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Screening of gamma irradiated rice variety Ranjit Sub-1 against rice leaf folder, *Cnaphalocrocis medinalis* Guen. (Pyraustidae: Lepidoptera)

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Abstract

Five doses of gamma radiation (100Gy, 150Gy, 200Gy, 250Gy and 300Gy) along with a control and check variety were screened against rice leaf folder, *Cnaphalocrocis medinalis* Guen. (Pyraustidae: Lepidoptera) at Assam Agricultural University, Jorhat-13 during kharif season of 2018 and 2019. The field experiment was laid out in a randomized block design and the entire experiment was conducted organically. The irradiation doses were evaluated based on the Standard Evaluation System (SES) for rice with a scale of 0-9. Infestation of *Cnaphalocrocis medinalis* ranged from 5.49±1.93% to 38.50±1.24%. Infestation was lowest at 200Gy (14.84±0.98%) and highest at 300Gy (24.80±2.01%). The doses 100Gy, 150Gy and 200Gy were recorded as Moderately Resistant, 250Gy and 300Gy as Moderately Susceptible against *C. medinalis* infestation according to SES, IIRI.

Keywords: Gamma radiation, screening, leaf folder, moderately resistant

1. Introduction

Rice being the staple crop for nearly half of the world's population is enriched with plenty of energy and protein providing global food security as well as economic stability of a country. In Assam is grown in a total area of 2.46 million ha with production of 5.14 million tonnes and its productivity is 2086 kg/ha (Directorate of Economics and Statistics, Govt. of India 2018-2019). Although Assam is blessed with high diversity of rice genotypes yet various constraints limits its potential production. Out of these insect pests are one of the primary constraints. Leaf folder, *Cnaphalocrocis medinalis* Guen. (Pyraustidae: Lepidoptera) causes severe losses to the rice crop at its vegetative stage and sometimes even causing damage during its tillering stage. Young larvae of the pest fold the leaf longitudinally and feed on its tissue. The scraped leaves turn whitish which reduces its photosynthesis efficiency and ultimately its yield is reduced. To control these pests most of the farmers are using pesticides indiscriminately influenced by delusion and over reckoning of damages which in turn intensifies pest outbreak and thereby insects turning to be a major competitor with human race for the ultimate product. With the cognizance of agricultural scientists about the inimical of the cultivation practices that have accompanied the 'Green Revolution', now the pest management concept has been shifted to a more naturalized approach, the integrated pest management (IPM). Host plant resistance is an important part of the IPM concept. It is one of the best ways to reduce losses caused by insects. Nuclear techniques like X-rays, gamma rays, ultraviolet rays which causes induced mutations in plants with exclusively new gene combinations are recently being used in the agricultural sector for various purposes including development of host plant resistance. Gamma radiation is used in different sectors of agriculture for application in sterilization and preservation of food (Maity *et al.*, 2008., Hyun-Pa *et al.*, 2006 and Bari *et al.*, 2003) [10, 5, 4]. Gamma rays are the most energetic ionizing radiation having energy level from nearly 10 kilo electron volts (keV) to several hundred keV and penetrate rapidly through the polysaccharide granules Bao *et al.* (2005) [3]. Gamma radiations are also environmentally sound with least damage to the seeds. The biological effect of gamma radiations are based on its interaction with atoms or molecules in the cell, most particularly water, to produce free radicals (Kovacs and Keresztes, 2002) [7]. These radicals are capable of modifying important components of plant cells and have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants depending on the radiation dose (Ashraf *et al.*, 2003) [2].

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In the present study seeds of Ranjit Sub-1 was exposed to different doses of gamma irradiation to screen out the most promising doses imparting tolerance against *Cnaphalocrocis medinalis*.

2. Materials and Methods

Seeds of Ranjit Sub-1 were subjected to five doses of gamma radiation (100Gy, 150Gy, 200Gy, 250Gy and 300Gy) at

Nuclear Research Laboratory, New Delhi. Unirradiated seeds of Ranjit Sub-1 was taken as control and the variety Jaya was taken as a check. The field experiment was laid out in Randomized Block Design (RBD), with four replications. Each treatment in each replication was accommodated randomly and the net experimental area was 336 m². The treatments and their notations are shown in Table.1.

Table 1: Treatments and their notation

Treatments	Notations
100Gy	T ₁
150Gy	T ₂
200Gy	T ₃
250Gy	T ₄
300Gy	T ₅
Untreated control	T ₆
Check (variety Jaya)	T ₇

The crop was raised using standard agronomic practices and the entire experiment was conducted organically. Infestation of *Cnaphalocrocis medinalis*. was recorded on 10 randomly selected plants per treatment in each plot at 30, 50 and 70 days after transplanting. The total damaged leaves were counted on each treatment and per cent leaf damage was worked out by using the following formula:-

$$\text{Damaged leaves (\%)} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

The per cent infestation was subjected to 0-9 scale of Standard Evaluation System (SES) for *Cnaphalocrocis medinalis* (IRRI scale, 2002) [6].

Table 2: Standard Evaluation System (SES) for screening *Cnaphalocrocis medinalis* infestation (IRRI)

<i>Cnaphalocrocis medinalis</i> damage (%)	Scale	Status
0	0	Highly Resistant (HR)
1-10	1	Resistant (R)
11-20	3	Moderately Resistant (MR)
21-35	5	Moderately Susceptible (MS)
36-50	7	Susceptible (S)
51-100	9	Highly Susceptible (HS)

3. Results and Discussion

In the present investigation seeds of the variety Ranjit Sub-1 were irradiated with five doses of gamma rays (100Gy, 150Gy, 200Gy, 250Gy and 300Gy) and same quantity of seeds was kept untreated as a control. Seeds of all the treatments along with the control were sowed during 2017 as M1 generation. The harvested seeds were subsequently grown during 2018 and 2019 as M2 and M3 generation. The present study of screening different doses for insect tolerance was carried out during M2 and M3 generations.

Results of damage leaf percent were found to be statistically significant among the gamma irradiated doses in both generations. During M2 generation there was significant difference in the damage percentage of *Cnaphalocrocis*

medinalis among the gamma irradiated doses at 30 and 70 DAT. At 30DAT lowest percent damage was recorded at 200Gy (14.80%) followed by 150Gy (19.29%) which was at par with 100Gy (20.40%). Highest infestation was recorded at 300Gy (28.37%). During M3 generation (2019) lowest damage percentage among the gamma irradiated doses was observed at 200Gy (13.39% at 70 DAT) and was at par with 150Gy and 100Gy. Considering both the generations, 200Gy was found to be least affected by *Cnaphalocrocis medinalis* followed by 150Gy and 100Gy and all the three doses were categorized to be Moderately Resistant according to the SES (IRRI, 2002) [6]. On the other hand, 250Gy and 300Gy had comparatively higher percent leaf damage and categorized as Moderately Susceptible along with the untreated control. During both the generations, irrespective of the doses, highest infestation was recorded in the check variety with leaf damage ranging from 37.14% to 38.32%. The check variety was categorized under susceptible category.

In the present investigation the doses 150Gy and 200Gy has shown the best results with minimum leaf infestation. Hence there may be certain beneficial traits (morphological or chemical) induced as a result of irradiation which may have resulted in less preference in those plants for feeding. Since gamma rays are high energy waves it easily penetrates into exposed cells and cause severe alternations in the DNA of the target cells. The alternations may be due to direct strike by the gamma particles or may be due to production of reactive oxygen species which has the capacity to interact with the DNA or other cellular components inside the cell which may cause changes in the entire metabolic activity of the plants and thereby bringing alternations in the biochemical constituents and morphology of the plants (Zaka *et al.*, 2004 and Majeed *et al.*, 2017) [11, 9]. Kumari (2013) [8] also reported in a study that gamma irradiated rice seed at dose 200Gy showed the lowest infection of disease caused by pathogen.

Table 3: Per cent leaf infestation of gamma irradiated rice variety Ranjit Sub-1 against *Cnaphalocrocis medinalis*

Treatment	M2(2018) generation			M3(2019) generation			IRRI Scale	Remark
	30DAT	50DAT	70DAT	10DAT	20DAT	30DAT		
100Gy	12.25±1.11 (20.40)	12.19±0.74 (20.37)	8.00±0.43 (16.41)	9.50±0.62 (17.92)	9.25±0.74 (17.66)	8.75±0.86 (17.14)	3	MR
150Gy	11.00±1.02 (19.29)	11.75±0.75 (20.00)	7.45±0.71 (15.85)	9.25±1.48 (17.54)	8.00±1.67 (16.19)	7.14±0.97 (15.53)	3	MR
200Gy	6.75±1.67 (14.80)	8.13±1.32 (16.55)	5.49±1.93 (13.17)	7.75±1.08 (16.06)	7.49±0.71 (15.85)	6.25±2.23 (13.99)	3	MR
250Gy	15.00±0.99 (22.73)	15.12±2.60 (22.42)	11.47±1.12 (19.73)	14.50±1.32 (22.28)	16.37±2.45 (23.47)	13.00±0.59 (21.11)	5	MS
300Gy	22.83±1.70 (28.37)	17.61±1.58 (24.61)	13.41±1.58 (21.41)	19.86±1.65 (26.27)	17.25±0.84 (24.50)	14.75±1.41 (22.47)	5	MS
Control	32.50±0.40 (34.74)	31.75±0.64 (34.27)	32.25±1.30 (34.56)	31.5±1.84 (34.06)	31.25±3.70 (33.62)	33.50±1.37 (35.32)	5	MS
Check	37.00±0.54 (37.45)	38.25±1.28 (38.17)	37.50±0.71 (37.74)	36.5±1.10 (37.14)	38.50±1.24 (38.32)	37.00±3.89 (37.17)	7	S
S.Ed.±	1.60	2.14	1.22	1.41	2.76	2.87		
CD (P=0.05)	3.39	4.53	2.59	2.99	5.84	6.07		

All values are mean of 4 replications from 10 randomly selected plants

No. of Plots: 28, Size: 4x3 m²

Figures in parenthesis are angular transformed values

DAT: Days after transplanting

MR: Moderately resistant

MS: Moderately susceptible

S: Susceptible

4. Conclusion

From the investigation and discussions based on the present study, it could be inferred that gamma irradiation can be used in seeds of rice crop to develop tolerance against insects. The dose 200Gy and 150Gy was found to be least preferred by *Cnaphalocrocis medinalis* so it can be further evaluated until the 8th generation (M8) to test their distinctiveness, uniformity and stability. Thus, the result of the present findings opens a broad opportunity for using gamma irradiation in crop seeds not only to impart tolerance against insect pests but also to improve other desirable characters in the host plant.

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