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INDUCED GENETIC VARIABILITY FOR QUANTITATIVE CHARACTERS IN GRASSPEA (*LATHYRUS SATIVUS* L.)

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ABSTRACT

Mutagenic treatments generated substantial magnitude of genetic variability for economic characters in M2 and M3 generations. Grain yield per plant followed by number of pods per plant, number of seeds per pod and plant height showed significant increased variability in both the generations. For days to flowering, days to maturity, number of primary branches, pod length and number of seeds per pod reduction in variability from M2 to M3 was observed. There was no consistancy in the behaviour of means for different characters. Mean and range for days to flowering and maturity shifted towards lateness from M2 to M3 in comparison to control indicating selection for this trait would be less effective in advanced generations. Significant differences between M3 families led to the identification of several desirable families for different economic characters including yield. The negative association between number of seeds per pod and seed size was broken in 35 and 40 kR gamma irradiated population and was retained in M3 also, such association has helped for simultaneous improvement of both the traits.

Key Words : *Lathyrus sativus*, mutations, quantitative characters, genetic variability, correlated response.

Genetic improvement of grasspea is based on developing high yielding low seed ODAP containing lines. Though cultivated for a long time, yet little evolutionary progress is observed in *Lathyrus sativus* [1]. Low genetic variability for the major characters becomes a limiting factor for its improvement. Induction of mutations has been perceived as an important tool to create additional variability for qualitative as well as quantitatively inherited traits in number of crop plants [2]. In the present study attempt has been made to ascertain the magnitude of induced through mutagenesis genetic variability and also magnitude and nature of associations between yield and its component characters in M2 and M3 generations.

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MATERIALS AND METHODS

The material for the present investigation consisted of P27, a cultivar of *Lathyrus sativus* with low ODAP content. Dry healthy seeds of the cultivar were treated with different doses of gamma rays and ethyl methane sulphonate (EMS), as per the procedure described [3]. Separately harvested individual M1 plants were grown as 756 single plant progeny rows (families) along with as many as 30 single plant progenies of control at IARI, New Delhi during *rabi* 1992. Plant progenies appearing uniform in M2 were advanced to M3 generation. The plant progenies in M2 and M3 were spaced at 45 cm apart with a plant to plant distance of 20 cm. All the normal packages of practices were followed for raising the crop.

The observations for yield and its components were recorded on five random plants in each of the single plant progeny in each treatment in both M2 and M3 generations. The quantitative characters studied included: days to flowering, days to maturity, plant height, number of primary branches per plant, number of pods per plant, pod length, number of seeds per pod, seed size (100 seed weight) and grain yield per plant. Range, mean, coefficient of variation and correlation coefficient were calculated as per the standard procedures.

RESULTS AND DISCUSSION

The mutagenic treatments generated substantial magnitude of genetic variability for all the economic characters studied in M2 and M3 generations. There was no consistancy in the behaviour of treatment means which showed shift in both the directions, i.e. positive or negative, for most of the characters for various doses of mutagens (Table 1).

Days to flowering : The general population means in M2 and M3 were higher than in control (table 2) indicating general lateness for days to flowering. However, treatment means in 5 kR, 0.5% (2h) and 0.5% (4h) EMS were significantly low. The range showed 5-8 days early flowering, providing scope to exercise selection for earliness in M2. In M3, there was a shift in the treatment means and range towards the higher side indicating selection was more effective in early generation. Increase in range and shift in mean flowering time in M2 and M3 was also reported by Singh and Chaturvedi [4] in *Lathyrus* who held that selection for earliness was equally effective in M3 as was in M2 generations.

Days to maturity : The mean number of days to maturity were reduced by 4-5 in M2 and M3 in 10, 15, 30 and 40 kR gamma rays and EMS treatments. The overall range was wider in M2, however, in M3 it got narrowed as compared to control. Interestingly, significant reduction in M3 population mean was observed in 40 kR

Table 1. Mean values for various economic characters in M2 and M3 generations

Treatments	Days to flowering		Days to maturity		Plant height (cm)		No. of primary branches		No. of pods per plant		Pod length (cm)		No. of seeds per pod		Seed size 100-seed weight (g)		Grain yield per plant (g)	
	M2	M3	M2	M3	M2	M3	M2	M3	M2	M3	M2	M3	M2	M3	M2	M3	M2	M3
Gamma Rays																		
5 kR	66.3	83.0	142.5	148.9	68.7	69.9	4.23	4.36	57.7	63.2	3.28	3.32	2.71	3.05	13.63	11.96	14.5	13.9
10 kR	68.9	74.9	143.8	143.7	73.4	68.1	5.17	4.80	72.4	66.1	3.26	3.31	2.66	2.96	13.24	12.18	18.2	16.8
15 kR	72.6	73.0	147.2	144.5	75.2	64.2	5.62	4.80	77.2	49.2	3.28	3.26	2.83	2.92	13.29	12.14	20.3	10.8
20 kR	73.4	73.6	146.9	146.4	75.5	65.4	5.52	4.12	76.3	52.1	3.22	3.34	2.73	2.99	12.72	12.95	20.1	13.8
25 kR	79.4	80.1	149.3	148.7	75.1	76.1	5.87	5.33	116.2	85.2	3.43	3.26	2.99	2.90	12.58	12.29	23.0	19.5
30 kR	74.0	78.6	147.9	145.0	67.9	65.9	4.65	4.77	73.0	50.8	3.25	3.34	2.72	3.06	12.07	11.99	15.2	12.2
35 kR	70.9	80.3	148.6	147.1	69.4	69.0	5.27	4.63	69.6	80.9	3.17	3.29	2.44	2.95	13.10	12.46	14.8	20.6
40 kR	79.9	74.9	149.0	144.7	66.8	71.2	4.17	4.17	75.0	46.7	3.15	3.22	2.33	2.92	14.43	11.01	14.4	8.9
EMS																		
0.5% (2h)	65.8	74.0	142.5	143.1	69.8	71.2	4.82	4.34	60.4	58.7	3.24	3.33	2.83	3.19	13.11	12.42	15.7	15.1
0.5%(4h)	65.4	77.4	146.8	143.0	73.3	66.2	4.90	4.47	71.0	63.0	3.30	3.31	2.56	3.08	13.62	11.68	17.4	14.4
1.0%(2h)	67.6	77.3	144.9	144.6	72.5	66.9	4.79	4.42	75.1	56.1	3.28	3.46	3.01	3.34	12.09	12.03	19.0	14.9
1.0%(4h)	75.9	78.8	153.1	146.1	75.1	66.4	4.78	4.14	98.6	54.6	3.27	3.41	2.63	2.88	11.82	12.46	20.2	12.9
Control (Pooled)	69.9		147.1		69.3		5.09		68.6		3.34		2.93		13.71		19.1	
CD at 5% level	2.56		1.85		3.81		0.49		12.2		0.09		0.19		0.75		2.21	

treatment, though in M2 it was significantly higher, and quite opposite was true in 5 kR treatment. As no selection pressure was exercised in M2 such a reversible change in M3 mean could be due to delayed appearance of phenotypic differences or due to segregation and recombination of induced micromutations [5]. Such changes may also be brought about to some extent by diplontic selection or genetic drift operating due to sampling.

Variation in flowering and maturity date in induced early mutants is generally considered to have parallel relation. However, early flowering mutants that are not so early maturing [6] or early maturing mutants with normal flowering date have also been reported in different crops [7].

Plant height : The mean plant height varied in all the treatments of M2 and M3 generations. Treatment means were significantly higher in M2 generation in 10, 15 and 20 kR and 0.5% (4h) EMS treatments but a significant reduction in mean plant height was observed in M3. The range for plant height was quite high in both the generations and no dose dependent relationship was noticed. However, Das and Prasad [8] reported to have achieved dose dependent increase or decrease in plant height in M2 generation in *Lathyrus sativus*.

Number of primary branches per plant : Though the population means were significantly higher in 15, 20 and 25 kR treatments in M2; M3 generation showed significant reduction in mean, range and magnitude of variability over M2. Similar observations for number of branches per plant were reported by Singh and Chaturvedi [4] with var. S220, whereas var. LSD 6 showed increase in mean values from M2 to M3 using NMU as a mutagen.

Number of pods per plant : In M2 significantly higher population mean (116.2 pods per plant) was noted in 25 kR gamma irradiation followed by EMS 1.0% (4h), (98.6 pods per plant), as compared to control. The population means got reduced in all the treatments except in 5 and 35 kR treatments in M3 generation. The M3 population mean was highest in 25 kR (85.2 pods per plant) followed by 80.9 pods per plant in 35 kR treatment. The range was very wide in all the treatments in M2 and M3 generations. The variability estimates were also significantly higher in 15, 20, 25, 40 kR, 1.0% (2h) and 1.0% (4h) EMS treatments in M2; and 25 and 35 kR treatments in M3. The increase in variability for number of pods per plant following mutagenic treatments has been reported in *khesari* [4].

Pod length : The population means in most of the treatments (except 25 kR) were significantly less than that in control. Subsequently, in M3, the mean increased approaching the control mean in most of the treatments. The range was wide enough

in both the directions but frequencies shifted more towards the lower side. The increased variability was observed only in 35 kR treatment in M2 and it was comparable to the control in M3.

Number of seeds per pod : The average number of seeds per pod was remarkably reduced in most of the treatments in M2 generation. However, average number of seeds per pod increased in most of the treatments in M3. The M3 population mean was higher than control mean. Probably the individuals carrying sterility due to chromosomal abnormalities or mutations were more frequent in M2 generation and gradually got eliminated in M3 generation. Similar results were reported by SIngh and Chaturvedi [4] in *Lathyrus sativus* cultivars LSD-6 and S-220. The range for this character was significantly wider and showed increased variability in both the generations [4].

Seed size (100 seed weight) : The seed size showed significant reduction in both M2 and M3 generations. The population mean in M2 was less but comparable to control, however, it showed further reduction in M3. Possibly P27 has been developed for bolder seed size and the present shift is against the previous history of selection [1]. Singh and Chaturvedi [4] and Chekalin [9] reported increased M2 and M3 population means for seed size in *khesari*. The M2 range for seed size showed an increase over the control, which further increased in M3, however, the variance in both the generations was comparable to control.

Grain yield per plant : The treatment means were considerably less (except in 25 kR treatment) in M2 and showed further reduction in M3 generation. However, range of seed yield per plant and coefficient of variation (CV) were of higher order in all the treatments in M2 and M3. Wider range and CV provide scope to exercise selection. In majority of experiments, reduction in mean seed yield per plant in M2 and M3 has been reported [5]. The reduction in mean seed yield may be due to higher frequency of mutations with persistent negative effects for yield contributing traits. Increase in mean seed yield in M3 over the M2 and control could be a result of directed selection for yield exercised in M2 generation [10]. Chekalin [9] achieved considerably increased mean yield in combination of physical and chemical mutagenic treatments in comparison to single mutagenic treatments. Increase in variability for yield per plant after mutagenic treatments has also been reported by several workers in various crops [5, 10].

The comparative results on overall induced polygenic variability in M2 and M3 showed wider range for all economic characters than in control (Table 2). There was no consistancy in behaviour of means for different characters which shifted in positive

or negative direction in both the generation. Among the economic characters grain yield per plant followed by number of pods per plant, number of seeds per plant and plant height showed significant variation in both the generations. There was reduction in variability for days to flowering, days to maturity, number of primary branches, pod length and number of seeds per pod from M2 to M3.

Table 2. Parameters of induced polygenic variability in M2 and M3 generation and control

Characters	M2			M3			Control (Pooled)		
	Range	Mean	CV(%)	Range	Mean	CV (%)	Range	Mean	CV (%)
Days to flowering	53-94	71.43	10.99	60-103	77.16	9.96	58-91	69.90	8.54
Days to maturity	134-161	146.88	2.68	137-157	145.48	1.87	137-160	147.10	3.19
Plant height (cm)	26-120	71.89	18.12	31-118	68.38	19.23	55-88	69.30	15.30
No. of primary branches/plant	2-14	4.98	28.64	2-10	4.53	25.87	2-8	5.02	27.90
No. of pods/plant	6-560	76.88	64.12	5-394	60.55	66.56	18-160	68.60	54.90
Pod length (cm)	2.3-4.4	3.26	8.62	2.1-4.3	3.32	7.93	2.9-4.1	3.34	8.46
No. of seeds/plant	0.0-5.0	2.70	23.40	0.0-6.0	3.02	20.8	1.0-5.0	2.93	17.80
Seed size (100 seed weight in g.)	6.1-22.4	12.98	17.51	5.1-23.2	12.13	17.11	8.6-19.5	13.71	18.00
Grain yield/plant (g.)	1.4-151.3	17.73	70.24	1.1-102.1	14.55	70.18	4.5-54.4	19.1	58.80

Significant differences for major yield contributing characters were observed between M3 families. This situation was exploited to its advantage and using these parameters, a number of promising M3 families for different economic characters were identified. These are : number of pods per plant (70), pod length (31), seed size (51), grain yield (41) and number of seeds per pod (29). About 15 M3 families were identified which showed increased value for yield in combination with number of pods per plant, pod length, number of seeds per pod and or seed size. These

identified families were advanced to M4 generation which showed superior performance.

The yield, as such, is a complex manifestation of large number of genes involved in physiochemical processes of the plant system. Induced mutations can contribute to the physiological efficiency of the plant for grain yield by generation of more favourable correlations between various yield components. A comparison of mutated and control population revealed that the negative association between number of seeds per pod and seed size ($r = -0.564$) in control population was broken down in 35 kR ($r = 0.089$) and 40 kR ($r = 0.149$) gamma rays treatments in M2, and this was retained in M3 generation also. This was highly desirable from the point of view of simultaneous selection and improvement of more than one trait. Some of the desirable associations observed in control have also been broken down due to mutagenic treatments. However, none of them involves the association of major yield components such as pods per plant and seed yield. Such desirable changes in association with yield contributing characters have also been reported by Scossiroli et al. [5].

REFERENCES

1. J. Smartt. 1984. Evolution of grain legumes. I. Mediterranean pulses. Experimental Agriculture., **20**: 275-296.
2. R. D. Brock. 1971. The role of induced mutations in plant improvement. Rad. Bot., **11**: 181-196.
3. V. N. Waghmare. 1993. Genetic and mutation studies in *Lathyrus sativus* L. Unpubl. Ph.D. Thesis, P.G. School, IARI, New Delhi.
4. M. Singh and S. N. Chaturvedi. 1990. Improvement of yield and quality character of *khesari dal* by use of mutagens. Mysore J. of Agric. Sci., **24**: 325-330.
5. R. E. Scossiroli, D. L. Palenzona and S. Scossiroli-Pellengrini. 1966. Studies on the induction of new genetic variability for quantitative traits by seed irradiation and its use for wheat improvement. *In*: Mutations in Plant Breeding. Proc. Panel. Disc. IAEA, Vienna: 197-229.
6. O. Tedin. 1954. X-irradiation of *Lupinum luteus*. Acta Agri. Scand., **4**: 569-573.
7. W. Porsche. 1963. Mutations versuche mit weissen Lupinen (*Lupinus albus* L.) I. Rotgen-Bestrahlung der Sorte: neutra Zuchter., **33**: 33-39.
8. A. K. Das and A. B. Prasad. 1978. Variation induced quantitative characters of some varieties of *Lathyrus sativus* L. J. Ind. Bot. Soc., 57 (suppl.): 74.
9. N. M. Chekalin. 1971. Effect of repeated treatment with chemical and physical mutagens of *Lathyrus sativus* L. *In*: Praktika khim. mutageneza Moscow, USSR, Nauka., : 138-145.
10. N. P. Singh. 1988. Mutation studies with early generation selection for polygenic variability in Peas (*Pisum sativum* L.). Unpubl. Ph.D. Thesis, IARI, New Delhi.