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Variability studies in rice (*Oryza sativa* L.) using induced mutation

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Abstract
Rice (*Oryza sativa* L. 2n=24) is the most important cereal crop cultivated widely in many parts of the world. Creation of genetic variability is the basic step in any crop improvement programme. Mutation breeding has been a controversial issue for many years. In recent times, many successful results have been reported and a number of mutants have been released as cultivars. The material consisted of rice variety PY-5 whose M_2 generation was studied with four sets of well dried 200 seeds were selected for treating with ethyl methane sulfonate. The concentrations of the mutagens used for four sets were 0.2, 0.4, 0.6 and 0.8 percent. In M_2 generation, the bulked seeds of M_1 were sown treatment wise along with control (non-treated). In M_2 generation, observations we taken for six important yield component characters *viz*., plant height, number of productive tillers per plant, length of the primary panicle, length of boot leaf, 100 grain weight and grain yield per plant. Statistical parameters like mean, variance, co-efficient of variation(CV), heritability and genetic advance as percent of mean were computed for all traits studied adopting the standard statistical method. In the current investigation, mean for different traits shifted both in the positive and negative directions due to mutagenic treatments. The mean value recorded the positive shift for characters such as length of boot leaf, number of productive tillers per plant, panicle length and grain yield per plant in M_2 generation. Both positive and negative shift was found in plant height and 100 grain weight. In the present investigation, significant variation has been observed in the mutant populations for the traits, number of productive tillers per plant, panicle length and grain yield per plant. Mutants having significantly high number of productive tillers, panicle length and grain yield per plant were selected from the plants treated with 0.8 percent.

Keywords: Rice, Mutation, M_2 Generation. Crop improvement, Mutation breeding

Introduction
Rice (*Oryza sativa* L. 2n=24) is the most important cereal crop cultivated widely in many parts of the world. Mutation breeding has been a controversial issue for many years. In recent times, many successful results have been reported and a number of mutants have been released as cultivars. Creation of genetic variability is the basic step in any crop improvement programme. Hence, the present study was undertaken to estimate the extent of genetic variability in the mutant population of rice created through the treatment of EMS at different concentrations for certain economic characters.

Materials and Methods
The present investigation was carried out at the plant breeding farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, during 2014-2015. The material consisted of rice variety PY-5 whose M_2 generation was studied with four treatments namely 0.2, 0.4, 0.6 and 0.8 concentration. Based on LD_{50} value four concentrations of ethyl methane sulfonate were used for treatments. Well dried 200 seeds were selected for treating with ethyl methane sulfonate. Seeds pre soaked in distilled water for few hours. The seeds were treated with 25 ºC under controlled conditions with freshly prepared aqueous EMS solutions for 12 hours with intermittent shaking. In M_2 generation, the bulked seeds of M_1 were sown treatment wise along with control (non-treated) during November 2014 to February 2015. Thirty days old seedling were transplanted at the rate of one seedling per hill by adopting an uniform spacing of 20 cm between rows and 15 cm between plants in randomized block design with three replications. Recommended cultural practices and plant protection measures were followed.

In M_2 generation, observations are taken for six important yield component characters *viz*., plant height, number of productive tillers per plant, length of the primary panicle, length of boot leaf, 100 grain weight and grain yield per plant. Statistical parameters like mean, variance, co-efficient of variation (CV), heritability and genetic advance as per cent of mean were computed for all traits studied adopting the standard statistical method (Panse and Sukhatme, 1961) [4].

Results and Discussion

In M_2 generation, there was a considerable decrease in plant height the maximum reduction of plant height was at 0.8 percent (15.69 per cent). The maximum increase was found in at 0.4 percent (21.15 per cent) in number of productive tillers. Chikkalingaiah Shridhara *et al.*, (1999) [1] and Michad Gomez *et al*., (2001) [3] also reported similar. The maximum increase in lenth of boot leaf was recorded at 0.4 percent (31.69 per cent). The panicle length recorded considerable increase in all the treatments among treatments, 0.2 percent is more increase (9.84 per cent). The 100 grain weight showed a slight increase at 0.6 percent treatment (9.7 per cent). The maximum grain yield per plant was observed at 0.2 percent (25.20 per cent) (table 1). Kalaimani and Sakila (1999) [2] and Singh and Sanjeev Singh (2001) [6] also reported increased grain yield per plant in mutant populations. From that results, 0.4 percent showed the maximum mean values for most of the economic characters.

In the present study, mean for different characters shifted both in the positive and negative directions due to mutagenic treatments. The mean value recorded the positive shift for characters such as length of boot leaf, number of productive tillers per plant, panicle length and grain yield in M_2 generation. Both positive and negative shift was found in plant height and 100 grain weight (Table 1). The results also revealed that more number of semi-dwarf plants were observed at 0.8 percent in the M_2 generation. Among the four treatments, the maximum number of productive tillers per plant was observed at 0.4 percent.

The results also revealed that the moderate GCV and PCV were 11.43 per cent and 15.47 per cent respectively at 0.2 percent, Unnikrishnan (1980) [11] found moderate to low phenotypic and genotypic co-efficient of variation for plant height. Moderate heritability (54.59%) and high genetic advance was 22.29 per cent at 0.2 percent where recorded for plant height. Number of productive tillers at 0.8 percent showed high GCV (56.55 per cent) and PCV (70.68 per cent) at 0.2 percent, heritability was moderate in all treatments without 0.8 percent, the genetic advance was high at 0.2 percent (93.72%).

Moderate GCV and high PCV values of 14.31 per cent and 24.47 per cent respectively were found in 0.6 percent, 0.4 percent showed the highest heritability (84.45 per cent), high genetic advance was observed in treatment 0.4 percent (32.31 %) for boot leaf length. For panicle length, the low GCV and moderate PCV values were recorded in 0.4 percent (7.93 per cent and 14.75 per cent) moderate to high heritability was found in all treatments except 0.4 percent. Paramasivan (1995) [8] observed moderate heritability. All the treatments showed moderate genetic advance. For 100 gram weight, the treatment 0.8 percent observed moderate GCV and high PCV values (18.38 per cent and 21.93 per cent), high heritability was recorded at 0.8 percent (70.29 per cent) and high genetic advance was observed at 0.8 percent (40.69 per cent). Amirthalingam (1998) [9] and Rao *et al.*, (1999) [10] reported high rate of heritability and genetic advance. For grain yield, the high values of GCV and PCV were observed at 0.8 percent (46.71 per cent and 73.52 per cent), all the treatments expressed moderate heritability values its also by Mishra (1999) [7] and the high genetic advance was registered in 0.2 percent and 0.8 percent treatments Michael Gomez *et al.*, (2001) [3] also reported high genetic advance (Table 2).

In the present investigation, significant variation has been observed in the mutant populations for the traits, number of productive tillers per plant, panicle length and grain yield per plant. It is possible to identify mutant for different characters, which can be useful in future breeding programme. Mutants having significantly high number of productive tillers, panicle length and grain yield per plant were selected from the plants treated with 0.8 percent. In the present study, high PCV and GCV were reported for plant height, and number of productive tillers per plant at 0.2 percent. For 100 grain weight and grain yield per plant high GCV and PCV productive tillers was obtained at 0.8 percent. High GCV and PCV were also observed for boot leaf length at 0.6 percent. For panicle length high values of PCV and GCV was obtained at 0.4 percent in M_2 generation.

High heritability coupled with high genetic advance was recorded for plant height, number of productive tillers per plant and grain yield per plant at 0.2 percent. In length of boot leaf was high at 0.6 percent and 100 grain weight was high at 0.8 percent. Score card revealed that 0.4 percent induced more positive effect on yield component characters followed by 0.2 percent. Interestingly, in the present study the mutagenic effect was significant in the positive direction in boot leaf length and grain yield per plant (Table 3).

Among the treatments, the maximum mean yield was seen in 0.2 percent treatment (25.20per cent) increase. A significant increase in boot leaf length was observed in all the four treatments in M_2 generations, maximum increase of 31.69 per cent over control was observed at 0.4 percent. There was a progressive increase in number of productive tillers per plant in 0.4, 0.6 and 0.8 percent treatments respectively. There was positive and negative shift in the 100 grain weight in 0.4, 0.6 and 0.8 percent and 0.2 percent respectively. Maximum PCV and GCV values were observed for grain yield per plant at 0.8 percent followed by 0.2 percent. High heritability coupled with high genetic advance was recorded at 0.2 percent for grain yield per plant. Thus it is concluded from the score card, in M_2 generation that 0.4 percent induced more positive effect on yield component characters followed by 0.8 percent and 0.6 percent.

Table 1: Mean Performance of Yield and its Component Characters in M_2 Generation of Rice

Characters	Plant height (cm)		Number of roductive tillers		Boot leaf length (cm)		Panicle length (cm)		100 grain weight (g)		Grain yield (g)	
Treatments	Mean	Per cent decrease/ increase over control	Mean	Per cent decrease/ increase over control	Mean	Per cent decrease/ increase over control	Mean	Per cent decrease/ increase over control	Mean	Per cent decrease/ increase over control	Mean	Per cent decrease/ increase over control
0.2 percent	101.2	-1.68	18.11	-1.74	32.40	25.83	25.48	2.28	2.22	-2.2	18.78	25.20
0.4 percent	120.6	17.17	21.15	14.76	33.91	31.91	22.36	-0.84	2.39	5.3	17.80	18.67
0.6 percent	107.3	4.25	18.45	0.11	31.02	20.47	23.82	0.62	2.49	9.7	15.41	2.73
0.8 percent	84.30	-15.69	18.50	0.38	29.22	15.03	23.22	0.02	2.32	-2.2	15.64	4.27
Control	102.9	-	18.43	-	25.75	-	23.20	-	2.27	-	15.00	-

Table 2: Variability, Heritability and Genetic Advance for Yield and its Component Characters in M_2 generation of Rice

Concentration	0.2 %	0.4%	0.6%	0.8 %	0.2 %	0.4%	0.6%	0.8 %
	Plant height				Number of productive tillers			
PCV (%)	15.47	15.01	7.90	3.06	70.38	40.51	19.44	21.49
GCV (%)	11.43	9.42	4.42	4.92	49.98	25.60	16.74	56.55
H_2 (%)	54.49	39.45	21.05	38.63	50.44	39.94	32.00	24.43
GA as percent of mean (%)	22.29	12.20	10.22	5.01	93.72	42.71	14.81	16.81
	Boot leaf length				Panicle length			
PCV (%)	18.07	14.49	24.47	17.81	9.15	14.75	3.22	8.76
GCV (%)	6.40	13.32	14.31	10.76	6.12	7.93	6.87	6.25
H_2 (%)	12.57	84.45	34.19	39.22	44.83	28.93	81.99	50.79
GA as percent of mean (%)	8.03	32.31	17.23	17.80	10.82	11.27	16.43	11.75
	100 Grain weight				Grain yield per plant			
PCV (%)	13.74	10.66	12.76	21.93	59.07	40.16	33.69	73.52
GCV (%)	7.42	6.01	8.17	18.38	40.73	27.32	22.99	46.71
H_2 (%)	29.24	31.80	40.99	70.29	47.54	46.29	46.57	40.37
GA as percent of mean (%)	8.27	6.98	13.81	40.61	74.13	49.07	41.42	61.12

Table 3: Score card for Effectiveness of EMS treatment for Yield and its Component Characters in M_2 generation of Rice

Characters / Treatments		Plant height	No of productive tillers	Boot leaf length	Panicle length	100 grain weight	Grain weight	Overall score	
								-	+
0.2 percent		-	-	+	+	+	+	3	3
0.4 percent		+	+	+	+	+	+	0	6
0.6 percent		+	+	+	-	+	+	1	5
0.8 percent		-	+	+	+	-	+	2	4
Score	-	2	1	0	1	2	0	6 6	18
	+	2	3	4	3	2	4	18	

* in plant height(-) Negative is favorable to crop improvement.

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