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Effect of physical and chemical mutagens on soybean

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ABSTRACT

Two varieties of soybean (*Glycine max* (L) Merill) *viz.*, JS-335 and PKV-1 were treated with various doses of physical (gamma rays) and chemical (EMS) mutagens. A dose dependent decrease was noticed in most of the characters like plant survival germination. The maximum reduction was found in higher doses of mutagens in both the cultivars, while increased pollen sterility was associated with the corresponding increase in doses of mutagens. Results indicated that higher doses were more effective in all the three generations (M1, M2, and M3). However the M1 showed more pronounced reduction in germination and survival than M2 and M3. The increase in pollen sterility was more in cv. PKV-1 indicating its more sensitivity as compared to cv. JS-335.

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Introduction

In soybean (*Glycine max* (L) Merrill) hybridization practices are difficult due to its small flower size. Creation of genetic variability by induced mutagenesis provide a base for strengthening crop improvement programme and represents a more efficient source of genetic variability than the gene pool conserves by nature (Brock, 1965). Considering the above facts and findings the present study was planned to asses the effect of gamma rays and EMS (ethyl methane sulphonate) on induction of variability in soybean variety PKV-1 and JS-335. However to evaluate the effect of mutagen in early and later generation the germination, survival, pollen sterility and mitotic index are more important as initial indicators.

Materials and Methods

The seeds of soybean variety PKV-1 and JS-335 were irradiated with gamma rays at 15, 20, 25 and 30kR doses. Similarly a set of seeds were treated with EMS 0.05, 0.10, and 0.15 percent in different sets for 6 hours. The seeds of all the treatments were sown in the field to grow M1 generation. 100 seeds from each treatment in three sets (replication) were transferred in germination paper for germination in laboratory for recording the data on percent germination and mitotic index from primary root tip. The plant survival and pollen sterility were recorded from field grown plants to estimate mutagenic effect during M1 generation. The M1 plants were harvested individually and the M2 generation was raised in field in field in the next season. The seeds harvested from M2 generation were also sown to raise M3 generation. M2 and M3 population were screened for germination, survival percent.

Result and Discussion

The germination percent (laboratory as well as field) was reduced as the dose increase i.e. the reduction is directly proportional to dose. It was also recorded by Nandanwar and Khamankar (1996) and Singh et. al in Mung bean, Mehtre *et. al* (1994) in Soybean. Similarly the survival rate or percent upto maturity of the treated plants reduced with increased dose or concentration in M1 generation. The lowest laboratory germination of 66 percent was recorded in 0.15 percent EMS concentration followed by 30kR gamma rays dose (66.33%). The maximum decrease for germination (field) and survival percent was recorded in 30kR dose (gamma rays) and 0.15% EMS concentration in both the cultivars which may be due to physiological and acute chromosomal damage Singh (1997), Nilan *et al* (1976), Delay in the onset of mitosis (Yadav, 1987) and chromosomal aberrations iduced enzyme activity such as catalase and lipase (Singh, 1974) and hormonal activity resulted in reduced germination (Ananthaswamy *et al* 1971). Similarly, Strickberger (1976) reported that the probable reason for reduction in germination might be due to the disturbed base pair relationship due to radiation.

However the effect of mutagen was more prominent in term of pollen sterility, which is increase as doses increase in both the mutagen. The maximum sterility was observed in 30kR gamma rays (PKV-1- 28.5, JS-335- 29) and 0.15 percent EMS conc. (PKV-1 -15.1, JS-335 -14.9). The increasing pollen sterility has been mainly attributed to the chromosomal interchange, chromosomal aberrations, gene mutation (Gautam *et al*, 1992, Ekberg, 1969), cytoplasmic factor (Malinowski *et al*, 1973)

The germination percentage and survival percentage in variety PKV-1 and JS-335 studied during M2 and M3 generations exhibited similar kind of results as observed in M1 generation. i.e. as the dose or concentration increased the germination and survival percentage decreased. But the magnitude of reduction was very less particularly in M2 and M3 generation. It was also recorded by Raut *et al,* (1982) in soybean.

However in case of mitotic index it was reduced with increase in dose or concentration of the mutagen. Mitotic index of the variety JS-335 was comparatively lower than the PKV-1 and the magnitude of reduction was higher in gamma rays followed by ethyl methane sulphonate. 30kR gamma rays dose and 0.15% EMS conc. reduced the mitotic index significantly in both varieties viz., PKV-1 and JS-335. Hence gamma rays have been most effective in affecting the mitotic index. The similar results of reduction in mitotic index are also reported by Narsinghani and Kumar (1976, a), Kumar and Sinha and Chauhan (1988), Yadav (1987)

Table-1: Effect of physical and chemical mutagens on soybean M1 generation

Treatment	Field germination	Laboratory germination	Survival%	Pollen sterility
PKV-1(gamma rays)				
15kR	82.64	97.25	88.3	12.5
20 kR	78.47	86.94	73.44	16.12
25 kR	71.18	82.13	71.05	22.1
30 kR	59.38	76.98	68.33	28.5
Dry control	91.42	97.56	94.69	3.59
EMS				
0.05%	78.97	87.59	89.22	4.9
0.1%	69.31	85.17	79.96	11.2
0.15%	63.45	68.28	74.36	15.1
Soaked control	88.46	91.12	93.9	3.15
JS-335(gamma rays)				
15 kR	89.45	90.33	82	13.7
20 kR	79.39	85.67	79.33	18.2
25 kR	74.39	75.67	73	23.4
30 kR	63.66	66.33	55.33	29
Dry control	88.56	98.66	96.21	4.15
EMS				
0.05%	84.3	89	73.67	3.8
0.1%	76.22	74.33	64.67	9.2
0.15%	61.36	65.67	57.67	14.9
Soaked control	88.3	86.99	92.65	2.95

Table-2: Effect of physical and chemical mutagens on soybean in M2 and M3 generation

M2			M3	
Treatment	Germination%	Survival%	Germination%	Survival%
PKV-1(gamma rays)				
15 kR	93.12	95.12	94.56	89.9
20 kR	84.66	91.38	92.1	90.5
25 kR	87.22	88.99	88.4	81.66
30 kR	78.4	82.16	81.26	75
Dry control	96.59	91.12	91.52	93.52
EMS				
0.05%	92.99	89.33	88.9	89.22
0.1%	95.6	92.66	84	82.47
0.15%	83.33	88.2	87.6	79
Soaked control	93.45	92.23	91.69	90.95
JS-335(gamma rays)				
15 kR	92	92.6	96.25	94.33
20 kR	89.24	89	91.64	86.97
25 kR	91.33	87.99	89.9	87.64
30 kR	86.12	86.33	82.36	82.6
Dry control	90.99	96.5	92.6	93.12
EMS				
0.05%	86.24	93	92	91.33

0.1%	88.9	92.24	89.4	84.6
0.15%	81	87.99	86.15	83.64
Soaked control	92.29	96.96	92.6	96.35

Table-3: Mitotic division in M1generation

Treatment	No. of cell scored	No. of cells with division	Mitotic index	Inhibition%
PKV-1(gamma rays)				
15 kR	453	55	12.14	5.94
20 kR	423	48	11.35	12.09
25 kR	515	57	11.07	14.26
30 kR	481	48	9.98	22.69
Dry control	612	79	12.91	
EMS				
0.05%	612	60	9.8	10.65
0.1%	399	35	8.77	20.06
0.15%	438	34	7.76	29.26
Soaked control	483	53	10.97	
JS-335(gamma rays)				
15 kR	512	59	11.52	3.23
20 kR	459	49	10.68	10.36
25 kR	429	42	9.79	17.79
30 kR	467	39	8.35	29.87
Dry control	613	73	11.91	
EMS				
0.05%	566	63	11.13	11.32
0.1%	507	51	10.06	19.86
0.15%	415	38	9.16	27.05
Soaked control	486	61	12.55	

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