Effect of Gamma Rays on Morphological Traits and Yield of Three Rice Varieties

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INTRODUCTION

Mutation has been successfully employed in breeding of several food crop varieties and ornamentals worldwide. Past research in mutation breeding have reported seedling height, survival rate and tiller production as important traits to be improved to obtain optimum yields. Only one rice variety has been developed by induced mutation in Sri Lanka. Moreover, studies related to irradiation of rice varieties are scanty. The objective of this study was to determine the effect of gamma irradiation on plant morphological traits, age and yield of the three rice varieties.

MATERIALS AND METHODS

Three rice varieties including two improved (Bg 94-1, Bg 1165-6) and one traditional (Suwandal) rice varieties were tested. Two hundred grams of seeds of three rice varieties were subjected to gamma rays from 60 Co source using 3 doses of 200, 300 and 400 Gy to create the desirable variation. Irradiation was undertaken at the IAEA laboratories Seibersdorf, Austria in October 2014. The seeds were raised as a bulk population in M_1 generation and advanced from M_2 to M_4 generations in subsequent seasons at the Rice Research and Development Institute, Batalagoda, Ibbagamuwa. At M_4 generation in *Maha* 2016/17, twelve single plants were selected in each variety representing each dose to form 108 progenies. In *Yala* 2017 these selected progenies were field established along with twelve progenies of each parent variety to form total of 144 progenies. Each progeny was maintained as a three row plot planted at the spacing of 15x20cm with 99 plants per progeny. The crop was managed according to the Department of Agriculture recommendations. The progenies were evaluated for the agronomic and yield traits such as tiller number, panicle number, panicle length, plant height, flag leaf length, flag leaf width, days to heading, days to maturity and yield per plant.

***** Short Communication***

The data were analyzed using the procedure ANOVA and mean separation was done following Duncan Multiple Range Test using SAS computer software package version 9.1. The associations were determined using correlation analysis in SAS.

RESULTS AND DISCUSSION

Mean values of Tiller number per plant (TNP), Panicle number per plant (PNP), Plant height (PH), Panicle length (PL), Flag leaf length (FLL), Flag leaf width (FLW), Days to heading (DTH), Days to maturity (DTM), Yield per plant (YP) following gamma radiation and percentage as un-irradiated control are presented in Table 1.

Decrease in tiller and panicle production was not proportional to the increase in dose and no definite pattern was observed. At the dose of 200Gy all varieties the maximum number of tillers and PNP[1]. Bg 94-1 recorded the highest TNP[1] and PNP[1] of 7.5 and 7.25 respectively for the dose of 200 Gy. Significant reduction of tiller and panicle number was found in Bg 1165-6 at the 400 Gy as 36.04%. PH of the M_5 plants showed significant variation due to radiation treatment. The highest PH was observed was 89.56 cm from Suwandal. The maximum percentage reduction of PH was recorded from Bg 1165-6 at 400 Gy as 18.45%. Similar results have been reported in rice by Katoch *et al.,* (1992), Akbar and Barbar (2003) and Sasikala and Kalaiyarasi (2010). With regard to PL, all the radiation doses showed stimulatory effect on Suwandal, Bg 94-1 and Bg 1165-6. Thus at the 200 Gy, Bg 1165-6 showed a small suppressing effect on PL. Suwandal and Bg 94-1 did not show a definite pattern of decrease of FLL with the increased in gamma doses. Bg 1165-6 exhibited the linear pattern of increment in FLL upon increase in dose from 200 to 400 Gy. Bg 1165-6 showed significant increase in FLW with the increased dose rate. DTH and DTM has decline with increasing doses for Suwandal where 8 days earliness was recorded at 400 Gy. Bg 94-1 recorded late maturity with the increasing dose rate.

Bg 94-1 was recorded highest YP where Suwandal recorded lowest YP. A decreasing trend of YP with the increasing dose rate was observed for all three varieties. Similar yield was recorded at 200 Gy as the parent variety. Similar result were obtained by Muhammad *et al.,* 2003 who worked on Basmathi rice and reported decrease in grain yield of M_1 plants with increase in irradiation dose.

Table 1. Mean values of plant morphological traits, Days to heading, Days to Maturity and yield of three varieties and percentage as a control followed by dose rate of gamma irradiation of M5 generation in *Yala* 2017 season

Variety	Treatments (Gy)	TNP		PNP		PH(cm)		PL(cm)		FLL(cm)		FLW(cm)		DTH		DTM		YP(g)	
		Actual	% of control	Actual	% of control	Actual	% of control	Actual	%e of control	Actual	% of control	Actual	% of control	Actual	% of control	Actual	% of control	Actual	% of control
Suwandal	CTL	5.08^{b}	100	5.08b	100	89.56a	100	25.2^{c}	100	40.36b	100	1.35a	100	82.67^{a}	100	112.66^{a}	100	14.7a	100
	200	6.58^{a}	129.5	6.41^{a}	125.9	89.18^{a}	99.6	28.3^{b}	112.3	45.68^{a}	113.1	1.26^{b}	93.3	83.83^{a}	101.4	113.83^{a}	101	14.02^{ab}	95.3
	300	5.58b	91.03	5.41^{b}	106.2	79.83^{b}	89.1	27.95^{b}	110.9	43.47^{ab}	107.7	1.13^{c}	83.7	79.54^{b}	96.2	109.54^{b}	97.2	14.05^{ab}	95.6
	400	5.16^{b}	101.5	5.08^{b}	98.4	78.8^{b}	87.9	30.1^{a}	119.4	42.93^{ab}	106.3	1.14^{c}	84.4	74.87^{c}	90.6	104.87^{c}	93	13.55^{b}	92.1
Bg 94-1	CTL	6.75^{ab}	100	6.75^{ab}	100	74.89^{a}	100	24.15^{a}	100	28.32^{b}	100	1.29^{a}	100	73.33^{c}	100	103.33^{c}	100	25.25^{a}	100
	200	7.5a	111.1	7.25^{a}	107.4	66.97^{b}	89.4	24.25^{a}	100.4	29.16^{b}	102.9	1.14^{b}	88.3	78.04^{b}	106.4	108.04^{b}	104.6	25.65^{a}	101.6
	300	6.5^{b}	96.3	6.08^{bc}	90.0	64.95^{bc}	86.7	24.25^{a}	100.4	27.13^{b}	95.8	1.15^{b}	89.1	82.5^{a}	112.5	112.5^{a}	109	23.48^{b}	93
	400	5.5^{c}	81.48	5.41^{c}	80.1	64.0^{c}	85.4	24.96^{a}	103.3	34.21^{a}	120.8	1.15^{b}	89.1	85.6^{a}	116.7	115.62^{a}	112	23.27^{b}	92.1
Bg 1165-6	CTL	6.41^{a}	100	6.41^{a}	100	75.75^{a}	100	23.56^{a}	100	25.4^{b}	100	1.27^{b}	100	75.83^{ab}	100	105.83^{ab}	100	19.87^{a}	100
	200	7.0^{a}	109.2	7.0^{a}	109.2	70.5^{b}	93.0	23.0^{a}	97.6	26.46^{b}	104.1	1.01^{c}	79.5	78.16^{a}	103	108.16^{a}	102.2	19.86^{a}	100
	300	6.83^{a}	106.5	6.83^{a}	106.6	64.61^{c}	85.2	23.72^{a}	100.7	29.93^{a}	117.8	1.17^{b}	92.1	78.95^{a}	103.4	108.95^{a}	102.9	18.92^{b}	95.2
	400	4.1^{b}	63.96	4.1b	63.96	61.78^{d}	81.5	24.13^{a}	102.2	30.65^{a}	120.7	1.44^{a}	113	73.29^{b}	96.65	103.29^{b}	97.6	17.75^{c}	89.3

Note: Tiller number per plant(TNP), Panicle number per plant(PNP), Plant height(PH), Panicle length(PL), Flag leaf length(FLL), Flag leaf width(FLW), Days to heading(DTH), Days to maturity(DTM), Yield per plant(YP-1),Control(CTL), Means within the each column followed by same letters are not significant at P-0.05, Mean separation was done separately for 3 varieties.

Sensitivity of varieties to increasing gamma irradiation

Relationship of plant characters, age and yield with increasing radiation dose are presented in Table 2. Increased radiation doses showed highly significant negative correlation with TNP[1], PNP[1] and PH where highly significant positive correlation was found with PL. FLL and FLW showed significant positive and negative correlations respectively. DTH, DTM, and YP[1] were the least affected traits in all varieties. Correlation co-efficients, which are insignificant, also proved that even at high dose (400 Gy) level these characters were not much affected in the three varieties tested. PNP[1] was highly affected where percentage reduction was 20.06 followed by TNP, PH, YP and FLW.

Table 2. Relationship of plant characters, age and yield with increasing radiation dose.

Plant character	Correlation with dose rate	Response mean of the control(Parent)	Response mean at the 400Gy	Reduction percentage
TNP-1	(-0.270)**	6.08	4.94	18.75
PNP-1	(-0.308)**	6.08	4.86	20.06
PH(cm)	(-0.475)**	80.06	68.19	14.83
PL(cm)	(0.265)**	24.3	26.41	-8.68
FLL(cm)	(0.190)*	31.36	35.93	-14.57
FLW(cm)	(-0.193)*	1.3	1.25	3.84
DTH	(0.078)ns	77.27	77.93	-0.85
DTM	(0.078)ns	107.27	107.93	-0.61
YP-1(g)	(-0.148)ns	19.94	18.19	8.78

Note: * Significant at p>0.05, ** significant at p>0.01, ns - not significant

CONCLUSIONS

This study showed that most efficient and effective dose rate for tiller and panicle production was 200 Gy. However, at the 400 Gy level Suwandal and Bg 1165-6 showed earliness than the lower dose rates which would be desirable. At 200 Gy yield per plant, the three varieties were similar to parent cultivar. The results showed that the mutagenic effectiveness decreased with the increasing doses of gamma rays. Radiation doses ranged from 200 Gy to 300 Gy were found to be most effective for viable mutation.

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