Induced Variation in Quantitative Traits due to Physical (γ rays), Chemical (EMS) and Combined Mutagen Treatments in Soybean [*Glycine max* (L.) Merrill].

Archana Patil, S. P. Taware and V. M. Raut

Plant Breeding and Genetics Department, Agharkar Research Institute, Maharashtra Association for Cultivation of Science,
G. G. Agarkar Road, Pune 411 004 (Maharashtra, India)

Abstract

Indian Soybean variety, MACS-450 has semi determinate growth habit, medium maturity and high yield potential which is very well adapted to agro-climatic conditions of Southern India. Seeds of this variety were exposed to various doses of γ rays, ethyl methane sulphonate and combination of both. Observations on percentage germination, percentage leaf abnormalities, percentage survival, days to maturity, plant height, pods per plant, seed weight per plant and yield kg/ha were recorded on M_1 generation. Likewise percentage reduction in various quantitative characters through various treatments was also recorded. The results indicate dose related effect of mutagenic treatments on quantitative traits. 20 to 25 Kr γ rays dose and 0.10 to 0.20% EMS dose may be optimum to obtain maximum variations in qualitative as well as quantitative traits in M_2 population.

Introduction

Mutation breeding in crop plants is an effective tool in hands of plant breeders especially in crops having narrow genetic base. So far 83 crop varieties released owe to their mutant origin. Many mutants have been identified as donors of desirable traits in breeding program. Mutation breeding work in soybean crop has yielded in identification of many mutant lines with desirable traits like resistance to pod shattering habit, low linolenic and high oleic content (Rahman *et al.*, 1994, 1995) etc. Variations in M_1 generation, though less important in view of obtaining stable gene mutations, are often considered as

indicator in measuring efficiency of mutagen treatments (Plesnik, 1993). There are papers dealing with analysis of M_2 and M_3 generation of soybean induced by physical and chemical mutagen (Borejko, 1970; Lee *et al.*, 1968; Raut *et al*., 1982; Patil *et al, 1985;* Bohmova *et al.*, 1999). Present studies were initiated to induce variability for quantitative traits by giving physical (γ rays), chemical (EMS) and combined mutagenic treatment at different doses in soybean [*Glycine max* (L.) Merrill].

Materials and Methods

Seeds of soybean variety MACS 450 were treated with γ rays at 10, 15, 20, 25 Kr doses. Further these treated seeds were soaked in water for 4 hrs and treated with 0.05, 0.10, 0.15% v/v ethyl methane sulphonate (EMS) for 4 hrs at 7 pH (by using phosphate buffer solution). The treatment was followed by 4 hrs of washing in running water. 20 treatments (Table 1) including sole treatment of γ rays and EMS and untreated control were immediately sown in the field in a randomized complete block design (RCBD) with four replications. Each treatment consisted of two rows of 5 m length/replication, in which 100 seeds per row were sown with 5 cm and 45 cm distance within and between rows respectively. Data were recorded on eight quantitative characters and further statistically analyzed. The treatments were compared at 5 and 1% probability levels by using respective LSD values. Likewise, percentage reductions due to mutagen treatment over untreated control were estimated and are presented in Table 2. Mean values for 8 quantitative traits in different treatments and percentage reduction over untreated control are presented in Table 1 and 2, respectively.

Result and Discussion

Germination percentage was found to be significantly reduced in all the mutagen treatments except for 0.05% EMS treatment. Similar results have been recorded in soybean by Raut *et al.*, 1982 and Patil *et al*. 1985. Percentage reduction in germination over control ranged from 6.51% in 0.05% EMS to 21.44% in 25Kr+0.10% EMS. This might have been due to the effect of mutagens on meristematic tissues of the seed. However survival percentage was found to be least affected by mutagen treatments. Significant reduction in survival percentage was observed in the higher doses of γ rays

(20 and 25 Kr) and EMS (0.15%) and their combination. Morphological variations, especially leaf abnormalities, are the indicators of effective mutagen treatment. In different treatments morphological variation like 4, 5, 6 leaflets, fused leaflets etc. were observed in the present studies. These variations were expressed in percent plants with leaf abnormalities. The higher doses of mutagen treatments and their combinations showed higher percentage of leaf abnormalities which were maximum upto 51.12% in 25 Kr + 0.15% EMS treatment. Plant height was also found to be significantly reduced in higher doses of mutagen and their combination treatments.

In the higher doses of mutagen treatments and their combinations, days required for maturity were found to be significantly increased. The maximum prolongation in maturity was up to 8 days in 25Kr + 0.15% EMS treatment. Due to reduced vigor and prolongation of maturity period, the number of pods/plant was also significantly affected in these treatments. Reduction in number of pods/plant over control rise from 1.11 to 47.76%. However, seed weight per plant in different treatments indicated significant reduction in the higher doses of mutagen treatment and their combination only. Percentage reduction in seed weight per plant over control was maximum (56.63%) in 25Kr + 0.05% EMS combination treatment. Plot yield for each treatment was recorded in grams and was converted to kg/ha. Maximum seed yield of 1954 kg/ha was recorded in untreated control. There was significant reduction in seed yield in all the treatments except for 10Kr treatment. The percentage reduction in seed yield ranged from 1.40 in 10Kr to 65.54% in 25Kr + 0.10% treatment.

Conclusion

The treatments showing maximum variation in quantitative characters may show the stable gene mutations in subsequent generation. Hence, M_2 populations of these treatments should be critically screened for desirable mutant traits. The results indicate dose related effect of mutagen treatments on quantitative traits. 20 to 25 Kr γ rays dose and 0.10 to 0.20% EMS dose may be optimum to obtained maximum variations in further generation

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Table 1. Effect of physical (γ rays) and chemical (EMS) mutagens in M_1 generation on quantitative traits in soybean

Sr. No.	Treatment	% Germi-nation	% Leaf abnorm alities	% Survival (%)	Days to maturity	Plant height (cm)	Pods/ plant	Seed wt /plant (g)	Seed yield (kg/ha)
1	10 Kr	80.88	10.98	83.15	79.50	44.40	24.98	6.20	1925.00
2	15 Kr	83.38	9.31	83.35	80.50	41.95	23.80	5.43	1673.33
3	20 Kr	81.00	18.60	83.61	85.00	36.53	19.33	4.13	1242.78
4	25 Kr	80.38	14.47	80.10	86.00	34.13	21.10	2.53	719.44
5	10 Kr + 0.05% EMS	73.50	12.05	83.01	80.00	41.60	26.75	4.83	1299.45
6	10 Kr +0.10% EMS	76.25	11.69	86.92	79.75	41.73	21.38	5.41	1518.33
7	10 Kr +0.15% EMS	73.88	8.82	86.77	80.25	40.40	24.08	5.90	1673.33
8	15 Kr +0.05% EMS	77.75	9.68	86.64	81.00	39.40	26.60	5.70	1700.00
9	10 Kr +0.10% EMS	77.13	13.70	86.06	82.50	39.45	23.25	5.69	1669.45
10	10 Kr +0.15% EMS	77.25	17.27	87.92	83.75	38.98	21.53	4.49	1353.33
11	20 Kr +0.05% EMS	73.25	17.96	77.73	84.50	38.55	19.03	4.24	1096.11
12	20 Kr +0.10% EMS	73.38	17.90	83.30	86.75	37.05	22.18	4.00	1075.00
13	20 Kr +0.15% EMS	74.25	19.57	78.43	86.25	38.20	18.20	4.10	1057.78
14	25 Kr +0.05% EMS	75.75	41.63	80.53	85.25	34.63	15.95	2.52	675.00
15	25 Kr +0.10% EMS	71.00	47.18	79.70	86.00	32.18	15.28	2.71	673.33
16	25 Kr +0.15% EMS	76.63	51.12	70.84	87.00	33.25	14.13	3.11	746.67
17	0.05% EMS	84.50	10.34	87.50	80.00	40.83	21.15	5.21	1720.00
18	0.10% EMS	80.88	10.46	89.58	81.00	45.90	21.08	5.28	1688.33
19	0.15% EMS	84.13	11.31	87.15	81.75	41.55	19.00	5.20	1694.45
20	Control	90.38	0.56	89.66	79.00	43.53	27.05	5.81	1953.89
	S.E.	2.11	1.47	2.48	1.14	1.57	1.33	0.26	60.39
	C.D. at 0.05	5.98	4.15	7.04	3.23	4.44	3.78	0.75	171.07
	C.D. at 0.01	7.96	5.53	9.37	4.29	5.91	5.03	1.00	227.78
	C.V. (%)	5.39	16.53	5.94	3.67	7.99	12.54	11.50	8.90

Table 2. Percentage reduction in different quantitative traits due to mutagen treatments over control in M_1 generation

Sr. No	Treatment	% Germi-nation	% Survi-val	Plant height	Pods/ plant	Seed wt./ plant	Seed yield (kg/ha)
1	10 Kr	10.51**	7.26	-2.00	7.65	-6.71	1.48
2	15 Kr	7.75*	7.04	3.63	12.01	6.54	14.36**
3	20 Kr	10.38**	6.75	16.08**	28.54**	28.92**	36.39**
4	25 Kr	11.06**	10.66**	21.59**	22.00**	56.45**	63.18**
5	10 Kr + 0.05% EMS	16.46**	7.42	4.43	1.11	16.87*	33.49**
6	10 Kr + 0.10% EMS	15.63**	3.06	4.14	20.96**	6.88	22.29**
7	10 Kr + 0.15% EMS	18.26**	3.22	7.19	10.98	-1.55	14.36**
8	15 Kr + 0.05% EMS	13.97**	3.37	9.49	1.66	1.89	12.99**
9	10 Kr + 0.10% EMS	14.66**	4.02	9.37	14.05**	2.07	14.56**
10	10 Kr + 0.15% EMS	14.53**	1.94	10.45*	20.41**	22.72**	30.74**
11	20 Kr + 0.05% EMS	18.95**	13.31**	11.44*	29.65**	27.02**	43.90**
12	20 Kr + 0.10% EMS	18.81**	7.09	14.89**	18.00*	31.15**	44.98**
13	20 Kr + 0.15% EMS	17.85**	12.53**	12.24*	32.72**	29.43**	45.86**
14	25 Kr + 0.05% EMS	16.19**	10.18*	20.45**	41.04**	56.63**	65.45**
15	25 Kr + 0.10% EMS	21.44**	11.11	26.07**	43.51**	53.36**	65.54**
16	25 Kr + 0.15% EMS	15.21**	20.99**	23.62**	47.76**	46.47**	61.79**
17	0.05% EMS	6.51	2.41	6.20	21.81**	10.33	11.97**
18	0.10% EMS	10.51**	0.09	-5.44	22.07**	9.12	13.59**
19	0.15% EMS	6.99*	2.80	4.55	29.76**	10.50	13.28**

*, ** Significant reduction at 5% and 1%, respectively.