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Induced genetic variability for protein content, yield and yield components in microsperma lentil *(Lens culinaris* Medik)

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Abstract : The seeds of microsperma lentil *(Lens culinaris* Medik.) variety Pant L 406 were irradiated with gamma rays (10,15, 20, 25 and 30 kR) and treated with EMS (0.02, 0.03, 0.04 and 0.05 M) and combination of EMS (0.03 M) with all doses of gamma rays. Positive and negative shift in mean values were observed for days to maturity, plant height, primary and secondary branches per plant, number of pods per plant, grain yield per plant, 100 grain weight, number of nodules per plant, nodule dry weight and protein content in M_2 and M_3 generations. The lower dose of gamma rays (10 kR) and EMS (0.02 M) treatments increased the mean values for all the characters in both M_2 and M_3 generations except for protein content in M_3 generation. Generally the higher doses of mutagen decreased the mean values for most of the characters. In case of plant height dwarfness was induced at higher doses of mutagenic treatments (single and combination doses). Significant increase in mean values for number of nodules per plant was observed at 10 kR and 20 kR of gamma rays, 0.02 M EMS and combination treatment (0.03 M +15 kR) in M3 generation. The maximum value of coefficient of variability (CV) was observed for pods per plant at 0.05 M EMS in M_2 and 0.04 M EMS in M_3 generation. In general, variability was directly proportional to the doses of mutagenic treatments.

Key words : Lentil, mutagen, genetic variability, yield, protein content.

Introduction

Lentil is one of the most important pulse crops grown in winter season of India. It is considerably rich in protein content (25%). The nitrogen requirement of this crop is substantially met through symbiotic nitrogen fixation. The amount of fixed nitrogen depends on effective nodulation. Plants having more nodules and better expression of its component have significant effect on yield and quality. In lentil limited variability exists for important economic traits. Induced polygenic variability is expected to play an important role in increasing the genetic variability. In this connection mutation breeding offers a great scope and promise to generate additional variability for yield and other economically important traits in lentil. The choice of mutagen and its dose are crucial for creating new genetic variability. In view of the above facts, the present investigation was undertaken to study the effect of different doses of gamma rays, EMS and their combinations on the magnitude of induced genetic variability in M_2 and M_3 generations.

Table 1. Mean and CV for nine characters in M_2 generation of Lentil variety Pant L - 406.

Treat-ment	Days to maturity		Plant height (cm)		Primary branches/ plant		Pods/plant		Yield/plant (g)		100 grain wt. (g)		No.of nodules/ plant		Nodule dry wt. per plant (mg)		Protein (%)	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Control	127.41	6.01	35.67	7.60	2.87	10.52	99.90	24.16	3.20	19.89	1.69	6.39	33.54	20.65	50.48	15.41	24.80	4.96
Gamma rays																		
10	137.86*	7.51	36.53	11.02	3.21*	13.29	113.09	32.40	3.89	23.84	1.85	8.87	4.42	26.18	75.36*	15.41	22.30*	9.80
15	125.37	8.06	35.37	15.04	2.59*	17.21	89.83	37.19	3.19	28.38	1.67	10.55	33.37	27.25	65.70*	27.09	24.50	15.30
20	132.36*	10.45	38.84	18.50	3.18*	17.42	103.55	39.64	3.63	31.47	1.80	12.23	40.33	27.77	88.38*	29.17	24.90	14.35
25	128.38	14.21	33.49	22.03	2.97	22.86	105.61	41.62	3.38	38.68	1.72	14.67	32.67	38.13	52.43	28.94	26.20	16.90
30	123.82	12.51	21.16*	24.92	2.35*	28.32	73.76*	45.73	2.29	43.91	1.61	15.87	25.60	34.81	39.42	33.44	26.60	15.80
EMS																		
0.02	134.64*	7.73	37.31	10.42	3.24*	13.84	116.45	28.82	3.75	28.70	1.83	9.36	36.27	27.83	70.61*	36.17	23.20	7.50
0.03	124.83	9.15	32.65	14.04	2.52*	18.02	80.34	37.71	2.42	30.94	1.64	10.07	34.39	25.75	51.43	28.48	24.40	12.30
0.04	199.38*	11.18	31.66*	18.04	2.14*	20.26	59.36*	40.41	2.14*	32.12	1.54	12.39	18.47*	32.45	27.22*	26.94	25.75	11.10
0.05	123.65*	12.57	30.83*	20.84	2.27	26.88	70.59*	49.36	1.81*	40.65	1.60	13.39	22.31*	32.82	35.19*	31.64	25.10	12.25
EMS + Gamma rays																		
0.03+10	127.65	9.34	34.83	10.90	2.79	13.81	94.34	30.21	3.01	26.68	1.69	8.75	35.32	25.33	71.56*	29.83	24.25	10.30
0.03+15	136.37*	10.66	39.64*	15.10	3.08*	15.81	109.41	34.97	3.42	29.44	1.84	11.29	40.67	27.62	76.78*	27.42	24.95	12.53
0.03+20	129.90	12.44	35.82	17.21	2.64	20.67	101.94	30.51	3.52	35.86	1.77	11.69	40.63	27.92	69.21*	27.87	24.45	11.49
0.03+25	122.17*	14.85	29.97*	21.25	2.20*	24.68	64.29*	32.38	2.02*	41.44	1.58	13.32	19.41*	35.11	31.42*	36.54	28.20*	15.22
0.03+30	120.74*	16.96	27.72*	25.27	2.05*	27.31	52.23*	45.94	1.52*	44.03	1.47*	15.82	20.70*	30.06	21.38*	35.92	26.60	14.32
SEM (dif)	1.79		1.72		0.13		10.33		0.49		0.08		4.96		7.34		1.17	
CD at 5%	3.67		3.52		0.27		21.16		1.00		0.16		10.16		15.03		2.40	

* Significant at 5%

Materials and Methods

Healthy and dry seeds (250 g) of lentil variety Pant-L 406 (microsperma) with moisture content of 12 per cent were treated with gamma rays and EMS separately and in combination. The doses of gamma rays irradiation were 10, 15, 20, 25 and 30 kR. The soaked (6 hrs. in distilled water) seeds were treated with different concentrations (0.02, 0.03, 0.04 and 0.05 M) of EMS solution prepared in phosphate buffer pH7. For combination treatment, the gamma rays irradiated seeds with various doses were treated with 0.03 M concentration of EMS. Thus, total treatments including control were fifteen *viz.,* 10 kR, 15 kR ,20 kR ,25 kR ,30 kR ,0.02M, 0.03M, 0.04M ,0.05M, 0.03M+10 kR, 0.03M+15 kR, 0.03M+20 kR , 0.03M+25 kR , 0.03M+30 kR. All the mutagen treated seeds along with control were sown at a spacing of 30 cm. (row- row) and 5cm. (plant-plant) in the field to raise M_1 generation at Agriculture Research Farm, Banaras Hindu University, Varanasi during *Rabi 2001.* The M_1 plants of each treatment were harvested individually. M_2 generation was raised as plant to row progenies in Randomized Block Design (RBD) with three replications *(Rabi* 2002). All the recommended agronomic and cultural practices were followed to maintain a good plant stand. Data were recorded on 20 randomly selected plants from each treatment for number of pods per plant, grain yield per plant, 100 grain weight, number of nodules per plant, nodules dry weight/plant and protein content. The seeds of normal looking plants (excluding macromutants) were bulked replication wise for each treatment in M_2 generation and were sown to raise M_3 generation in RBD with three replications during *Rabi* 2003. The data were recorded for the traits as similar to M_2 generation. The standard statistical procedures were followed to estimate variance, mean and coefficient of variation (C.V.). Estimation of protein content was carried out by Micro-Kjeldahl method (Sadasivam and Manickam, 1996).

Results and Discussion

The induced polygenic variability (micromutation) was estimated in terms of mean and variance of the mutagenically treated populations in M_2 and M_3 generations. Analysis of variance of all the characters revealed significant differences among the treatments under study in both M_2 and M_3 generations. It is revealed from the data of Table 3, that mutagenically induced earliness was more pronounced at higher does of EMS and combinations of 0.03M EMS with various does of gamma rays. The 10 kR and 20 kR doses of gamma rays and 0.02M concentration of EMS were most effective for increasing the mean expression of almost all the characters, except protein content in M_2 and M_3 generations. Whereas, higher doses of mutagens reduced the mean values of most of the characters (Table1 & 2). Lower doses of mutagens increased the mean values whereas higher doses were observed to reduce the mean performance (Singh *et al.,* 1985). The height of lentil mutants compared to the control variety, increased at 20 kR doses of gamma rays in M_3 and at 0.03M EMS + 15 kR of combination treatment in M_2. Induction of dwarfness was observed at higher doses of mutagens (Single and Combinations). None of the mutagenic treatments recorded a significant increase for number of pods, grain yield per plant and 100 grain weight in both the generations.

Increased mean values for number of nodules per plant were observed at 10 kR

Table 2. Mean and CV (%) for nine characters in M_3 generation of Lentil variety Pant L - 406.

Treat-ment	Days to maturity		Plant height (cm)		Primary branches/ plant		Pods/plant		Yield/plant (g)		100 grain wt. (g)		No.of nodules/ plant		Nodule dry wt. per plant (mg)		Protein (%)	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Control	130.27	5.48	36.81	6.50	2.82	9.57	107.31	20.54	3.28	18.95	1.71	5.15	34.38	18.80	53.21	13.01	25.10	5.52
Gamma rays																		
10	130.48	6.31	37.02	9.69	3.37*	10.41	118.84	26.41	4.28	22.93	1.83	8.16	47.87*	27.49	84.38*	28.26	21.42*	7.84
15	129.60	7.18	32.45	13.45	2.64	14.99	94.37	30.36	3.41	27.77	1.68	8.30	30.31	28.65	64.59*	27.43	25.67	11.66
20	136.86*	10.83	41.68*	16.04	3.02*	15.05	127.33	35.19	3.88	28.91	1.78	10.64	42.62*	28.39	69.11*	27.94	23.25	9.98
25	133.83*	9.42	37.65	19.71	2.89	21.19	110.85	37.54	3.50	37.18	1.74	12.18	31.91	32.76	59.23	30.91	25.92	12.87
30	126.49	11.40	33.67	21.76	2.39*	25.34	80.52*	43.06	2.37	41.11	1.63	13.90	22.83*	30.60	35.43*	32.27	25.20	10.47
EMS																		
0.02	136.32*	6.94	38.38	8.65	3.17*	10.42	107.30	27.10	3.98	22.53	1.80	8.11	41.61*	26.90	74.28*	27.24	23.08*	6.19
0.03	126.25*	7.68	34.21	11.01	2.54*	11.31	88.67	32.68	2.63	29.27	1.65	9.26	37.36	23.76	52.61	29.71	24.80	10.36
0.04	122.51*	9.65	28.61*	16.72	2.19*	18.04	62.34*	48.43	2.32	30.52	1.57	10.66	17.87*	28.85	31.53*	30.53	26.20	8.02
0.05	125.67*	10.97	33.70	18.66	2.45*	21.68	79.97*	43.38	1.89*	36.94	1.62	13.28	25.62	31.87	39.21	29.57	25.32	9.54
EMS + Gamma rays																		
0.03+10	130.29	8.40	33.97	10.71	2.68	11.94	97.38	37.51	3.04	24.47	1.69	7.69	34.87	26.06	67.22*	27.92	24.35	9.37
0.03+15	140.81*	8.26	38.37	11.97	3.23*	13.63	130.32	38.90	3.67	28.95	1.81	9.51	43.38*	26.18	78.34*	31.64	22.71*	10.27
0.03+20	132.41	13.84	33.97	16.39	2.77	17.53	116.10	34.64	3.63	32.92	1.76	10.56	37.13	26.44	68.64*	29.35	24.84	9.54
0.03+25	123.73*	14.45	34.67	19.38	2.33*	20.09	69.82*	30.68	1.19	36.14	1.58	12.35	22.89*	32.22	35.53*	31.82	26.86	12.61
0.03+30	123.53*	13.20	29.53*	23.47	2.11*	23.35	57.32*	40.81	1.58*	39.80	1.48*	14.61	32.32*	32.54	24.28*	33.19	25.90	11.89
SEM (dif)	1.67		2.22		0.09		11.11		0.57		0.07		3.49		4.99		1.22	
CD at 5%	3.42		4.55		0.18		21.75		1.17		0.14		7.15		10.22		2.50	

* Significant at 5%

and 20 kR doses of gamma rays and at lower concentrations of EMS as well as in combination treatments of mutagens in Mo. The increase was significant in M_3 at 10 kR and 20 kR doses of gamma rays, 0.02M EMS and 0.03M EMS + 15 kR gamma rays treatments. These findings are in accordance with the findings of Lee *et al.* (1996) in soybean. The significant increase in nodule dry weight per plant was observed at lower doses of mutagenic treatment in both M_2 and M_3 generations in comparison to control. The higher doses of mutagenic treatments significantly reduced the nodule dry weight in both the generations. The coefficient of variation (C.V.) for most of the characters was higher in treated populations compared to the control. The maximum magnitude of C.V. was recorded for pods per plant at 0.05M EMS in M_2 and 0.04M EMS in M_3 generations. The minimum C.V. was recorded for days to maturity (10 kR-gamma rays) and protein content (0.02M EMS) in M_2. This indicates that the lower doses of gamma ray and EMS were ineffective for creation of desired variabilities for days to maturity and protein content. For most of the characters increased variability was associated with the increase in the dose of mutagenic treatments. In general, the magnitude of variation was higher in M_2 than in M_3 generation and this indicated that selection for desirable types for most of the characters would be more effective in M_2 generation. The increased C.V. in M_2 compared to the control for all the characters suggested that a large part of variability would be genetic in origin as the variability due to environmental factors being common to both treated and control populations. Reduction of variation in M_3 was as per expected results of selfing towards the attainment of homozygosity. Further, the bulking of normal looking plants in each treatment separately avoided the chance inclusion of deleterious genes and increased the probabilities of advancing alike genotypes which exhibited less variation within the treatments. Decline in polygenic variability in M_3 as compared to M_2 generation had also been reported by Kharkwal (2001) in chickpea. Based on the present study on mutagenesis it is observed that the gamma rays, EMS and combinations treatments were effective in the creation of polygenic variability which could be exploited for the improvement of lentil with respect to various characters.

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