

EFFECT OF PHYSICAL AND CHEMICAL MUTAGENS AND THEIR INTERACTIONS ON GERMINATION, GROWTH, FERTILITY AND YIELD IN TWO CULTIVARS OF KHESARI

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Seeds of khesari cultivars DL-250 and PLK-750 were subjected to 15Kr, 35Kr and 50Kr doses of gamma rays. Besides this DES at 0.5% in DL-250 and 0.25% in PLK-750, were applied separately as well as in combinations of a gamma dose and the chemical mutagen. The two varieties put up differing response regarding plant survival and 100-seed weight but had a similar response regarding germination percentage, seedling height, maturity period, plant height, number of branches, pollen sterility, number of pods, number of seeds, seeds per pod and yield and yield per plant. All these traits were retarded by mutagenic treatments. A comparison of all the traits studied reveal that var.PLK-750 was more sensitive than var. DL-250.

Keywords :Gamma rays, DES, Khesari, growth and yield.

Introduction

Induced mutagenesis offers a quick method of enhancing variability which is the base of crop improvement. A programme to study the effects induced by separate and simultaneous application of chemical and physical mutagens on genetically distinct varieties of khesari i.e. DL-250 and PLK-750 was recently undertaken. This paper reports the effects of gamma rays and DES on germination, growth, fertility and yield.

Materials and Methods

Dry seeds of DL-250 and PLK-750 varieties of khesari (*Lathyrus sativus* L.) were subjected to 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 aqueous solution of DES at 0.5% for var.DL-250 and at 0.25% for var. PLK-750 for six hours. A sample of untreated seeds of both the varieties was soaked in water for the same period to serve as soaked control. Thus in both the varieties there were a total of eleven treatment viz. four treatment of gamma rays, a treatment of DES at 0.5% or 0.25%, four treatments of combined application of the two mutagens, a water soaked and an unsoaked control. There were a total of 125 seeds in each treatment of which

50 seeds were shown in the sand culture to study the effect on germination and seedling growth and the remaining 75 seed of each treatment were shown at the Research field of Janta Mahavidyalaya, Ajitmal, Etawah under randomised row design where observations were recorded on survival percentage, plant height, number of branches, days to flower, pollen sterility, number of pods, number of seeds, seeds per pod, 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 are summarised in Tables 1 and 2.

Observations

1. Germination and seedling growth (Table 1)

The two varieties were similar in their response to mutagenic treatments with regard to germination percentage and seedling height as recorded 19 days after sowing. Individual application of gamma rays and combined applications of gamma rays with DES produced more severe effects. DES alone did not produce marked variation in both the parameters. A dose dependent reduction was noted with the increase in mutagenic doses

individually as well as in combined treatments.

Generally individual application of gamma rays produced more serve effects than the other treatments. Cultivar PLK-750 was found to be more sensitive with regard to germination and seedling growth than var. DL-250.

2. *Plant survival* : Mutagenic treatments had differing effect on the plant survival in the two varieties. Most of the mutagenic treatments brought about highly reduced plant survival, however, lowest dose of gamma rays in DL-250 showed slightly promoting effect. A dose dependent reduction was also noted in DL-250 while no such response could be made out in PLK-750. Cultivars DL-250 was found to be less effected for plant survival than PLK-750.

3. *Maturity* : Maturity was studied in terms of days taken to flower. Flowering was delayed in al the mutagenic treatments in both the varieties . However, in var. DL- 250 significant delay in flowering was induced only by highest gamma dose individually and two highest gamma dose combined with DES in var. DL-250 while in var. PLK-750 all the treatmnets showed highly sinificant delay in flowering except the two lower doses of gamma rays combined with DES. Effect of individual application of DES was found to be significant only in var. PLK-750. Cultivar PLK-750 proved to be more sensitive for days to flower than DL-250.

4. *Plant height* :Average plant height at maturity measured as length of main branch, varied significantly among mutagenic treatments. In both the varieties a dose dependent palnt reduction in plant height was recorded. The decrease became more pronounced with the increase in mutagenic doses both in individual and combined applications of physical and chemical mutagens. Generally individual applications of gamma rays or DES proved to be more toxic than the combined applications.

5. *Number of primary branches* :

All the mutagenic treatments induced decreased number of branches in both the varieties. In var. DL-250 significant reduction was noted in individual applications of gamma ray dose combined with DES while in var. PLK-750 all the mutagenic treatments showed highly significant reduction. The reduction in branches was dose dependent in both the varieties. However, var. PLK-750 was found to be more sensitive to mutagenic treatments than var. DL-250.

6. *Pollen sterility* : The mutagenic treatments produced similar response regarding pollen sterility in the two varieties where a high degree of pollen sterility was induced. DES induced lesser pollen sterility than gamma rays applied either seperately or in combined treatments. A progressive increase in gamma ray doses was coupled with an increase in pollen sterility in both the varieties in both seperate and combined treatments. Some plants showing very high degree of pollen sterility (50% or above) were recorded in both the varieties.

7. *Number of pods per plant* : Number of pods perplant was significantly reduced in almost all the mutagenic treatments in both the varieties. The decrease became more pronounced with the increase in mutagenic doses both in individual and combined treatments of physical and chemical mutagens. However, two lower doses of gamma rays individually in DL-250 and combined with DES in PLK-750 failed to produce significant effect on this trait.

8. *Number of seeds per pod* :A decrease in number of seeds per pod was induced by all the mutagenic treatments in the two varieties. But this decrease was non-significant in lowest gamma ray dose in var. DL-250 and in application of DES individually or in combination with lowest gamma ray dose in either variety.

9. *Number of seeds per plant* :As in the number of seeds per pod, most of the mutagenic treatments decreased the number

Table 1. Summarising the effects of mutagenic treatments on germination, seedling growth, plant survival, days to flowering, plant height and number of primary branches in cultivars DL-250 and PLK-750 of Khesari (*Lathyrus sativus* L.)

Treatments	Germination(%) (APC)		Seedling height (APC)		Plant survival (APC)		Days to flower		Plant height (cm)		No. of Primary Branches	
	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750
Control												
Unsoaked	100.00	100.00	100.00	100.00	100.00	100.00	87.86	80.04	68.76	40.92	6.28	5.52
Soaked	92.00	108.00	103.66	102.85	106.67	84.62	85.74	80.54	69.64	39.52	5.57	5.28
Gamma rays												
15Kr.	92.00	96.00	58.48	45.99	100.94	53.86	88.96	85.53**	60.16*	41.39	5.31*	3.69**
25Kr.	92.00	60.00	52.19	36.79	66.67	7.70	89.11	91.80**	59.59*	39.36	5.29*	3.20**
35Kr.	52.00	48.00	27.37	23.71	68.57	12.31	90.64	93.77**	58.19**	36.16**	5.29*	2.83**
50Kr.	24.00	44.00	19.36	17.61	24.76	7.70	91.75*	97.80**	53.16**	34.98**	4.47**	2.80**
DES												
0.25%		76.00		81.72		36.92		84.65*		30.27**		3.83**
0.5%	92.00		87.56		64.76		86.43		57.15**		6.04	
Gamma rays+DES												
15Kr+DES	76.00	48.00	84.16	77.49	57.14	18.46	87.00	79.87	68.81	40.13	6.23	4.73*
25Kr+DES	68.00	44.00	76.76	61.30	53.33	15.38	88.37	81.13	67.22	40.02	6.19	3.97**
35Kr+DES	64.00	36.00	68.85	49.55	59.04	9.23	92.44**	85.90**	62.39*	39.15	5.67	3.20**
50Kr+DES	60.00	32.00	42.73	47.11	47.61	12.31	93.55**	88.30**	60.27*	37.63*	4.84**	3.27**
C.D. at 5%	NAS	NAS	NAS	NAS	NAS	NAS	3.09	3.13	5.26	2.07	0.82	0.67
C.D. at 1%	NAS	NAS	NAS	NAS	NAS	NAS	4.11	4.17	9.83	3.94	1.09	0.98

APC = As percent of control

* = Significant at 5% level

NAS = Not analysed statistically

** = Significant at 1% level

Table 2. Summarising the effects of mutagenic treatments on pollen sterility and yield parameters in cultivars DL-250 and PLK-750 of Khesari (*Lathyrus sativus* L.)

Treatments	Pollen sterility %		Pods/plant		Seeds/pod		Seeds/plant		100-seed weight (g)		Yield/plant (G)	
	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750	DL-250	PLK-750
Control												
Unsoaked	11.91	11.84	88.81	64.73	3.04	2.95	270.50	182.61	7.340	6.349	20.136	11.447
Soaked	5.92	19.99	82.81	57.50	3.03	2.99	251.54	173.18	8.112	6.429	19.899	11.100
Gamma rays												
15Kr.	29.43	30.17	86.50	55.69**	2.66	2.01**	225.80**	111.41**	8.632*	7.023*	19.703	7.767**
25Kr.	41.65	42.39	81.27	53.60*	2.20*	2.06**	184.00**	109.40**	9.499**	7.211*	17.124**	7.240**
35Kr.	50.00	57.08	70.43**	25.70**	2.16*	1.86**	138.81**	49.47**	9.941**	7.662**	14.064**	3.700**
50Kr.	60.30	75.06	29.93**	14.00	1.78**	1.94**	46.49**	29.20	7.924	5.430*	3.610**	1.634**
DES												
0.25%	27.57	36.32**	72.88*	36.32**	2.95	2.62	95.18**	217.06**	8.051	5.876	17.668*	5.429**
0.5%	25.35	72.88*	72.88*	36.32**	2.95	2.62	95.18**	217.06**	8.051	5.876	17.668*	5.429**
Gamma rays+DES												
15Kr+DES	29.69	31.00	73.10*	67.07	3.00	2.67	255.31	187.22	8.637*	5.936	19.230	10.659
25Kr+DES	40.40	44.44	72.02*	60.63	2.39*	2.36**	177.63**	142.97	9.155**	6.982	16.309**	9.926*
35Kr+DES	59.58	61.52	62.17**	40.10**	2.23*	1.95**	133.02**	80.50**	9.242**	7.731**	12.288**	5.973**
50Kr+DES	77.15	80.76	57.76	31.47**	1.83**	1.72**	108.94**	55.23**	9.902**	6.662	10.887**	3.833**
C.D. at 5%	NAS	NAS	10.05	7.49	0.62	0.36	29.02	45.51	1.121	0.636	1.720	1.400
C.D. at 1%	NAS	NAS	17.49	11.29	1.00	0.48	38.35	59.34	1.571	1.002	2.562	2.172

NAS = Not analysed statistically

* = Significant at 5% level

** = Significant at 1% level

of seeds per plant also in both varieties. Mutagenic treatments induced a progressive decrease in seeds number with increasing doses of mutagens. Individual application of gamma rays or DES proved to be more effective than the combined treatments.

10. *100-seed weight* : The two varieties put up a differing response to the mutagenic treatments regarding test weight. Most of the mutagenic treatments showed significant increase in test weight in var. DL-250 while in var. PLK-750, a significant decrease was found in highest gamma ray dose applied individually. However, lower doses of gamma irradiation increased test weight in this variety also.

11. *Seed yield per plant* : Most of the mutagenic treatments brought about a significant retardation in seed yield in both the varieties. The retardation was found to be dose dependent. Only lowest dose of gamma rays individually or in combination with DES failed to produce a significant reduction in seed yield.

Discussion

The two khesari differed in response to the mutagenic treatments regarding plant survival and 100-seed weight. A similar response was recorded regarding germination, seedling growth, maturity, plant height, number of branches, pollen sterility, number of pods and seeds, seeds per pod and seed yield. Mostly mutagenic treatments are known to effect the germination percentage adversely. During the present study also a dose dependent reduction in germination percentage and seeding height was recorded.

Percentage of pollen or ovule sterility and percentage of plant survival are of important consideration for determining the effectiveness of mutagens. In the present study pollen setrility showed a dose dependent increase both in case of individual and combined applications of the mutagens. While survival percentage showed a corresponding

decrease. Highest gamma ray dose individually as well as in combined application was highly effective in increase pollen setrility and reducing survival percentage. Nerkar¹, Prasad and Das²⁻³ and Kumar and Dubey⁴ concluded that sterility increase with increasing radiation dose in M₁ generation.

A decrease in plant height, number of branches, number of fruits, seeds per fruit and seed yield as also delayed maturity and increased pollen sterility are common features of mutagenic treatments in various crops⁵⁻¹⁰. During present study decreased plant height, number of branches, fruiting ability and seed yield besides delayed maturity were induced by various mutagenic treatments. An interesting observation of the present study is the increase in test weight in almost all the mutagenic treatments which may indicate a possibility of isolating types with bolder seeds in later generations.

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References

1. Nerkar Y S 1970, *Studies on the induction of mutagens in Lathyrus sativus L. with special reference to the elimination of the neurotoxic principle*. Ph.D. Thesis IARI New Delhi.
2. Prasad A B and Das A K 1980a, *J. Cytol. Genet.* 15 156
3. Prasad A B and Das A K 1980b, *Indian J. Genet.* 40(1) 176
4. Kumar S and Dubey D K 1996, *Res. J. Pl. Environ.* 12 19
5. Sjodin J 1962, *Heriditas* 48 565
6. Blixit S, Ehrenberg L and Gelin O 1969, *Agric. Hort Genet.* 22 186
7. Dixit P and Dubey D K 1981, *Botanical Progress* 4 10
8. Sarkar A and Sharma B 1989, *LENS Newsletter* 16(2) 8
9. Tripathi A and Dubey D K 1990, *Res J. Pl. Environ.* 6(1) 67
10. Tripathi A and Dubey D K 1992, *LENS Newsletter* 19(1) 9