

EFFECT OF SEPARATE AND SIMULTANEOUS APPLICATION OF GAMMA RAYS AND EMS ON GERMINATION, GROWTH, FERTILITY AND YIELD IN CULTIVARS NIRMAL AND LSD-3 OF KHESARI (*LATHYRUS SATIVUS* L.)

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Seeds of two cultivars viz. NIRMAL and LSD-3 of khesari (*Lathyrus sativus* L.) were subjected to 15Kr, 25Kr, 35Kr and 50Kr of gamma rays. EMS at 0.125% in NIRMAL and at 0.05% in LSD-3 was also applied separately as well as in combinations of a gamma dose and the chemical mutagen. The two varieties put up a similar response to mutagenic treatments regarding germination, seedling height, plant survival, number of branches, pollen sterility, pod number, seed number, seeds per pod and seed yield while differing response was recorded regarding days to flower, plant height and 100-seed weight. A comparison of germination, survival, growth, fertility and yield reveals that cultivar LSD-3 was more sensitive to mutagenic treatments than cultivar NIRMAL.

Keywords : Gamma Rays, EMS, *Lathyrus sativus*, growth and yield.

Introduction

Studies on M_1 parameters is important as apart from being useful in comparing the effectiveness and efficiency of mutagens, these can be used to distinguish the plants on the basis of genetic damage. It helps in identifying plants with maximum genetic damage that are likely to carry micromutations in M_2 and M_3 generations. This can help in increasing the efficiency of mutagens for polygenic traits because a larger proportion of the non-mutated or poorly mutated plants can be rejected even in the M_1 generation. In the present study effect of separate and simultaneous applications of gamma rays and ethyl methane sulphonate (EMS) have been studied on two cultivars of khesari (*Lathyrus sativus* L.). The present paper reports the effects on germination, growth, fertility and yield in the cultivars NIRMAL and LSD-3.

Material and Methods

Dry and dormant seeds of khesari cultivars NIRMAL and LSD-3 having uniform shape and size were treated with 15Kr, 25Kr, 35Kr and 50Kr doses of gamma rays at N.B.R.I., Lucknow. Some of the irradiated and some

fresh seeds were also treated with 0.125% aqueous solutions of EMS in cultivars NIRMAL and 0.05% EMS in cultivar LSD-3 for six hours at $20 \pm 1^\circ$ C. A sample of untreated seeds of both the varieties was soaked in water for the same period to serve as soaked control. In case of chemical mutagens, the solutions were drained off and replaced by freshly prepared solutions after every one hour. Thus in both the varieties there were a total of eleven treatments viz. four treatments of gamma rays, a treatment of EMS at 0.125% or 0.05%, four treatments of combined application of the two mutagens, a water soaked and an unsoaked control. After treatment the seeds were thoroughly washed in running tap water. The treated seeds along with controls were sown immediately in the research field of Janata Mahavidyalaya, Ajitmal, Etawah to raise the M_1 generation in 450cm long rows with 45 x 45 cm spacing. Recommended optimum agronomic and cultural practices were followed. Observations were recorded on germination percentage and seedling height after 19 days of sowing, survival percentage at maturity,

days taken to flower, plant height, number of primary branch, pollen sterility, pods per plant, seeds per pod, seeds per plant, 100-seed weight and yield per plant. The result for all the traits except germination percentage, seedling height, plant survival and pollen sterility were subjected to analysis of variance. The mean and C.D. values for germination, survival, maturity and growth parameters are summarised in Table 1 while those for fertility and yields are summarised in Table 2.

Observations

1. Germination and seedling growth

The two varieties were similar in their response to mutagenic treatments with regard to germination and seedling growth as recorded 19th day from sowing. Soaking in water promoted germination percentage only in var. NIRMAL while lowest dose of gamma rays in NIRMAL and EMS at 0.05% individually as well as its combined application with lowest gamma dose in var. LSD-3 produced same level of germination as in unsoaked control. A dose dependent reduction was noted in individual as well as combined applications of both the mutagens. Effects induced by combined applications were found to be more drastic than the individual applications in both the varieties. Seedling height also showed a dose dependent reduction in most of the treatments in the two varieties but it slightly increased in water soaked controls and EMS at 0.05% on LSD-3. Individual application of gamma rays was found to be more effective in both the varieties.

2. Plant survival

Percentage of plant survival was adversely affected by the mutagenic treatments in both the varieties, cultivar LSD-3 being more sensitive than the cultivar NIRMAL. Individual application of EMS did not produce any marked effect on plant

survival in either variety. Combined treatments of gamma rays with EMS proved to be more toxic than the single mutagen treatments. In treatments involving gamma irradiation progressive reduction in survival percentage with every increase in radiation doses was noted in both the varieties.

3. Maturity

Maturity was studied in terms of days taken to flower. In var. LSD-3 this trait was not affected significantly by any of the treatment applied in this study. While in var. NIRMAL average number of days taken to flower were found increased with an increased in irradiation dose in individual and combined treatments. Significantly delayed flowering was induced by higher doses of gamma irradiation individually or in combination with EMS.

4. Plant height

Average plant height at maturity was measured as length of main branch. The two varieties differed in their response to treatments with regard to plant height. In var. NIRMAL, highest gamma ray dose, EMS at 0.125% and all the combined treatments of gamma rays with EMS decreased plant height significantly. Reduction in plant height was found to be dose dependent. On the other hand in var. LSD-3 gamma rays at 15Kr, EMS at 0.05% and its combined dose with 50Kr increased plant height significantly while individual application of 50Kr and combined application of 15Kr with EMS significantly retarded plant height. A dose dependent decrease in plant height was found in individual treatments of gamma rays with EMS.

5. Number of primary branches

Branching was adversely affected by mutagenic treatments in most treatments in either variety. Decreased number of primary branches with the increasing mutagenic doses

Table 1. Summarising the effects of mutagenic treatments on germination, seedling growth, plant survival, days to flowering, plant height and number of branches in cultivars NIRMAL and LSD-3 of Khesari (*Lathyrus sativus* L.)

Treatments	Germination(%) (APC)		Seedling height (APC)		Plant survival (APC)		Days to flower		Plant height (cm)		No. of Primary Branches	
	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3
Control												
Unsoaked	100.00	100.00	100.00	100.00	100.00	100.00	81.08	80.82	68.88	51.19	4.66	5.12
Soaked	108.69	96.00	111.97	102.84	96.79	87.32	81.21	80.51	66.17	50.60	4.75	5.60
Gamma rays												
15Kr.	100.00	96.00	75.06	69.03	78.99	73.13	84.48	82.43	65.50	57.03*	4.48	4.48
25Kr.	82.61	84.00	41.64	47.77	62.17	49.25	84.98*	81.98	65.45	49.26	4.26	4.38
35Kr.	69.56	60.00	15.16	37.34	45.36	34.33	85.09*	80.47	64.67	48.28	4.21	3.93**
50Kr.	60.87	52.00	13.05	11.38	33.61	23.88	87.13**	80.32	58.07**	46.14*	4.04	3.25**
EMS												
0.05%	-	100.00	-	101.28	-	89.55	-	78.27	-	59.66**	-	5.02
0.125%	78.26	-	93.80	-	98.31	-	81.16	-	62.35*	-	5.05**	-
Gamma rays+EMS												
15Kr+EMS	95.65	100.00	79.07	69.29	77.30	64.18	82.72	82.11	60.90*	41.47**	5.19	4.71
25Kr+EMS	91.30	84.00	59.86	63.17	48.74	38.81	82.64	81.65	60.69*	53.97	5.12	4.70
35Kr+EMS	65.22	56.00	51.98	64.07	30.25	34.33	86.36**	81.36	58.80**	54.33	4.07	4.69
50Kr+EMS	52.17	44.00	34.06	34.17	21.84	20.90	90.03**	80.61	54.48**	56.30*	3.53**	4.40
C.D. at 5%	NAS	NAS	NAS	NAS	NAS	NAS	3.53	NS	5.01	4.44	0.71	0.78
C.D. at 1%	NAS	NAS	NAS	NAS	NAS	NAS	5.04	NS	8.92	6.98	0.98	1.10

APC = As percent of control NAS = Not analysed statistically
 NS = Not Significant * = Significant at 5% level ** = Significant at 1% level

Table 2. Summarising the effects of mutagenic treatments on pollen sterility and yield parameters in cultivars NIRMAL and LSD-3 of Khesari (*Lathyrus sativus* L.)

Treatments	Pollen sterility %		Pods/plant		Seeds/pod		Seeds/plant		100-seed weight (g)		Yield/plant (g)	
	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3	Nirmal	LSD-3
Control												
Unsoaked	8.97	11.89	58.61	59.36	2.88	3.00	167.95	174.10	5.690	7.058	9.539	12.295
Soaked	14.37	17.08	58.41	60.31	2.86	2.84	167.28	175.32	5.555	7.370	9.259	13.286
Gamma rays												
15Kr.	22.56	35.50	53.70	35.63**	2.53	2.32*	139.90	87.70**	5.913	8.441**	8.326	7.257**
25Kr.	26.60	58.55	52.61	35.93**	2.41*	2.14**	133.46	80.55**	6.239	8.422**	8.277	6.808**
35Kr.	39.30	62.79	38.57**	39.98**	2.23**	1.97**	87.79**	84.33**	8.141**	8.001**	7.127**	6.668**
50Kr.	60.45	76.77	35.74**	17.07**	1.84**	1.60**	70.55**	31.98**	8.293**	7.919*	6.226**	2.736**
EMS												
0.05%	-	29.38	-	58.10	-	2.79	-	163.68	-	7.870*	-	13.004
0.125%	20.63	-	55.02	-	2.76	-	156.74	-	5.558	-	8.248	-
Gamma rays+EMS												
15Kr+EMS	17.30	19.25	48.38*	49.71*	2.51	2.36*	123.24	115.12**	6.338	7.706*	7.563*	8.349**
25Kr+EMS	31.29	39.17	45.90*	47.60**	2.29**	1.92**	109.70**	96.07**	6.834*	8.102**	7.446*	7.911**
35Kr+EMS	45.45	65.07	25.38**	45.81**	2.13**	1.84**	55.11**	91.82**	7.557*	8.119**	3.966**	7.520**
50Kr+EMS	59.71	79.87	18.07**	41.10**	1.80**	1.76**	33.23**	73.70**	8.465**	8.936**	2.714**	6.741**
C.D. at 5%	NAS	NAS	9.38	7.55	0.42	0.53	41.61	39.55	1.012	0.510	1.552	1.441
C.D. at 1%	NAS	NAS	15.32	10.04	0.55	0.71	55.34	48.22	2.028	0.933	2.197	2.005

NAS = Not analysed statistically

* = Significant at 5% level

** = Significant at 1% level

could be noted in both the varieties. This decrease was significant in case of two higher gamma ray doses applied individually on var. LSD-3 and in highest combined application dose in case of var. NIRMAL. However, in var. NIRMAL highly significant increase in branching was induced by the individual application of EMS at 0.125% while its combined application with two lower doses of gamma rays produced non-significant increase.

6. Pollen sterility

The mutagenic treatments induced a high degree of pollen sterility in both the varieties. EMS alone was found to be less toxic to pollen fertility than gamma rays either separately or in combination with EMS. Progressive increase in gamma ray dose was coupled with an increase in pollen sterility in both the varieties. Var. LSD-3 was found to be more effected than the var. NIRMAL. Some plants showing very high degree of pollen sterility (50% or more) were recorded in both the varieties.

7. Number of pods per plant

Number of pods per plant was significantly reduced in almost all the gamma ray treatments, individual or combined with EMS in both the varieties. The decrease became more pronounced with the increase in radiation dose. Individual application of EMS did not produce any significant effect on pod number in either variety.

8. Number of seeds per pod

Average number of seeds per pod was also reduced in all the mutagenic treatments. However, the reduction in seeds per pod induced by individual EMS treatments of either variety and by gamma irradiation at lowest dose of 15Kr in var. NIRMAL were non-significant. Reduction in seeds per pod was more drastic in the treatments involving gamma irradiation at 35Kr or above

individually or in combination with the chemical mutagen. Chemical mutagens have generally been found to produced lesser toxic effects on seeds per pod than the gamma rays.

9. Number of seeds per plant

Like the number of seeds per pod, average number of seeds per plant was also reduced by the mutagenic treatments. Reduction in seed number becoming more pronounced with the increase in gamma ray doses individually or in combination with EMS. Individual application of EMS, however, did not produce a significant effect on seed number in either variety. Cultivar LSD-3 was found to be more effective than NIRMAL with regard to seed number.

10. 100-seed weight

The two varieties put up a similar response to the mutagenic treatment regarding test weight. All the mutagenic treatments showed increase in average test weight. This increase was significant in all the treatments of var LSD-3 and in all treatments involving gamma irradiation above 25Kr in var. NIRMAL.

11. Seed yield

Per plant yield was significantly reduced by most of the mutagenic treatments involving gamma irradiation in both the varieties. EMS alone failed to produce any significant effect on per plant yield. A dose dependent reduction was noted in individual gamma rays as well as in combined treatments in both the varieties.

Discussion

The two varieties included in the study put up a similar response to the mutagenic treatments regarding germination, seedling growth, plant survival, number of branches, pollen sterility, pod number, seed number, seeds per pod and yield per plant while a differing response was observed regarding days to flower, plant height and 100-seed

weight. Mostly mutagenic treatments are known to effect the germination percentage adversely. In khesari Kumar and Dubey¹ also noted reduced germination following separate and simultaneous application of gamma rays, EMS and DES. Seedling height was retarded by all the treatments in both the varieties. Thus it appears that different genotypes put up a similar response for the germination and seedling growth following mutagenic treatments.

Decreased plant survival and height, number of branches, pods and seeds per plant as well as seeds per pod, seed yield, delayed maturity and increased pollen sterility are common features of mutagenic treatments in various crops²⁻⁶. Increase in 100-seed weight due to mutagenic treatments holds promise for isolating bold seeded types in further generations.

When the effects of mutagenic treatment on various parameters like germination, survival, growth, fertility and

yield induced in the two genotypes of khesari included in the present study are compared, it is found that cultivars LSD-3 was more sensitive to mutagens than cultivar NIRAML.

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