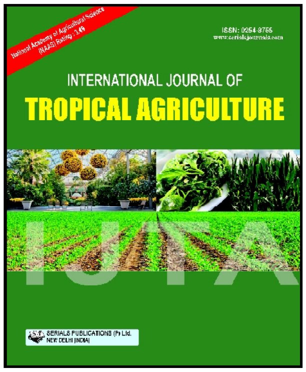

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Improvement in Yield and Yield Attributes Produced through Different Doses of Gamma Irradiation in Paddy Variety Pawana

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Abstract: In order to induce mutation in Pawana variety of Paddy the seeds were irradiated with 20, 25, 30 and 35 kR doses of gamma rays. Treated seeds were sown along with control to study the induced variation and improvement in yield and yield contributing traits in M_2 and M_3 generations. The results revealed significant differences among the treatments. All the four doses were quite effective in inducing genetic variability. The mean performance showed improvement in most of mutagenic treatments in M_3 as compared to the corresponding treatments in M_2 generation over untreated check. The most beneficial dose was 30kR. The impact of this dose was promising in days to 50% flowering, plant height, number of tillers plant^{-1}, length of panicle and yield plant^{-1}. However, high reduction in the mean value for all the characters were obtained in response to higher dose of gamma rays (35kR). It was concluded from this study that there was significant genetic variability induced through all the four mutagenic treatments. Significant enhancement in yield and yield contributing traits were observed at 30kR followed by 25 and 20kR. Under the influence of higher dose of gamma rays (35kR) significant reduction were observed in yield and yield attributes. It indicates that inducing genetic variability and improvement in quantitative traits would be possible through gamma rays.

Key words: Irradiation, improvement, paddy, variety pawana

INTRODUCTION

Mutation is a major source of genetic variation and may be used for gene functional analysis. Changes in the gene status of rice plant can be driven in a random manner by disruption via physical such as fast neutron, gamma rays, ion beam (Bruce *et al.* 2009 and Wu *et al* 2005), chemical such as ethyl methane sulphate (EMS), methyl nitroso urea (MNU), sodium azide (SA) (Till et al.2007) or insertion mutagenes like T-DNA, Ac/Ds, En/Spm, Tos17, nDART/aDART (Krishnan *et al.*, 2009). Mutation breeding is relatively quicker method for improvement of various crop species. It is an important tool to create variability for quantitatively inherited traits in different plants and is considered as an alternative method to increase genetic variability in plant breeding (Camargo, *et al.,* 2000). It is often used to correct defects in a cultivar, which has a set of good agronomic characteristics (Sigurbjornsson, 1977). Gamma radiation is an important tool for inducing the genetic variability, enhancing yield and yield contributing traits. However, there is a need to predict the most beneficial dose of gamma rays for improvement of specific traits of crop plants because gamma radiation can induce useful as well as harmful effects. The present investigation was undertaken with the objectives to develop awnless culture from awned Pawana which is an early, scented and high yielding variety of paddy, induce genetic variability and to study the effect of various doses of gamma rays on yield and yield components of paddy.

MATERIALS AND METHODS

The present investigation was carried out at Zonal Agriculture Research Station, Igatpuri, Dist-Nashik of M.P.K.V. Rahuri, Dist-Ahmednagar-415722(M.S.). Seeds of paddy genotype Pawana irradiated with 20, 25, 30 and 35 kR doses of gamma rays from radioactive element Cobalt-60 (60Co) source at BARC, Trombay, Mumbai before onset of monsoon of Kharif-2013. The effect of various doses of gamma rays was studied in M_2 and M_3 generations (M_1 generation was already raised during *Kharif-2013*). M_2 and M_3 generations were raised and studied during *Kharif season* 2014-15 and 2015-16 respectively. The experiment was laid out in randomized block design with three replications, at 20 x 15 cm spacing with plot size 3.75 x 1.20 m. Seedlings of 23 mutants that were already selected from each treatment (20, 25, 30 and 35 kR) in M_1 generation were planted along with non-irradiated Pawana variety (control) to raise M_2 and subsequently M_3 generation. Desirable plants from each treatment were harvested individually and selection was further advanced on the basis of single plant selection method. The recommended cultural practices were followed during the crop growth period. The observations were recorded for days to 50% flowering, plant height, number of tillers plant^{-1}, length of panicle and yield plant^{-1} on five randomly selected plants in each plot. The data recorded for the above mentioned characters were averaged and subjected to statistical analysis as outlined by Steel and Torrie, 1980 and subsequently Duncans Multiple Range Test (Leclarg, *et al.,* 1963) to establish the differences among the different treatment means.

RESULTS AND DISCUSSION

The differences in the mean value of all the traits due to different radiation doses were highly significant in both M_2 and M_3 generation. The results correspond to those of T. Radhamani *et al.* (2015), who irradiated Rice cultivar *ADT (R) 47* by gamma rays at 150, 200, 250,300 and 350 gy, observed highly significant differences in the mean value due to different radiation doses. It is revealed from the Tables 1-2 that, days to 50% flowering significantly increased due to various doses of gamma radiation over untreated control. The extent of variability for this trait was higher in both M_2 and M_3 generations. Significant delay in flowering was recorded in mutant pawana at different radiation doses. As the doses increased to higher level; a delay in days to 50% flowering was noted. An increase by 11.65 and 11.75 days was recorded by 20kR in M_2 and M_3 generation respectively followed by 25kR dose (10.40 and 10.00 days) and 30kR (4.70 and 4.00 days) and 35 kR (1.60 and 1.28) as compared to control (90 and 91 days). The present results are in conformity with the finding reported by Dushyantkumar, *et al.,* 2011. It was apparent from the results (Tables 1-2) that extent of variability in plant height increased in both the generations. The radiation dose of 20kR gamma rays reduced plant height, 93.21 cm in M_2 generation and 94.43 cm in M_3 generation over the control. It was noted that plants radiated with 30 kR gamma rays showed significant increase in plant height, 98.20 cm in M_2 and 98.11 cm in M_3 generation over untreated. The present results are in conformity with the finding reported by Rutger, 1982 and Kawai and Amano, 1991. It was observed (Tables 1 and 2) that, the differences in mean values for tillers plant^{-1} due to various doses of gamma rays varied significantly both in M_2 and M_3 generations. By comparing the mean values of various doses with one another it was found that, tillers plant^{-1} significantly decreased due to 35kR radiation dose, 9.32 in M_2 and 9.43 in M_3 generation as compared to control. The maximum increase in tillers plant^{-1} was observed in response to 30 kR radiation dose, 16.42 in M_2 and 16.46 in M_3 generation followed by 25kR and 20kR radiation dose over untreated check. In general gradual increase in tillers plant^{-1} appeared due to increase in radiation intensity up to 30 kR both in M_2 and M_3 generations. The above results are in conformity with the findings by Bughio et al (2007). The data regarding panicle length showed significant variability for paddy genotype pawana due to different radiation doses. However, all the radiation doses showed reduction in panicle length while comparing the mean values of gamma rays with one another. The minimum panicle length (19.80 in M_2 and 20.30 cm in M_3 generation) was recorded with 35kR dose and maximum panicle length (21.10 in M_2 and 21.20 cm in M_3 generation) was recorded by control.

Table 1
Mean performance of various characters of Paddy genotype Pawana treated with different doses of gamma rays in M_2 generation.

Radiation dose (kR)	*Days to 50% flowering*	*Plant height (cm)*	*Tillers Plant^{-1}*	*Panicle length (cm)*	*Yield Plant$^{-1(g)}$*
Controll	90.00 e	97.81 b	15.42 d	21.10 a	19.24 d
20	101.65 a	93.21 d	15.82 c	20.85 b	19.42 c
25	100.40 b	95.60 c	16.20 b	20.40 c	20.62 b
30	94.70 c	98.20 a	16.42 a	20.30 d	22.82 a
35	91.60 d	91.72 e	08.32 e	19.80 e	17.35 e

Mean values sharing same letter does not differ significantly at 5% level of probability (P=0.05)

Table 2
Mean performance of various characters of Paddy genotype Pawana treated with different doses of gamma rays in M3 generation

Radiation dose (kR)	*Days to 50% flowering*	*Plant height (cm)*	*Tillers per Plant-1*	*Panicle length (cm)*	*Yield Plant-1*
Controll	91.00 e	98.00 b	15.60 d	21.20 a	19.44 d
20	102.75 a	94.43 d	16.10 c	21.00 b	19.82 c
25	101.00 b	96.25 c	16.30 b	20.80 c	21.44 b
30	95.00 c	98.11 a	16.46 a	20.68 d	23.44 a
35	92.28 d	92.79 e	9.43 e	20.30 e	18.88 e

Mean values sharing same letter does not differ significantly at 5% level of probability (P=0.05)

The differences in the mean values for grain yield plant^{-1} due to different doses of gamma rays were highly significant. The data from the Tables 1-2 revealed that there was significant gradual increase in the grain yield plant^{-1} with the increase in the intensity of radiation viz. 19.42, 20.62 and 22.82 respectively due to 20, 25 and 30 kR in M_2 and 19.82, 21.44 and 23.44 g due to 20, 25 and 30 kR respectively in M_3 generation. However, 35 kR dose of gamma rays, yield plant^{-1} decreased significantly 17.35 g in M_2 and 18.88 g in M_3 generation as compared to control. In rice crop significant improvement through the use of induced mutatios have been reported for high yield by Bughino, *et al.* (2007) and Wen and L. QW (1996). However, at 35kR radiation dose, grain yield decreased significantly, 17.35 in M_2 and 18.88 in M_3 generations as compared to control. Change brought by mutation is permanent and heritable. If the changes would be brought by environment they are not fixable and heritable. For example, from present investigation it has been observed that in both M_2 and M_3 generation, there is continuous induction of genetic variability and all the treatments are showing their effect continuously. If it will be due to environmental fluctuation such permanent changes could not observed generation after generation.

CONCLUSION

From the above foregoing results and discussion, it is concluded that different doses of gamma rays in paddy genotype pawana, provide enough scope by developing a wide range of variation in desirable plant attributes to select high yielding mutants. From the present study significant genetic variability was induced through all the four mutagenic treatments and also enhancement in yield and yield contributing traits were observed at 30kR followed by 25kR and 20 kR. Under the influence of higher dose of gamma rays (35kR) significant reduction were observed in yield and yield attributes. It indicates that, inducing genetic variability and improvement in quantitative traits would be possible through gamma rays. Hence, gamma ray played a pivotal role in crop breeding through mutation and stability of genetic variability should be analyzed in succeeding generations and selection of desirable mutants could be performed for a successful breeding programme.

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