Characterization of Some Macromutations Induced by Single and Combination Treatments of Gamma Rays, EMS and SA in Urdbean (*Vigna mungo* L. Hepper)

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Two cultivars of urdbean (*Vigna mungo* L. Hepper), namely, PDU1 and T9 were treated with single and combination doses/concentrations of gamma rays, ethyl methane sulphonate (EMS) and sodium azide (SA). Number of various types of morphological macromutations were induced in M_2 generation. Of these, thirteen mutants from PDU1 and twelve from T9 were identified as true breeding for plant morphology, pod and seed characters and early maturity in M_3 generation. Many macromutants showed significant improvement in yield and other yield components as compared to their parents.

Key Words: Urdbean ((*Vigna mungo*), Macromutations, Gamma rays, Ethyl methane sulphonate (EMS), Sodiumazide (SA)

Introduction

Urdbean (*Vigna mungo* L. Hepper) is an important pulse crop of India grown on an area of about 3.25 million hectares with a production of 1.45 million tonnes with an average yield of 4.48 q/ha (Anonymous, 1999-2000). Since urdbean is a highly self-pollinated crop, the natural variability available is far less to make selections for its improvement. Induced mutagenesis has immense potential in creating genetic variability among naturally exhausted population which is utilized in selection programme for obtaining desirable improvement. The present study was conducted to induce and isolate useful macromutants which could be utilized for genetic improvement of this crop.

Materials and Methods

Two cultivars of urdbean (*Vigna mungo* L. Hepper), namely, PDU1 and T9 were used as experimental materials. Three hundred pure, healthy and dry seeds of each cultivar were used for each treatment. The seeds were irradiated with ^{60}Co gamma rays at 15, 30, 45 and 60 kR doses at IARI, New Delhi. For chemical mutagenic treatments, the seeds were presoaked in distilled water for 6 hr and then treated with ethyl methane sulphonate (0.02, 0.04, 0.06 and 0.08 M concentrations) in freshly prepared phosphate buffer (pH 7.0) or sodium azide (2, 4, 6 and 8 mM concentrations) in phosphate buffer (pH 3.0). For combination treatment, the gamma irradiated seeds at 15-60 kR doses were presoaked in distilled water for 6 hr and then treated with 0.02 M EMS or 4 mM SA in the manner described earlier. The mutagen treated seeds were thoroughly washed in running water for an hour to avoid traces of the chemicals, if any.

The mutagen treated seeds along with the untreated control seeds were sown in five rows each measuring 5 m with 30 x 10 cm spacing to raise M_1 generation in *kharif*, 1996. The surviving plants were harvested separately and individual plant progenies were raised in M_2 generation in Summer, 1997. A number of macromutations were induced in various treatments in M_2 generation. The macromutants having sufficient seeds were grown in M_3 generation in RBD with three replications in *kharif*, 1997 at Research Farm, Institute of Agricultural Sciences, BHU, Varanasi and they were characterized and also confirmed for their breeding behaviour. The observations were recorded on ten competitive plants from each replication for various yield and yield components in M_3 generation.

Results and Discussion

Several types of macromutations were induced by different mutagenic treatment in M_2 generation with respect to growth habit, leaf structure, maturity period and flower-, pod- and seed characteristics in both the cultivars, *viz.*, PDU1 and T9. A dose dependent increase in the frequency and spectrum of macromutations was recorded in M_2 generation. A total of 31 and 34 types of macromutants were induced in cvs. PDU1 and T9,

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respectively. The probable causes of these macromutations may be chromosomal changes and most probably point or gene mutations. Most of these macromutations are reported to be polygenic in nature (Yadav and Singh, 1988; Saini and Mahana, 1989; Thakur and Sethi, 1993).

Thirteen and twelve true breeding macromutants for plant morphology, pod- and seed-characters and early maturity derived from cultivars PDU1 and T9, respectively were isolated in M_3 generation. These macromutants showed distinct morphological features as compared to their parents (Tables 1 and 2). Ten macromutants derived from both cultivars showed significantly higher seed yield than their parents.

Dwarf, tall, bushy, spreading, tendriller and long peduncled mutants were isolated in M_3 generation. The *dwarf* mutants were characterized by condensed nodes, shorter internodes and low yield as compared to the control. The plants exceeding the height of the respective controls by at least 10 cm were placed in tall category.

Table 1. Mean values of yield and yield traits of macromutants in cultivar PDU1 in M_3 generation

S.No.	Macromutant	Mutagen treatment	Plant height (cm)	Days to maturity	Number of branches plant	Number of pods/ plant	Pod length (cm)	Number of seeds/ pod	Seed yield/ plant (g)	100-seed weight (g)
1.	Tall	30 kR + 4mM SA	52.50**	79.20	5.36**	36.40**	4.25	5.85	7.50**	4.50
2.	Bushy	45 kR	42.82	81.50	6.90**	34.86**	4.36	5.60	7.30**	4.25
3.	Spreading	30 kR + 4mM SA	40.24	85.50**	7.58**	27.60**	4.35	5.85	7.10**	4.40
4.	Dwarf	30 kR + 4mM SA	31.10**	75.60**	3.15*	20.15**	4.10	5.58	6.15	4.25
5.	Broad leaved	0.08 M EMS	38.63*	85.25**	4.50	20.58**	3.90**	5.15**	5.90	4.05
6.	Hairy	45 kR + 0.02 M EMS	38.36**	82.37	4.52	18.22**	4.40	5.86	5.35**	3.90**
7.	Thick podded	0.02 M EMS	39.52	82.50	3.92	32.86**	5.05**	6.80**	7.32**	4.82**
8.	Short podded	0.08 M EMS	44.50	81.85	4.35	35.68**	3.25**	4.90**	6.10	3.85**
9.	Large seeded	8 mM SA	45.50**	80.68	4.55	32.87**	4.75**	6.25**	7.25**	5.45**
10.	Small seeded	45 kR	42.56	82.86	4.55	30.50**	3.90**	4.80**	4.85**	3.05**
11.	Round seeded	15 kR +0.02 M EMS	41.96	84.85**	3.90	30.80**	3.95**	4.95**	5.05**	3.50**
12.	Brown seeded	4 mM SA	46.80**	82.90	4.35	32.80**	4.35	5.70	6.90**	4.50
13.	Early maturing	15 kR + 0.02 M EMS	35.50**	65.00	4.05	20.15**	4.15	5.56	5.15**	4.15
		Control (PDU1)	42.00	80.50	4.25	25.50	4.30	5.75	6.25	4.30
		SE ±	1.29	1.30	0.296	1.64	0.105	0.136	0.237	0.147

* Significant at 5 per cent level
** Significant at 1 per cent level

Table 2. Mean values of yield and yield traits of macromutants in cultivar T9 in M_3 generation

S.No.	Macromutant	Mutagen treatment	Plant height (cm)	Days to maturity	Number of branches plant	Number of pods/ plant	Pod length (cm)	Number of seeds/ pod	Seed yield/ plant (g)	100-seed weight (g)
1.	Tall and erect	15 kR + 4mM SA	44.28**	80.55**	5.15**	28.62**	4.29	5.75	6.75**	4.35
2.	Tendriller	60 kR	30.65**	82.86	2.05**	15.70**	4.05	4.95**	4.58**	4.50**
3.	Bushy	0.08 M EMS	37.85*	83.07	5.90**	32.86**	4.25	5.80	6.50**	4.15
4.	Narrow leaved	4 mM SA	37.26**	82.80	4.25	18.75**	4.26	5.26	4.75**	4.08
5.	Dwarf	45 kR + 4mM SA	25.60**	78.65**	2.75**	19.80	4.10	5.16**	5.16	4.36
6.	Early maturing	60 kR	32.82*	70.56**	3.65	20.85	4.25	5.75	4.80**	4.46**
7.	Hairy	30 kR	32.46**	85.26	3.70	18.26**	4.25	5.65	4.62**	4.26
8.	Thick and long podded	15 kR + 0.02 M EMS	40.81**	84.67	4.50*	30.65**	5.25**	6.95**	6.90**	4.55**
9.	Long peduncled	30 kR + 4 mM SA	38.52**	86.80**	4.95**	20.26	4.58**	6.05**	5.10	4.10
10.	Large seeded	0.08 M EMS	36.75	80.37**	4.25	27.55**	4.75**	6.50**	6.60**	5.35**
11.	Chocolate seeded	60 kR + 4 mM SA	30.56**	86.82**	4.50*	25.86*	4.25	5.62	6.05*	4.35
12.	Short podded	0.08 M EMS	38.20*	82.80	4.15	30.86**	3.05**	4.30**	4.25**	3.90**
		Control (T9)	35.25	83.50	3.90	22.50	4.15	5.50	5.50	4.20
		SE ±	1.31	1.09	0.215	1.53	0.127	0.127	0.246	0.090

* Significant at 5 per cent level
** Significant at 1 per cent level

The bushy mutants were also induced in both the cultivars which were characterized by shorter internodes, compact stature and with higher number of pods. The spreading mutant exhibited branching parallel to the ground and covered more area than the normal plants. In the tendriller mutant, the leaflets were modified into tendrils. The long peduncled mutant had the characteristic of increased peduncle length joining the pods. Similar mutants have been reported by Pande and Raghuvanshi (1988), Singh and Yadav (1991), Sansiri *et al.* (2005) and Singh (2007) in greengram and Thakur and Sethi (1993) and Gautam and Mittal (1998) in blackgram. Two true breeding leaf mutants, namely, narrow leaved from T9 and broad leaved from PDU1 were isolated in M_3 generation. The broad leaved mutant exhibited increased leaf area and with significantly reduced plant height and number of pods per plant. The narrow leaved mutant showed reduced leaf area with decreased seed yield as compared to the parents. Many types of leaf mutants have been reported following mutagenesis in urdbean (Singh and Raghuvanshi, 1985; Thakur and Sethi, 1993; and Gautam and Mittal, 1998) and mungbean (Tickoo, 1987; Sansiri *et al.*, 2005; Singh, 2007).

Early maturing mutants were isolated from both the cultivars in M_3 generation. These mutants are 10 to 15 days earlier to the parents. The early maturing mutants have been reported in urd (Gautam and Mittal, 1998) and mung (Singh and Yadav, 1991).

Short, thick and long podded mutants were induced by different mutagenic treatments in both the cultivars in M_3 generation. The short podded mutants had relatively less number of seeds per pod with lower yield than the control. Such mutants have been reported by Thakur and Sethi (1993) and Gautam and Mittal (1998) in urdbean. The thick and long podded mutants had significantly increased pod length, greater number of seeds per pod and more seed yield over their parents. Gautam and Mittal (1998) observed such mutants in urdbean. Brown and chocolate testa colour mutants were isolated in M_3 generation from the black testa colour of the parents. Both the mutants exhibited a significant increase in the seed yield over the respective parents. The large seeded mutants were induced in both the cultivars which showed significantly increased pod length, number of seeds per pod, 100 seed weight and seed yield as compared to the controls. The small and round seeded mutants were also induced which showed significantly lower yield than the parents. The seed mutants for varied testa colours, shapes and sizes have been reported by Ali Khan and Veeraswamy (1974) in redgram and Singh *et al.* (1982) in greengram.

Gamma rays, EMS and SA have been demonstrated to induce mutations by different mechanisms. The combination of these mutagens in appropriate sequences has been shown to cause a synergistic increase in mutation frequency as observed during the present study. Similar results were also reported by Cheng (1987) and Cheng and Gao (1988). The combined treatments induced a higher mutation frequency, resulting in a higher mutation efficiency and an expansion of the spectrum of morphological mutations, thus offering more opportunities for selection in mutation breeding practice.

Many mutants, such as tall, bushy, early maturing, long- and thick-podded, large seeded, hairy, etc. induced during the present study, show the desirable characteristics from the breeders' point of view and hold promise for isolation of improved types from their progenies in the later generations.

Acknowledgements

One of us (MS) is grateful to the University Grants Commission, New Delhi for the award of Junior Research Fellowship during the present study.

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