

Induced polygenic variability in black gram [*Vigna mungo* (L.) Hepper]

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Black gram [*Vigna mungo* (L.) Hepper] is one of the important pulse crops considered as nutritious, but its productivity is very low. The most prominent constraint in its production is terminal drought under rainfed conditions. Induced mutations may prove promising for the improvement of quantitatively inherited characters in black gram. Recently developed long duration but well adopted variety Barkha was chosen for induction of variability through chemical mutagenesis.

Healthy, dry, dormant and selfed seeds of black gram variety Barkha were treated with three different concentrations of ethyl methane sulphonate (EMS) (0.2, 0.4 and 0.6 % concentration) and dimethyl sulphonate (DMS) (0.02, 0.04 and 0.06%). Further, EMS treatments were given with Indol Acetic Acid (IAA) while DMS with Gibberellic acid (GA) (3×10^{-3} M). Three hundred seeds were soaked in distilled water for 4hr at room temperature (25 ± 2^{o}C) for treatment. All the treatments were given for six hours in phosphate buffer (pH 7.8) with intermittent shaking. The treated and control (300 untreated) seeds were immediately sown after thorough washing to raise M_1 generation in RBD with three replications. Each treatment was accommodated in two rows of 4 m length with 30 x 15 cm between rows and plant to plant spacing. Pollen fertility of M_1 generation was determined by staining the pollen with 1% acetocarmine. Five flower buds randomly chosen from each plant were used for microscopic analysis. Unstained pollen grains showing abnormal shape and improper filling were scored as sterile. The 20 normal appearing plants from each treatment were selected from M_1 generation to raise M_2 generation. The progeny of each M_1 plant constituted one M_2 population, which was raised in Compact Family Block Design with 3 replications.

Lower doses of EMS and DMS were more effective and efficient then higher doses in inducing mutations and modifiers *viz*., IAA and GA also increased the effectiveness and efficiency of mutagens at lower concentrations. At biological comparable doses of both the mutagens, DMS was more effective then EMS (Table 1).

Positive or negative shift in the mean values for different characters from control was observed for various treatments. EMS (0.2%) and its combination with IAA induced earliness and also increased seed yield per plant, harvest index, number of pods per plant, number of seeds per pod and 100-seed weight. Days to 50% flowering and plant height shifted in positive direction at 0.2 and 0.4 % EMS with IAA, whereas biological yield and protein content shifted in positive direction for most of the concentrations of EMS and their modifiers. EMS treatment resulted in the reduction of mean values for all the characters at higher concentration. These results support the earlier findings [1, 2] with mutagenic treatment of EMS [4]. Mostly, DMS treatments was deleterious on yield and its contributing traits except for days to 50% flowering and days to 75% maturity at DMS 0.02 and biological yield at DMS 0.04. Whereas post treatment of GA exhibited shift in mean towards positive direction for seed yield (Table 2).

In general, the modifiers resulted in consistent performance and protective against the mutagens for

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Table 1. Estimation of effectiveness and efficiency of different mutagens and their modifiers in M_2 generation in black gram

Treatments	Total plant observed	Total progenies observed	Total number of mutants	Total no. of mutant progenies observed	Pollen sterility (%)	Mutation frequency		Mutagenic effectiveness		Mutagenic efficiency	
					S	Mp	Ms	Mp/TC	Ms/TC	Mp/S	Ms/S
EMS (%)											
0.2	2000	20	6	4	11.43	20.00	0.30	25.00	0.375	1.750	0.026
0.4	2000	20	8	3	20.83	15.00	0.40	9.38	0.250	0.720	0.019
0.6	2000	20	12	4	26.61	20.00	0.60	8.33	0.250	0.751	0.023
EMS + IAA											
0.2 + 3 x 10^{-3}M	2000	20	6	6	8.82	30.00	0.30	37.50	0.375	3.40	0.034
0.4 + 3 x 10^{-3}M	2000	20	9	3	14.26	15.00	0.45	9.38	0.281	1.052	0.082
0.6 + 3 x 10^{-3}M	2000	20	8	1	23.77	5.00	0.40	2.08	0.188	0.210	0.017
DMS (%)											
0.02	2000	20	8	5	14.23	25.00	0.40	312.50	5.00	1.757	0.028
0.04	2000	20	11	3	25.59	15.00	0.55	93.75	3.44	0.586	0.021
0.06	2000	20	15	2	32.50	10.00	0.75	41.67	3.13	0.308	0.023
DMS + GA											
0.02 + 3 x 10^{-3}M	2000	20	7	4	13.24	20.00	0.35	250.0	4.38	1.511	0.026
0.04 + 3 x 10^{-3}M	2000	20	8	3	23.89	15.00	0.40	93.73	2.50	0.628	0.017
0.06 + 3 x 10^{-3}M	2000	20	10	2	30.46	10.00	0.50	41.67	2.08	0.328	0.016

Mp = Mutation frequency on M_2 family basis, Ms = Mutation frequency on population basis, T = Duration of mutagenic treatment, C = Concentration of mutagens, S = Pollen sterility

Table 2. Mutagenic effect of EMS and DMS and with their modifiers on mean, range and CV in M_2 generation in black gram

Characters		Control	EMS			DMS			EMS+IAA($3x10^{-3}$M)			DMS+GA($3x10^{-3}$M)		
			0.2	0.4	0.6	0.02	0.04	0.06	0.2	0.4	0.6	0.02	0.04	0.06
Seed yield (g/plant)	M	4.29	5.92	3.18	3.00	4.00	3.90	3.67	4.85	3.20	3.16	5.92	3.36	3.87
	Min.	5.00-	3.30-	2.26-	2.20-	2.63-	2.50-	2.37-	3.90-	2.27-	2.25-	3.12-	2.99-	2.37-
	Max.	5.80	6.71	3.80	3.95	4.30	4.00	4.22	6.35	3.90	3.90	6.58	4.23	4.33
	CV	10.00	29.21	20.92	22.20	17.32	19.00	21.00	28.85	19.00	20.20	18.74	16.70	20.00
Biological yield (g/plant)	M	19.77	20.09	22.44	21.00	14.19	21.95	14.21	20.81	22.90	22.91	20.87	18.34	15.00
	Min.	19.36-	14.89-	18.77-	11.41-	12.72-	12.50-	11.31-	15.39-	18.80-	14.20-	14.75-	13.40-	11.50-
	Max.	21.66	26.55	29.98	28.21	18.67	22.70	19.25	26.44	29.00	28.31	27.31	24.75	20.20
	CV	13.40	20.79	15.84	22.20	42.51	43.00	42.00	33.76	15.10	20.00	26.05	29.35	40.00
Harvest index (%)	M	26.78	26.90	14.37	14.28	23.39	27.95	25.82	23.87	18.90	13.79	19.37	19.24	25.80
	Min.	20.98-	13.89-	10.45-	1 1 .20-	17.29-	17.20-	14.21-	15.38-	12.30-	12.00-	14.28-	13.31-	20.00-
	Max.	28.50	34.47	18.20	19.20	30.69	30.20	30.00	32.65	23.20	24.00	30.01	25.37	27.00
	CV	15.30	46.74	51.65	40.00	27.79	38.00	40.00	32.68	40.00	41.00	29.70	20.00	40.00
Days to 50% flowering	M	43.00	41.48	46.22	47.20	40.20	43.00	44.33	40.57	45.00	44.00	39.90	43.37	45.00
	Min.	1.00-	40.00-	43.33-	43.20-	39.00-	41.67-	41.33-	39.00-	43.00-	42.00-	38.67-	42.33-	41.00-
	Max.	44.67	46.67	47.67	52.31	44.67	44.33	46.33	46.00	46.00	45.00	47.67	44.33	47.00
	CV	2.38	3.48	3.96	4.11	3.09	3.40	4.00	5.07	3.90	3.20	5.76	21.20	3.67
Days to 75% maturity	M	73.53	71.60	75.10	76.20	70.00	74.33	76.00	71.48	74.00	75.00	70.73	73.95	74.00
	Min.	72.00-	67.67-	71.00-	72.00-	66.33-	71.33-	71.00-	69.00-	72.00-	73.00-	69.67-	72.67-	71.00-
	Max.	75.00	76.33	77.33	79.00	76.00	76.33	78.00	74.33	77.00	77.00	77.00	75.33	76.00
	CV	1.25	2.24	1.67	2.10	2.20	3.00	3.49	2.81	1.70	1.80	1.51	2.64	2.90
Plant height (cm)	M	40.46	43.99	31.99	29.20	33.73	35.72	30.00	44.03	33.00	32.00	33.02	42.19	33.00
	Min.	38.00-	32.97-	26.37-	22.31-	30.17-	30.00-	22.00-	36.90-	28.00-	23.00-	25.97-	35.40-	30.00-
	Max.	42.00	45.87	36.30	34.25	37.50	38.60	39.00	47.83	37.00	34.00	42.47	48.60	38.00
	CV	7.29	12.35	13.13	16.20	11.85	13.51	19.20	10.33	12.20	15.00	19.25	11.79	13.00
No. of primary branches/plant	M	5.11	5.25	3.05	3.00	4.42	4.11	4.00	6.01	4.20	3.33	3.01	6.49	4.50
	Min.	5.20	-4.10-	2.03-	2.00-	3.97-	3.50-	3.22-	4.90-	3.20-	2.22-	2.00-	5.60-	3.50-
	Max.	5.30	5.70	3.97	4.10	5.10	5.60	5.70	7.23	5.21	4.33	4.03	7.70	5.50
	CV	11.45	14.24	28.27	29.00	16.50	17.50	18.50	17.71	21.00	22.00	35.67	17.93	17.00
No. of seeds per pod	M	4.75	5.14	3.55	3.50	3.49	3.40	3.29	5.32	3.90	3.90	3.82	5.08	3.60
	Min.	4.23-	3.10-	3.03-	3.00-	2.97-	2.60-	2.60-	3.33-	3.29-	3.22-	3.07-	4.43-	2.41-
	Max.	5.40	5.50	4.27	4.50	4.47	4.52	4.70	6.23	4.33	4.22	5.07	6.20	4.60
	CV	9.41	28.13	17.15	18.35	18.32	19.31	20.00	12.46	14.20	15.00	34.01	16.99	18.00

100-seed weight (g)	M	3.43	3.57	2.91	2.40	3.25	3.20	3.18	3.61	3.25	2.60	3.19	2.87	3.29
	Min.	3.13-	3.11-	2.40-	2.10-	2.97-	2.90-	2.87-	3.28-	3.00-	2.20-	2.65-	2.18-	2.80-
	Max.	3.96	4.33	3.39	3.59	3.97	3.99	4.21	4.03	4.00	3.40	3.89	3.15	4.00
	CV	9.67	16.28	14.34	15.11	12.38	13.00	14.50	11.65	10.00	14.20	13.22	20.07	12.00
No. of pods/plant	M	32.08	42.93	23.37	18.20	26.83	20.00	18.30	38.58	25.00	19.11	35.83	31.45	19.20
	Min.	29.33-	14.33-	14.09-	12.41-	20.00-	16.31-	11.51-	23.00-	20.00-	13.42-	24.67-	22.00-	11.00-
	Max.	36.00	59.67	34.00	35.15	35.00	30.11	28.31	60.00	30.00	35.00	44.67	37.00	28.00
	CV	10.58	66.09	41.60	42.95	34.35	35.00	36.21	47.95	34.00	40.00	27.27	29.03	34.00
Protein content (%)	M	25.04	25.50	25.24	25.20	24.93	24.90	24.80	25.42	25.23	25.50	24.51	24.52	24.80
	Min.	24.13-	23.60-	24.10-	24.00-	23.67-	23.90-	23.80-	24.33-	24.00-	24.22-	24.03-	24.07-	23.89-
	Max.	25.83	26.43	26.73	26.25	25.67	25.41	25.22	26.70	26.70	25.90	24.97	25.07	25.33
	CV	2.98	4.76	4.65	4.71	4.73	4.80	4.90	4.10	4.70	4.70	2.80	3.35	4.80

M = Mean, R = Range, CV = Coefficient of variation

all the .traits. IAA along with EMS was more efficient as compared to GA with DMS treatment. Modifiers increased mean, range and coefficient of variation for most of the traits as compared to separate mutagenic treatments.

Best fifteen progenies were selected on the basis of seed yield per plant, days to 75% maturity and also showed higher magnitude of coefficient of variation, formed a basis for their M_3 evaluation. The analysis of variance in M_3 generation revealed significant differences at 0.01 and 0.05% probability for all the characters studied. Since, only high yielding, high protein content with early maturing progenies were advanced in the M_3 generation, apparently it would be seen that the variation would converge, however, the results of the present study indicated the possibility of exercising even further selection in M_3 progenies to identify relatively superior individuals. A comparison of mean of M_3 progenies with the mean of control revealed that the progenies *viz*., 2-5, 7-2, 31-4, 174-7 and 164-3 were significantly superior for seed yield and maturity and hence can be advanced for further selection.

Genetic parameters of variation were estimated for all the characters studied in order to assess the selection criteria for improvement of seed yield per plant and early maturity. High heritability along with relatively high genetic advance (given in parenthesis respectively) as percentage of mean were recorded for number of pods per plant (68.7, 3.47), plant height (65.5, 17.1), number of seeds per pod (39.1, 11.5) and seed yield (55.7, 27.5). This indicated that selection for these quantitative traits in further generation will be highly responsive. Similar findings have been reported in other pulse crops. From the results of present study it may be inferred that relatively lower doses of mutagens are effective for micro mutations in desirable direction in black gram and further it was noticed that plant growth regulators resulted in consistent performance and exhibited protective properties against mutagens. Progenies showing high mean in positive direction and high CV then control should be advanced for further selection for isolating early maturity and high yielding lines.

References

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