Cluster Analysis of Rice (*Oryza sativa* L.) Mutant Lines of Using Morphological Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

In recent decades, a large number of crop types have been developed using mutation breeding. In present investigation, gamma irradiated indica rice cultivar Rajendra Mahsuri 1 were morphologically analysed for identify candidate mutants. M3 mutant lines were screened using eleven morphological characteristics. Morphological investigations revealed that gamma irradiation created enough variability for selection of specific traits. We have observed huge variation in maturity (105 and 135 days) and plant height (45 to 160 cm) in M3 mutant lines. The results of morphological analysis showed a great deal of potential for identifying beneficial mutations caused due to gamma irradiation.

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1. INTRODUCTION

"One third of the world's population relies on the grain known as rice (*Oryza sativa* L.), which is a member of the Graminae family. Around 20% of all calories consumed globally come from rice, which is the second greatest source of calories in the human diet after wheat. It is a crucial food source for Asia and gives more than two billion people between 60 and 70 percent of their daily energy needs" (FAO, 2021). "Since the 1960s, numerous collections of mutant lines from various species have been discovered and employed productively in a variety of plant biology and agricultural breeding applications" [1,2]. "Among them more than 2700 mutant varieties that have been made public around the world, 64% were produced by exposure to gamma rays, 22% by radiation to x-rays, and the remaining 3% by other mutagenic processes" [3], Shu and Lagoda, 2007. "Despite the fact that gamma rays are physical mutagens, gamma irradiation has shown to be an effective way to introduce novel trait variations that may benefit crops and can be utilised as an additional tool in plant breeding" [4]. Research tools for genetic and physiological evaluations of rice yield-limiting variables have included induced rice mutants. Mutants have made it feasible to pinpoint essential components for creating varieties with high yielding potential and desirable characteristics including semi-dwarfism, early maturation, more panicles per plant, and higher fertility. 440 mutant rice types had been created by the year 2003. These were divided into 264 that were formed with the use of mutagens directly and 176 that were produced through mating with induced mutants [5]. "In the past, mutants were recognised based on their morphological characteristics. Breeders consequently frequently use criteria for selecting germplasm that emphasise the significance of genetic variety" [6,7], Agrama et al., 2009.

2. MATERIALS AND METHODS

2.1 Plant Material and Mutagenic Treatment

Rice seeds (*Oryza sativa* L.) were exposed to dose of γ radiation of 450 Gy at 13% moisture using a Co60 source at the Department of Bhaba Atomic Nuclear Research Institute, Mumbai. The duration of the gamma irradiation treatment was between 0.5 and 2 hours, depending on the γray dose. The radiated seeds were grown through to the M1, M2 and M3 generations during 2014, 2015 and 2016.

2.2 Morphological Study

"Treated seeds, were planted in a seed nursery and then transferred to a paddy field after 28 days. The morphological characteristics of the M3 generation plants were measured and recorded; the specific traits measured were the plants' heights (cm), Total number tiller per plant, Spikelet fertility, number of grain per panicle, yield per plant number of fertile tillers, percentage of sterile panicles, panicle length (cm), number of spikelets per panicle, 1000 grain weight (gr), yield per plant (gr), stem color and the condition of the seed awn" [8].

2.3 Data Analysis

"Variation in the morphological traits of the M3 population was analyzed using a randomized complete block design (RCBD) with three replicates and mean separation by the least significant difference (LSD) method" [9]. Results obtained by Analysis clustering using the NTSyPc ver.17 software package [10].

3. RESULTS AND DISCUSSION

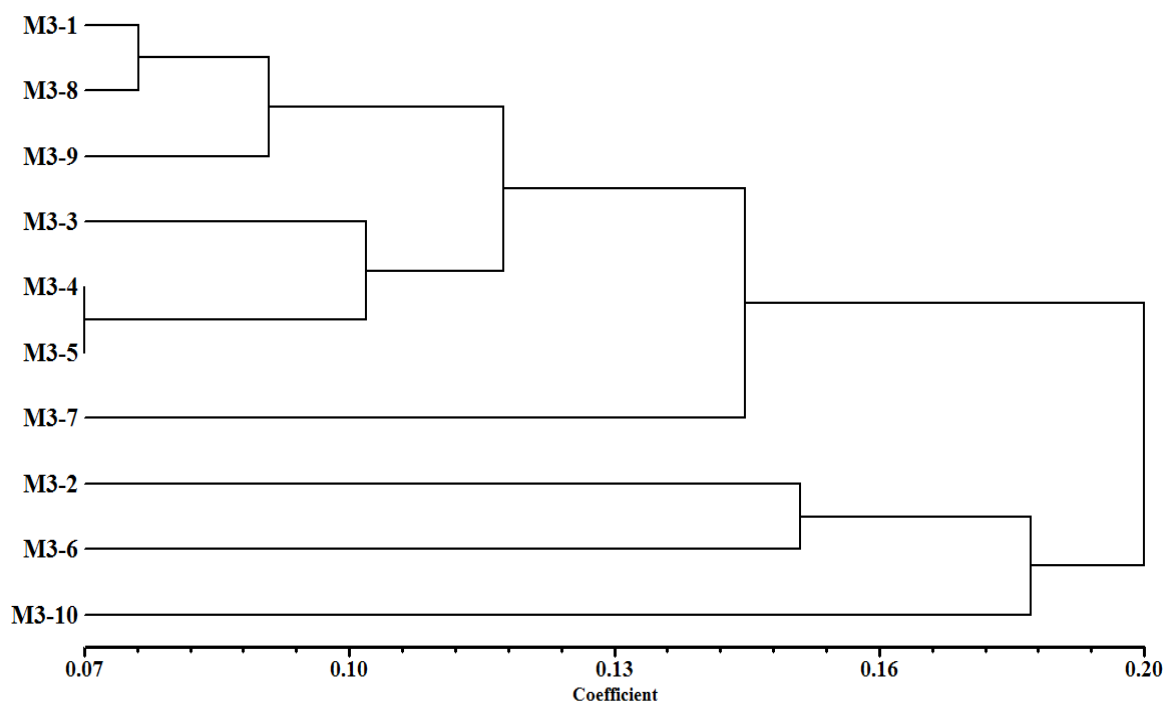### 3.1 Morphological Analysis

"Cluster analysis of the M3 cultivar indicated significant differences in plant height between the different γray doses relative to the control. A similar result was obtained for the proportion of unfilled seeds in the panicle and the yield per plant at the and also for total number of tillers, 1000-grain weight and the number of fertile tillers. No significant differences were found in the panicle length or the number of filled seeds per panicle between any of the gamma doses" [11,1,12].

3.2 Divergence Analysis

"The divergence study revealed significant differences among genotypes for eleven characters indicating presence of an acceptable amount of genetic variability. Assessment of clusters revealed that clusters were heterogeneous within themselves and between

each other based on major character relations. The results cleared that the inter cluster distance in most treatments were larger than intra cluster distance suggesting wider diversity among the mutant of different groups" [12,13,5]. These genotypes were grouped into five clusters, displaying cluster V with maximum number of genotypes (6 genotypes) accounting for 60.00 per cent of total genotypes followed by cluster I,

II, III and IV (1genotypes) offering 10 per cent of total genotypes monogenic as given in Fig. 1. The inter cluster distances were more than intra cluster distance stating wide genetic diversity among rice genotypes. The highest intra-cluster distance among genotypes from these clusters could be exploited as parental mutant lines in rice breeding programmes owing to their mean performance within their group [14].

Fig. 1. Cluster analysis of 10 M3 Mutant line genotypes based on 11 morphological traits

Table 1. Estimates of eleven morphological parameters based similarity coefficients among ten mutant lines rice used in the present study

	M3-1	M3-2	M3-3	M3-4	M3-5	M3-6	M3-7	M3-8	M3-9
M3-2	0.15								
M3-3	0.11	0.13							
M3-4	0.11	0.17	0.09						
M3-5	0.11	0.17	0.12	0.07					
M3-6	0.28	0.16	0.22	0.26	0.24				
M3-7	0.6	0.19	0.19	0.13	0.11	0.27			
M3-8	0.08	0.14	0.11	0.13	0.10	0.24	0.17		
M3-9	0.11	0.14	0.16	0.15	0.11	0.23	0.14	0.08	
M3-10	0.21	0.17	0.23	0.22	0.17	0.19	0.18	0.17	0.11

4. CONCLUSION

The present study utilized the potential of gamma irradiation in creating variability followed by identification of candidate mutants in an indica rice variety Rajendra Mahsuru 1. PCA and cluster analysis complemented each other with some slight inconsistencies in terms of cluster composition. It could be concluded that mutation has created sufficient variability in Rajendra Mahsuri 1, which was used to identify candidate mutants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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