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Induced variability and character association in mutants of lentil (*Lens culinaris* Medik) in M_4 generation

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ABSTRACT
The present investigation was undertaken to study the heritability, genetic advance and character association in M_4 generation of selected induced mutants of lentil varieties K-75 and Pant L-406 for some quantitative and qualitative traits. Seeds of both the varieties were treated with gamma-rays (10, 15, 20, 25 & 30 kR), EMS (0.02, 0.03, 0.04 &0.05M) and combinations of doses of gamma-rays with EMS (0.03M). Promising morphological mutants in M_2 were carried to M_4 for variability study. Mutant lines MK-5 and MP-4 were judged as dwarf among all the mutants. MK-5 was an early maturing mutant. Mutant line MP-4 had 1.5 times more grain yield than the control along with normal maturity duration. Both the sets of mutant(derived from K-75 and Pant L-406) showed a wide range of PCV and GCV and genetic advance as per cent of mean for grain yield, number of nodules and number of pods per plant, whereas these were low for 100-grain weight. Genetic advance for protein and metheonine content ranged from 5.25% to 10.5%. Broad sense heritability ranged from 49.28% to 92.96%. Number of pods per plant had positive and significant association with number of nodules per plant and grain yield per plant except grain yield with number of pods in mutant lines of Pant L-406. The association of protein content with metheonine and grain yield was positive but non significant.

Key words : Lentil, Induced mutants, Correlation, Genetic advance

INTRODUCTION
Among the pulse crops, lentil has an old history. In India lentil is grown as winter crop all over the country either as a pure crop or as mixed crop. On the basis of seed size and cotyledon colour it has been divided as macrosperma and microsperma. This crop so far has not received sufficient attention from geneticist and plant breeders for its improvement. During its evolution, lentil has acquired a number of characteristics, but it ideotype does not suit to confer the required improved agronomic practices. Thus induced mutations can be used to ratify simple, specific undesirable traits of well adopted varieties without grossly disturbing its genetic constitution. Broad spectrum genetic variability is a prerequisite for any successful breeding programme. Besides the use of induced mutations in fundamental studies, it can be used to create additional genetic variability for qualitative and quantitative traits. Thus, the present investigation was under taken to study performance of selected mutants of lentil derived from more than one mutagenic treatment. Genetic variability in terms of mean, variances (PCV & GCV), heritability, genetic advance and character association were studied in M_4 generation.

MATERIALS AND METHODS
Healthy and dry seeds (250gm) of lentil variety K-75 (macrosperma) and Pant L-406 (microsperma) were subjected to treatments of gamma-rays (10, 15, 20, 25 & 30 kR), EMS (0.02, 0.03, 0.04 & 0.05 M) and combinations of all doses of gamma-rays with EMS (0.03 M). Treated seeds along with their control were sown (*rabi*-2001) to raise M_1 generation. The individual plant progeny were grown in M_2 generation. Morphological mutants (plant stature, maturity duration, pod types, leaf shape and size etc.) observed in M_2 generation were selected and raised M_3. The 12 mutant lines of K-75 and 9 mutant lines of Pant L-406 carried forward to raise M_4 generation. The seeds of these mutant lines were sown in Randomized Block Design with three replications along with their respective control in M_4 generation during *rabi*-2004 at Agriculture Research Farm, B.H.U. Varanasi. Observations on characters namely; plant height, days to maturity, secondary branches per plant, number of pods per plant, number of nodules per plant, 100-seed weight, grain yield per plant, protein and metheonine content were recorded on 10 randomly selected plants per mutant line. Standard statistical procedure and simple correlation coefficient were followed to estimate variability parameters. Genetic advance as per method given by Comstock and Robinson (1952) and broad sense heritability was calculated following Hanson *et al.* (1956). Protein content and metheonine content were estimated by using Micro-Kjeldahl method (Sadasivam and Manickam, 1996) and Colourimetric method (Horn *et al.*, 1946), respectively.

RESULTS AND DISCUSSION
Mean performance of various mutant lines in M_4 generation are presented in table 1&2. Mutant lines, namely, MK-5 and MP-4 were judged as dwarf among all the mutant derivatives of variety K-75 and Pant L-406, respectively. MK-5 was an early maturing mutant (10 days early compared to parent K-75) but had low mean performance for yield and yield components. This line seems to be a good source for transfer of earliness in lentil. On the other hand mutant MP-4 exhibited significantly higher (1.5 times more than control) yield per plant along with normal maturity duration. This mutant was also good performer for almost all the yield components. Number of nodules per plant and

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number of pods per plant were significantly higher than the control. However, with respect to protein and metheonine content it was at par with the control. The higher yielding mutant of variety K-75 was MK-2, which exhibited significant increase for secondary branches per plant and 100- grain weight over the control.

Analysis of variance for mutant sets of both the varieties (K-75 and Pant L-406) revealed significant differences among the lines for the characters under study (table 3 & 4). Variability parameters are presented in table 5, separately for each set of mutants. Both the sets of mutants showed a wide range of phenotypic and genotypic coefficient of variation (PCV & GCV) for the various characters. In case of mutants of K-75, highest PCV and GCV was recorded for grain yield per plant followed by number of nodules and number of pods per plant. Similar trend was also observed among the mutant lines of Pant L-406. The lowest PCV and GCV were observed for 100-

Table 1 : Mean values of some quantitative and qualitative characters in induced mutants of K-75.

Treatments	Days to maturity	Plant Height (cm)	Number of secondary branches	Pods per plant	Grain yield per plant	100-grain weight	Nodules per plant	Protein %	Methionine (mg/100g)
Control	130.33	36.58	6.75	95.23	4.13	2.75	27.38	23.80	129.42
MK1	104.67**	29.37**	6.67	47.58	1.87	2.32	19.37	22.64	135.47
MK2	127.84	35.84	7.56*	120.32	7.01**	2.97**	32.28	25.13	147.32**
MK3	129.33	30.22**	6.84	101.34	6.62**	2.92**	37.43	22.88	143.58**
MK4	135.33*	30.29**	9.29**	137.67**	6.28*	2.80	41.63	25.18	138.22*
MK5	120.33**	25.29**	5.84	64.38	2.27	2.62	24.53	25.21	133.21
MK6	122.33**	40.32**	7.82**	113.21	6.75*	3.12*	32.34	25.21	143.86**
MK7	141.33**	38.22	7.42	127.44*	5.64	2.68	52.52**	24.98	134.29
MK8	134.53	36.28	8.42**	117.24	4.78	2.57	39.29*	27.53**	146.64**
MK9	134.28	37.92	7.66*	88.24	2.84	2.79	31.67	23.31	148.26**
MK10	138.14**	29.28**	7.45	124.32*	4.84	2.48	44.84**	26.53*	127.38
MK11	121.24**	33.88**	8.22**	127.28*	3.18	2.57	56.32**	27.32**	140.34*
MK12	120.54**	37.28	8.11**	109.32	3.39	2.67	29.12	25.22	123.11
SEM(dif.) ±	2.05	1.08	0.36	13.45	0.99	0.05	4.89	0.99	4.21

*Significant at 5% level of probability **Significant at 1% level of probability

Table 2 : Mean values of some quantitative and qualitative characters in induced mutants of Pant L-406

Treatments	Days to maturity	Plant height	Number of secondary branches	Pods per plant	Grain yield per plant	100-grain weight	Nodules per plant	Protein %	Methionine (mg/100g)
Control	130.27	36.81	7.01	104.32	3.32	1.71	32.84	25.10	136.38
MP1	128.80	30.87**	7.54	135.58**	4.02	1.68	42.29	27.84**	149.21*
MP2	139.67*	29.72**	9.25**	120.39	3.61	1.79	40.59	24.89	140.10
MP3	112.58**	29.39**	5.49	60.67	2.56	1.82*	22.39	26.54*	147.62*
MP4	129.67	28.67**	9.93**	162.32**	4.92**	1.85**	51.30**	26.28	139.32
MP5	128.33	36.32	8.59**	130.42**	3.84	1.81*	46.49*	26.38*	122.54
MP6	120.54	32.54**	8.24*	126.34*	3.42	1.69	38.89	22.39	132.12
MP7	124.67	39.42**	8.13*	82.38	3.14	1.79	41.89	26.82*	124.52
MP8	132.60	35.53	8.94**	142.84**	4.22*	1.84**	40.50	25.10	134.32
MP9	140.67	33.68**	7.54	126.34**	3.28	1.54	54.64**	26.52*	141.54
SEM(dif.) ±	3.78	0.79	0.43	9.04	0.39	0.04	4.99	0.62	4.99

*Significant at 5% level of probability **Significant at 1% level of probability grain weight in both the set of mutants. Broad sense heritability ranged from 49.28% (mutants of K-75 for Methionine) to 92.96% (mutants of Pant L- 406 for plant height). Genetic advance as per cent of mean was highest for grain yield per plant (mutants of K-75) followed by number of pods and number of nodules per plant in both the sets of mutant lines. The genetic advance for protein and methionine content ranged from 5.25% (mutants of K-75 for Methionine) to 10.5% (mutants of Pant L-406 for protein). The magnitude of expected genetic advance and genetic advance as per cent of mean were at par for number of pods per plant in both the sets of mutant lines. The higher magnitude of genetic advance as per cent of mean (60.87) for grain yield was due to smaller overall mean of mutant lines, although the genetic advance as such was low. Moderate high heritability coupled with high genetic advance as well as genetic advance as per cent of mean was observed for number of pods per plant in both the sets of mutant lines. In general, the character exhibiting high heritability but low magnitude of PCV and GCV showed moderate genetic advance. However, Sinha (1991) reported moderate heritability with high genetic advance for pods per plant in urdbean. Findings regarding PCV and GCV for most of the characters are in close agreement with the earlier reports of Jain *et al.* (1995) in lentil.

Correlation study in both the sets of mutant lines (table 6) indicated that number of pods per plant had positive and significant association with number of nodules per plant.

Table 3 : Analysis of variance for some quantitative and qualitative characters in mutants of K-75

Source of variation	DF	Days to maturity	Plant height	Number of secondary branches	Pods per plant	Grain yield per plant	100-grain weight	Nodules per plant	Protein %	Methionine (mg/100g)
Replications	2	3.41	0.49	0.17	202.98	0.06	0.003	39.46	0.37	23.15
Treatments	12	248.13**	53.04**	2.37**	2060.50**	9.68**	0.073**	346.09**	9.1**	104.02**
Error	24	6.30	1.75	0.19	271.35	1.48	0.004	35.86	1.47	26.57

** Significant at 1% level of probability

Table 4 : Analysis of variance for some quantitative and qualitative characters in mutants of PL-406.

Source of variation	DF	Days to Maturity	Plant height	Number of secondary branches	Pods per plant	Grain yield per plant	100-grain weight	Nodules per plant	Protein %	Methionine (mg/100g)
Replications	2	33.77	1.76	0.56	89.21	0.90	0.001	18.91	0.42	68.20
Treatments	9	187.99**	37.93**	4.75**	15930.78**	1.39**	0.028**	247.34**	7.21**	231.10**
Error	18	21.41	0.93	0.28	122.71	0.23	0.003	37.35	0.57	37.33

** Significant at 1% level of probability

Table 5 : Estimate of genetic parameters in induced mutants of K-75 and Pant L-406 of Lentil.

Characters	PCV		GCV		Heritability (%)		Genetic Advance		Genetic advance As % of mean	
	K 75	PL 406	K 75	PL 406	K 75	PL 406	K 75	PL 406	K 75	PL 406
Days to maturity	7.22	6.84	6.69	5.81	92.74	72.17	17.81	13.04	13.80	10.18
Plant height	12.63	11.06	12.03	10.52	90.71	92.96	8.11	6.98	23.60	20.89
Secondary branches	12.71	16.52	11.31	15.13	79.14	84.00	1.56	2.30	20.73	28.57
Pods/plant	27.88	24.46	23.11	21.88	68.73	79.98	41.71	40.80	39.37	40.31
Yield/plant	45.54	21.83	36.68	17.37	64.89	63.31	2.74	1.02	60.87	28.47
100 grain weight	6.23	6.132	5.71	5.15	83.99	70.61	0.29	0.16	10.78	8.91
Nodules /plant	32.73	25.16	28.20	20.32	74.25	65.21	18.05	13.92	50.06	33.80
Protein %	7.95	6.42	5.33	5.72	63.38	79.42	2.62	2.73	10.38	10.50
Methionine (mg/100g)	5.17	7.38	3.63	5.88	49.28	63.37	7.35	13.18	5.25	9.64

Table 6 : Estimates of simple correlation coefficient among different pairs of characters in induced mutants of lentil.

Characters	Mutants of	Days to maturity	Plant height	Secondary branches	Pods/ plant	100 grain weight	Nodules /plant	Protein %	Methionine (mg/100g)
Yield/plant	K-75	0.320	0.280	0.577*	0.789**	0.436	0.389	0.170	0.129
	PL-406	0.160	-0.117	0.631*	0.473	0.272	0.685*	0.239	-0.033
Days to maturity	K-75		0.243	0.279	0.546	0.405	0.506	0.226	0.048
	PL-406		0.073	0.425	0.277	-0.447	0.345	-0.120	0.032
Plant height	K-75			0.326	0.441	0.335	0.202	0.269	0.313
	PL-406			-0.009	-0.143	-0.090	0.067	-0.063	-0.710
Secondary branches	K-75				0.623*	-0.037	0.372	0.423	0.367
	PL-406				0.391	0.245	0.473	-0.074	-0.314
Pods/plant	K-75					0.211	0.647*	0.541	0.251
	PL-406					0.347	0.636*	-0.201	-0.020
100 grain weight	K-75						0.038	-0.182	0.251
	PL-406						-0.225	0.167	-0.211
Nodules /plant	K-75							0.380	-0.002
	PL-406							0.142	-0.246
Protein %	K-75								0.208
	PL-406								0.186

*Significant at 5% level of probability **Significant at 1% level of probability

Grain yield was positively associated with number of secondary branches per plant in both the sets of mutant lines. Number of pods per plant exhibited positive and significant association with the grain yield per plant in mutants of K-75, however, this association was positive but non significant in mutant lines of Pant L-406.Sharma and Sharma (1981) reported positive association of number of branches per plant with grain yield pods per plant in gamma rays and NMU treated population of lentil. Among the yield components only secondary branches per plant showed positive and significant association with number of pods per plant (mutants of K-75). The association of protein content with metheonine and grain yield was positive but non significant in both the sets.

It is evident from the findings of the present study on the mutagenesis in lentil that yield was positively influenced by number of nodules, number of pods and secondary branches per plant. These yield components also had high variability and genetic advance. Therefore, they may be used as suitable selection criteria for improvement of lentil crop through mutagenesis.

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