

CLUSTER ANALYSIS OF RICE (*Oryza sativa* L.) MUTANT LINES OF USING MORPHOLOGICAL PARAMETERS

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.

Key word: RICE, *Oryza sativa* L., Mutant Lines , Morphological Parameters

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” (Domingo et al., 2007; Fu et al., 2008). “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” (Ahloowalia et al., 2004; Shu and Lagoda, 2007). “Despite the fact that gamma (γ) 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” (Babaei et al., 2010). 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 (Shehata et al., 2009). “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” (Agrama and Eizenga 2008; Kiula et al., 2008; Agrama et al., 2009).

Materials and methods

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 γ ray dose. The radiated seeds were grown through to the M1, M2 and M3 generations during 2014, 2015 and 2016.

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”. (Babaei et. Al., 2011)

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” (Yazdi Samadi et al., 2008). Results obtained by Analysis clustering using the NTSyPc ver.17 software package.

Results and Discussion

Morphological analysis

“Cluster analysis of the M3 cultivar indicated significant differences in plant height between the different γ ray 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”. (Cheema and Atta, 2003; Domingo et al., 2007; Shereen et al., 2009)

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” (Shereen et al., 2009; Babaei 2010; Shehata et al. 2009). 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 Figure 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 (Luzi-Kihupi et al. 2009).

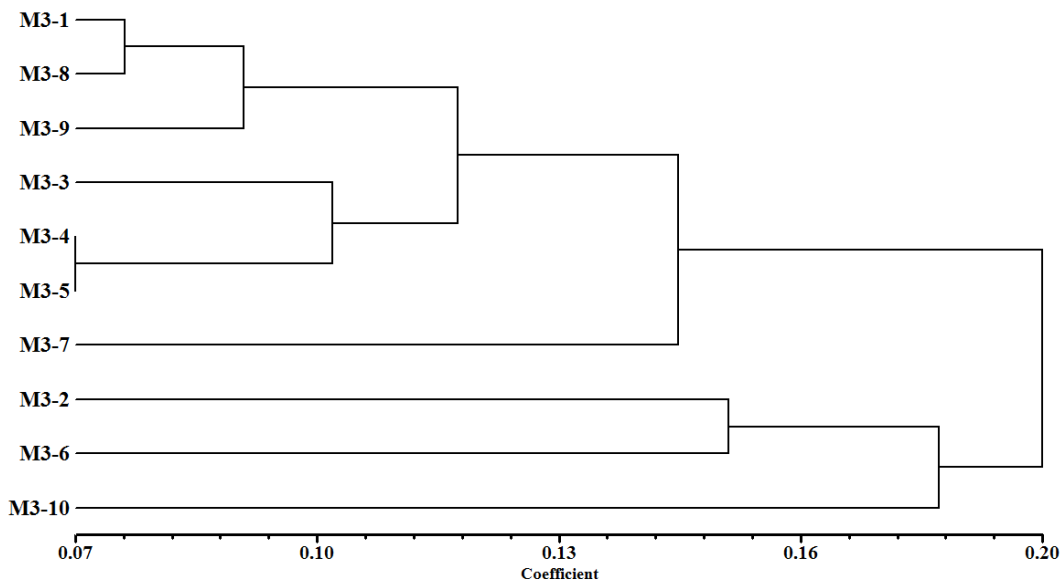


Figure 1. Cluster analysis of 10 M3 Mutant line genotypes based on 11 morphological traits

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

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 Mahsuri 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.

Reference

- Agrama HA, Eizenga GC (2008) Molecular diversity and genome-wide linkage disequilibrium patterns in a worldwide collection of *Oryza sativa* and its wild relatives. *Euphytica* 160: 339-355
- Ahloowalia, BS, Maluszynski M, Nichterlein K (2004) Global impact of mutation-derived varieties. *Euphytica* 135: 187-204
- Babaei A (2010) Genetic diversity analysis of Nemat rice mutant (*Oryza sativa* L.) via RAPD marker. *Am-Euras J Agric & Environ Sci* 8(4): 452-456.
- Babaei A, Nematzadeh GA, Avagyan V, Hashemi H (2010) Radio sensitivity studies of morpho-physiological characteristics in some Iranian rice varieties (*Oryza sativa* L.) in M1 generation. *Afr J Agric Res* 5(16): 2124-2130.
- Cheema A, Atta B (2003) Radio sensitivity studies in basmati rice. *Pak J Bot* 35 (2): 197-207.
- Domingo C, Andrés F, Talón M (2007) Rice cv. Bahia mutagenized population: a new resource for rice breeding in the Mediterranean basin. *Span J Agric Res* 5(3): 341347.

- Fu HW, Li YF, Shu QY (2008) A revisit of mutation induction by gamma rays in rice: implications of microsatellite markers for quality control. *Mol Breeding J* 22(2): 281-288
- Kiula BA, Lyimo NG, Botha AM (2008) Association between AFLP-based genetic distance and hybrid performance in tropical maize. *Plant Breeding J* 127: 140144
- Luzi-Kihupi A, Zakayo JA, Tusekelege H, Mkuya M, Kibanda N, Khatib KJ, Maerere A (2009) Mutation breeding for rice improvement in Tanzania. FAO, Rome Book.
- Rohlf FJ (1998) NTSYSpc: Numerical taxonomy and multivariate analysis system, Version 2.02. Exeter Software, NY, USA.
- Shehata SM, Ammar MH, Abdelkalik AF, Zayed BA (2009) Morphological, molecular and biochemical evaluation of Egyptian jasmine rice variety and its M5 derived mutants. *Afr J Biotechnol* 8(22): 6110-6116.
- Shereen A, Ansari R, Mumtaz S, Bughio HR, Mujtaba SM, Shirazi MU, Khan MA (2009) Impact of gamma irradiation induced changes on growth and physiological responses of rice under saline conditions. *Pak J Bot* 41(5): 2487-2495.
- Yazdi Samadi B, Rezaei A, Valyzadeh M (2008) Statistical designs in agricultural research, University of Tehran Press
- Babaei A, Nematzadeh GA, Hashemi H. An evaluation of genetic differentiation in rice mutants using semi-random markers and morphological characteristics. *Australian Journal of Crop Science*. 2011 Jan 1;5(13):1715-22.