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INDUCTION OF VARIABILITY IN QUANTITATIVE CHARACTERS OF RICE THROUGH MUTAGENIC TREATMENTS*

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The possibility offered by mutagenic agents to induce genetic variation is of extreme importance Information on the type and dose of mutagens which will effectively induce micro-mutations in economic characters has great significance in crop breeding. Induced mutagenesis has been extensively studied in rice and several radiations and chemicals are reported to be highly effective. But a critical assessment of the efficiency of these mutagens in inducing micro-mutations has not been made. In the present investigation a comparative evaluation of the mutagenic efficiency of gamma rays and ethyl methane sulphonate (EMS) in inducing micro-mutations in 5 quantitative characters of rice is therefore attempted.

Materials and Methods

The study of induced variation for quantitative characters was made in the M2, M3 and M4 generations following treatment of seeds of the rice variety, Gc.29 with gamma rays at doses 10. 20 and 30 krad and EMS at doses 38, 77 and 115 mM.. The characters studied were duration, height of plants, number of ears per plant, length of ear and number of spikelets per panicle. Gamma irradiation was done using the 2000 Gi ^{60}Co gamma cell installed at the IARI at a dose rate of 2500 rad per minute. Treatment with EMS was given bv soaking seeds in aqueous solution for 8 hours at room temperature. Seeds were presoaked for 16 hours in water. The Ml generation was grown as single plants.

The M2 generation was raised as Ml ear progeny rows. 50 progenies which did not segregate for macro-mutations were selected at flowering time in each of the six doses and from the control population. 10 plants in each progeny were selected at random and labelled. Observations regarding the first three characters were made on these labelled plants and regarding the remaining two characters on their main panicles. Seeds from all the 10 plants in each progeny were bulked and M3 progeny rows raised therefrom. Each progeny was grown in 3 replications with

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3 rows of 10 single plants in each replication. Observations were made on 8 plants in the middle of the central row. Seeds from all selected plants in each progeny were bulked to raise the M4 generation.

Results and Discussion

Induction of mutations in polygenes governing quantitative characters can be inferred by the estimation of mean and variance in successive generations of mutagen treated populations. The mean and variance in respect of the 5 quantitative characters in the M2 M3 and M4 generations were estimated by combining the data on all the progenies in each dose and presented in the table.

Neither gamma rays nor EMS at the dose levels employed change the means of populations with respect to characters such as duration, height of plants, length of ear and number of spikelets. Previous investigators have reported that the mean values of various quantitative characters in rice were not significantly altered by treatment with radiations and chemical mutagens (Oka *et al.*, 1958; Yamaguchi, 1964; Sharma and Saini, 1970). The mean number of ears per plant was higher in the M2 but not in later generations.

Variability for all characters was enhanced following the treatment. Increase in variance following mutagenic treatments was reported by Oka *et. al* (1958), Yamaguchi (1964) and Sharma and Saini (1970). This was explained to be due to the induction of micro-mutations i.e. mutations of polygenes governing the quantitative characters. Variance increased with increase in dose of mutagens. This increase was progressive but not linear Genetic variability was reported to increase in barley with increase in doses of gamma rays (Gupta, 1970) and in *Arabidopsis* with increase in concentrations of EMS (Bhatia and Van Der Veen, 1965). Yamaguchi (1964) reported that the relationship between dose and variance in rice was not linear.

The magnitude of induced variability was greater with gamma rays than with EMS. At the dose levels employed, gamma rays and EMS induced similar degrees of M_1 damage such as reduction in survival and seedling height, thereby indicating that gamma rays are more efficient than EMS in inducing micro-mutations in rice. Matsuo and Onozawa (1961) reported that the increase in variance was more in treatments with radiations than with di-epoxy-butane.

The magnitude of variability was the highest for height of plants The other characters which could be arranged in the order of decreasing variance were the length of ear, number of ears, duration and number of spikelets. Oka *et. al.* (1958) reported that for a constant dose of radiation

Table

Mean and variance for the quantitative characters in the M_2, M_3, and M4 generations

Mutagen and dose	M_2 - generation				M_3 - generation				M_4 - generation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
I. Duration - Days												
Control	88	100	3.4	100	94	100	10.3	100	88	100	8.5	100
Gamma rays												
10 krad	88	100	3.4	100	94	100	11.0	107	88	100	12.7	149
20 ,,	89	101	3.6	106	94	100	14 0	136	88	100	12.4	146
30 „	89	101	4.5	132	93	99	13 5	131	88	100	11.7	138
EMS - 38 mM	89	101	3.6	106	93	99	10.4	101	88	100	10.8	127
77 ,,	89	101	3.5	103	92	98	10.9	106	87	99	9.5	112
115 „	90	102	39	115	93	99	11.7	114	88	100	11.2	132
II. Height of plants - cm												
Control	113	100	37.4	100	99	100	35.0	100	100	100	40.6	100
Gamma rays												
10 krad	113	100	37.9	101	98	99	47.2	135	99	99	46.9	115
20 ,,	112	99	56.8	152	98	99	55.1	157	98	98	43.9	108
30 „	108	95	78.3	209	97	98	72.8	208	97	97	56.6	139
EMS - 38 mM	112	99	38.3	102	99	100	35.3	101	100	100	43.7	108
77 „	112	99	40.1	107	100	101	36.4	104	100	100	47.3	116
115	114	101	45.4	121	100	101	44.8	128	101	101	48.0	118

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
III. No. ot ears per plant												
Control	5,8	100	4,1	100	5.2	100	2.8	100	5.3	100	2.6	100
Gamma rays												
10 krad	5.8	100	4.2	102	5.2	100	3 1	111	5.2	98	3.0	115
20 ,,	6.7	115	6.1	149	5.4	101	3.6	129	5.1	96	2.9	112
30 ,,	6.4	110	6.4	156	5.4	104	3.4	121	53	100	3.1	119
EMS- 38 mM	6.1	105	4.1	100	5.5	105	3.3	118	5.4	102	2.7	104
77 ,,	6.3	109	4.4	107	5.4	104	3.1	111	5.2	98	2.6	100
115 ,,	6.2	107	4.6	115	5.7	109	3.5	125	5.3	100	2.7	104
IV. Length of ear – mm												
Control	209	100	208	100	196	100	268	100	201	100	229	100
Gamma rays												
10 krad	208	100	298	143	193	98	276	103	198	99	270	118
20 ,,	214	102	272	131	194	99	308	115	202	100	262	114
30 ,,	210	100	368	177	193	98	332	124	199	99	296	129
EMS- 38 mM	209	100	192	92	1%	100	267	1GO	201	100	248	108
77 ,,	210	100	255	122	196	100	260	97	201	100	258	112
115 ,,	210	100	281	135	195	100	302	113	200	100	233	102
V. No. of spikelets per panicle												
Control	95	100	99	100	78	100	54	100	83	100	53	100
Gammarays												
10 krad	99	104	97	98	76	97	55	102	82	99	54	102
20 ,,	96	101	104	105	76	97	52	96	84	101	58	109
30 ,,	99	104	124	125	77	99	67	124	83	100	60	113
EMS- 38 mM	97	102	99	100	76	97	53	98	84	101	60	113
77 ,,	93	98	112	113	76	97	50	93	85	102	60	113
115	96	101	103	104	77	99	51	94	83	100	55	104

the induced genetic variance was more for height of plants than for heading date. Gonzalez and Frey (1965) concluded that the magnitude of induced genetic variability was influenced by the character and the genotype treated. According to Gaul <1961), the larger the number of gene; involved in a character, the higher is the probability of obtaining an alteration by mutation of one of the multiple genes concerned.

Maximum variability was recorded for the number of ears, length of ear and number of spikelets in the M2 generation, for height of plants in the M3 generation and for duration in tha M4 generation. Differences in the expression of variability in different generations for the same character have been reported by Borojevic and Borojevic (1968) in wheat. Efficient use of induced variability in breeding through selection would be possible when the generation in which maximum variability is likely to be released is known.

The increase in variance was symmetrical for all characters except the number of ears per plant. This symmetrical increase of variability without significant alteration in the mean values might be due to the incidence of mutations with positive and negative effects in equal frequencies as inferred by Oka *et. al.* (1958 , Matsuo and Onozawa (1961), Yamaguchi *(1964)* and Sharma and Saini (1970)

Summary

Studies were undertaken to explore the possibility of inducing micro-mutations in 5 quantitative characters of rice by mutagenic treatments. Seeds of the rice variety, Co.29 were treated with gamm rays and EMS each at 3 dose levels. Induced variation was studied in the M2 , M3 and M4 generations.

Neither gamma rays nor EMS induced alterations in the means of populations in respect of characters such as duration, height of plants, length of ear and number of spikelets. Variability increased considerably in treatments with gamma rays and EMS This could be due to mutations of polygenes governing the quantitative characters. The magnitude of variability was greater following treatment with gamma rays than with EMS, Gamma rays were therefore more efficient in inducing micro-mutations than EMS.

Increase in variability was symmetrical for all characters except the number of ears per plant. This symmetrical increase without alteration of the mean indicated that micro-mutations with positive and negative effects occurred with equal frequencies.

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