



INFLUENCE OF GAMMA IRRADIATION AND CONTRASTING WATER REGIMES ON GROWTH AND YIELD ATTRIBUTES OF SOME VARIETIES OF RICE

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ABSTRACT: In light of the challenges posed by climate change and limited availability of drought-tolerant rice varieties, this study examined the effects of gamma-irradiation doses (100, 200 and 300 Gy) on growth and yield attributes of two rice varieties, FARO 67 and FARO 68, under contrasting water regimes- rainfed and irrigated conditions, in the 2023/2024 planting season. Seeds were exposed to gamma-irradiation derived from a cobalt-60 source and were sown in a randomised complete block design (RCBD) in three replicates. Data on agromorphological parameters were recorded and analysed following standard procedures. Results showed significant differences ($p < 0.05$) among irradiation treatments for most traits in both varieties across the two water regimes. The effect of irradiation doses on FARO 67 and FARO 68 was different for most traits. Also, results revealed significant variability in the plant's response for some traits under different growth conditions. Gamma irradiation significantly decreased seedling emergence, seedling survival and plant height of both varieties in both irrigated and rainfed plots. Low doses of 100 and 200 Gy significantly decreased the days to heading in rainfed and irrigated plots (9-21 d). Irradiation dose of 200 Gy significantly increased flag leaf length in irrigated FARO 67 (30.7 cm), while 300 Gy increased flag leaf length in irrigated FARO 68 (24.1 cm). Tillering was significantly influenced by a dose of 100 Gy in rainfed FARO 67. Gamma irradiation at low doses of 100 and 200 Gy significantly ($p < 0.05$) increased the number of grains per panicle in rainfed FARO 67 (193.1 and 194.9), while all irradiation doses significantly increased the number of grains per panicle in rainfed FARO 68. This study revealed variation in plant radiosensitivity and highlights the potential of gamma-irradiation in creating variability for crop improvement in different environmental conditions.

Keywords: Gamma-irradiation; genotype; mutants; rice; variability

INTRODUCTION

Rice (*Oryza sativa* L.) is the major dietary energy source contributing to global food security (Baheliya *et al.*, 2025). It is one of the most important cereals in

the world and serves as a source of livelihood for over 50 % of the global population (Tagliapietra *et al.*, 2024). Yuan *et al.* (2024) noted that the increasing demand for rice in Africa has been largely met through a parallel increase in both domestic rice production and imports. However, domestic production gains have mainly resulted from the expansion of rice area under cultivation [Food and Agriculture Organization of the United Nation (FAO), 2022]. This stagnation in yield is largely attributed to

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low genetic potential and the growing impact of climate change.

Rainfall regimes in many rice-growing areas are inconsistent, resulting in severe yield losses (Khan *et al.*, 2022). Most lowland rice production systems are characterised by too much water or insufficient water during the same growing season. Muhammad *et al.* (2022) noted that periodic drought is the major constraint of rain-fed rice production. Unfortunately, there is a lack of improved rice varieties that can withstand drought stress. Thus, it is important to develop rice varieties with improved productivity under different water regimes. One promising approach is the use of mutation breeding. Induced mutagenesis has emerged as an essential field of plant breeding to address global food security challenges (Bharat *et al.*, 2024).

In light of the challenges posed by climate change and the limited availability of drought-tolerant rice varieties, this study aimed to assess the effects of varying doses of gamma irradiation on growth performance and yield attributes of two rice varieties, FARO 67 and FARO 68, under contrasting water regimes- rainfed and irrigated conditions.

MATERIALS AND METHODS

Source of seed and irradiation

Seeds of two (2) lowland rice varieties- FARO 67 and FARO 68, were collected from the Rice Research Unit, National Cereals Research Institute (NCRI), Baddegi, Niger State. One hundred and fifty (150) seeds of each variety were exposed to gamma irradiation doses of 0 Gy, 100 Gy, 200 Gy, and 300 Gy according to Masrurah *et al.* (2016). The irradiation was derived from a Co-60 source (with current activity of 123 MBq, and a dose rate of 1.5 Gy/hour) situated at the Radiology Department, Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Experimental site

The study was conducted at the research field of the National Cereals Research Institute (NCRI) (9.0652195 °N; 6.0986163 °E), Baddegi village, Niger State, Nigeria. The climatic conditions of the area are typically tropical, characterised by two main seasons: the wet (rainy) season between April and October characterised by an average rainfall of 100 – 320 mm, average temperature of 24 – 30°C and an average humidity of 70 – 95 %, and the dry season between November and March, characterised by an

average rainfall of 0 - 30 mm, average temperature of 26 – 40 °C and an average humidity of 20 – 70 % (Nigerian Meteorological Agency [NIMET], 2025).

Experimental design

Seeds of each of the eight treatment combinations (FARO 67- 0, 100, 200 and 300 Gy, and FARO 68- 0, 100, 200 and 300 Gy) were planted under field conditions using a randomised complete block design (RCBD) in three replicates during both seasons to raise the first mutant plants (M₁). Each block measured 2 × 1 m in size, with a plot size of 7 × 12 m. Four seeds were sown per hole and were later thinned down to two plants per stand at three weeks after planting. The rainfed experiment was conducted between the months of July and October 2023, during the peak rainy season, while the irrigated experiment was conducted between the months of December 2023 and April 2024, during the peak dry season. During the dry season, the fields were irrigated to field capacity at 8-day interval to retain moisture.

Data collection and analysis

Data were collected on the following agromorphological parameters: seedling emergence, seedling survival, plant height, flag leaf length, tiller count, days to heading, productive tiller count, panicle length, panicle grain number and test weight following standard procedures as described by the International Rice Research Institute [IRRI], (1980).

Data collected were subjected to a Two-way Analysis of Variance (ANOVA), and the Ryan-Einot-Gabriel-Welsch Range test (R-E-G-W-Q) was used to separate the means. Pairwise comparison was used to separate the means of varieties with a significant difference. All results were considered significant at a confidence level of 95 %.

RESULTS AND DISCUSSION

Significant ($p < 0.05$) dose-dependent decrease was observed in the seedling emergence of FARO 67 and FARO 68 with an increase in the dose of irradiation under both rainfed and irrigated conditions (Table 1). Pairwise comparison revealed significantly higher seedling emergence in FARO 68 at 100 Gy under rainfed conditions, while no significant difference was observed in other treatment groups. The dose-dependent decrease observed in seedling emergence could be attributed to the physiological injuries caused by gamma irradiation, as gamma rays act by altering molecules directly within the cell (Barela *et al.*, 2022). Similar findings have been reported in gamma-irradiated Kalanamak rice by Mishra *et al.*

(2023) and in M₁ and M₂ gamma-irradiated Egyptian rice by Elsherbiny *et al.* (2024).

Results revealed a significant ($p < 0.05$) decrease in the seedling survival following gamma-irradiation, with 300 Gy resulting in the least survival rate (Table 2). A significantly higher survival rate was observed in FARO 67 exposed to 300 Gy in irrigated fields, in

comparison with rainfed plants. Results also showed a significantly higher seedling survival rate in rainfed FARO 68 exposed to 100 Gy. The significant decrease observed in the survival rate could be due to genetic aberrations caused by gamma irradiation. This is in line with the report of Barus *et al.* (2023).

Table 1: Seedling emergence (%) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	96.9 ^a	95.3 ^a	96.1	94.2 ^a	94.2 ^a	94.2
100 Gy	87.2 ^b	90.0 ^{ab}	88.6	91.3 ^a	83.6 ^{bc*}	87.5
200 Gy	82.7 ^{bc}	84.6 ^b	83.7	79.0 ^b	86.1 ^b	82.5
300 Gy	78.2 ^c	85.4 ^b	81.8	72.8 ^b	77.3 ^c	75.1
Varietal mean	86.3	88.8		84.3	85.3	
SE	2.120					
S × V	0.741					
S × D	0.242					
V × D	0.094					
S × V × D	0.065					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

Table 2: Seedling survival (%) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	90.0 ^a	89.7 ^a	89.9	86.7 ^a	87.3 ^a	87.0
100 Gy	81.4 ^b	85.4 ^{ab}	83.4	86.7 ^a	77.6 ^{b*}	82.2
200 Gy	71.2 ^c	79.6 ^b	79.4	72.6 ^b	79.1 ^{ab}	75.9
300 Gy	62.5 ^d	79.7 ^{b*}	71.1	66.6 ^c	71.6 ^c	69.1
Varietal mean	76.3	83.6		78.2	78.9	
SE	2.34					
S × V	0.853					
S × D	0.003**					
V × D	0.272					
S × V × D	0.087					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

A significant ($p < 0.05$) decrease was observed in the plant height of rainfed FARO 67 at 200 and 300 Gy, while no significant difference was observed in the irrigated field (Table 3). In FARO 68, a significant decrease was observed in the plant height of rainfed and irrigated plants following irradiation.

Pairwise comparison revealed a significantly higher plant height in rainfed FARO 67 at 0 and 100 Gy, and in rainfed FARO 68 at all irradiation doses, except for 100 Gy (Table 3). The significant decrease in plant height could be attributed to the damaging effects of ionizing radiation on cellular structures and DNA.

This conforms with reports of Katiyar *et al.*, (2022), who suggested that free radicals produced by gamma irradiation could affect the anatomy of plants depending on the level of irradiation. This is in line with reports of Ali *et al.* (2022) and Tinta *et al.*

(2025), who have reported a decrease in plant height with an increase in dose of gamma irradiation. Plant height is an important character in rice breeding as it is strongly associated with effective utilisation of plant assimilates (Sao *et al.*, 2022).

Table 3: Plant height (cm) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	123.7 ^a	104.1 ^{a*}	113.9	105.4 ^a	95.2 ^{a*}	100.3
100 Gy	113.8 ^a	102.3 ^{a*}	108.1	80.9 ^b	85.2 ^a	83.1
200 Gy	101.5 ^b	109.6 ^a	105.6	79.5 ^b	68.7 ^{b*}	74.1
300 Gy	100.8 ^b	108.4 ^a	104.6	76.4 ^b	61.0 ^{c*}	68.7
Varietal mean	110.0	106.1		85.6	77.5	
SE	2.84					
S × V	0.000***					
S × D	0.000***					
V × D	0.000***					
S × V × D	0.000***					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

The results showed no significant differences ($p > 0.05$) in the flag leaf length of both varieties under rainfed conditions. However, a significant increase was observed in the flag leaf length of FARO 67 at 200 Gy (30.7 cm) and FARO 68 exposed to 300 Gy (24.1 cm) in irrigated fields (Table 4). Pairwise comparison revealed a significantly higher flag leaf length in FARO 67 cultivated in an irrigated field at 300 Gy (28.1 cm), in comparison to the rainfed field, and in rainfed FARO 68 exposed to 100 Gy (22.6 cm). The differences in response between the rainfed and irrigated plants could be because gamma irradiation often produces more pronounced phenotypic effects under environmental conditions that impose physiological stress and reduce the plant's ability towards recovery from mutational damage (Roychowdury and Tah, 2013). The significant increase observed in the flag leaf of both varieties under irrigated conditions could be an adaptive response of the plants to enhance light capture and photosynthetic efficiency as a compensatory mechanism under stress (Ashraf, 2010).

Gamma irradiation dose of 200 Gy significantly decreased ($p < 0.05$) the days to heading in rainfed

FARO 67 (82 d), while the dose of 100 Gy significantly decreased the days to heading in irrigated field (109.3 d) (Table 5). Results showed that irradiation doses of 100 and 200 Gy significantly decreased days to heading in rainfed FARO 68 (66.0 and 85.0 d, respectively). Gamma rays significantly decreased days to heading in irrigated FARO 68, with 200 Gy having the least days to heading (107 d). The results also revealed significantly higher days to heading in irrigated plants (Table 5). The decrease in days to heading may be attributed to the influence of gamma irradiation on biochemical pathways responsible for the synthesis of flower-inducing compounds, either by directly mutating flowering genes or indirectly through changes in hormone levels or stress responses. Similar decrease in days to heading following gamma irradiation have been reported in rice by Ghazy *et al.* (2023). The increase recorded in days to heading at some doses could be attributed to the damage in plant cells caused by irradiation, resulting in the disruption of plant growth including flowering age and days to physiological maturity. Similar findings have been reported by Purwanto *et al.* (2019) in gamma-irradiated rice.

Table 4: Flag Leaf length (cm) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	25.2 ^a	23.4 ^b	24.3	22.6 ^a	16.7 ^{b*}	19.7
100 Gy	25.4 ^a	24.8 ^b	25.1	24.1 ^a	22.6 ^{ab}	23.4
200 Gy	27.2 ^a	30.7 ^a	29	23.8 ^a	23.2 ^{ab}	23.5
300 Gy	22.7 ^a	28.1 ^{b*}	25.4	20.7 ^a	24.1 ^a	22.4
Varietal mean	25.1	26.8		22.8	21.7	
SE	1.98					
S × V	0.307					
S × D	0.241					
V × D	0.521					
S × V × D	0.925					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

Table 5: Days to heading (d) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	91.0 ^a	120.0 ^{b*}	105.5	99.0 ^a	128.7 ^{a*}	113.9
100 Gy	86.7 ^a	109.3 ^{c*}	98	86.0 ^b	120.3 ^{b*}	103.2
200 Gy	82.0 ^b	113.3 ^{b*}	97.7	85.0 ^b	107.0 ^{c*}	96
300 Gy	93.0 ^a	128.7 ^{a*}	110.9	96.7 ^a	110.0 ^{c*}	103.4
Varietal mean	88.2	117.8		91.7	116.5	
SE	1.89					
S × V	0.86					
S × D	0.009**					
V × D	0.000***					
S × V × D	0.000***					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

A significant increase ($p < 0.05$) was observed in the number of tillers per plant in rainfed FARO 67 at 100 Gy (18.2), while the dose of 300 Gy significantly decreased tiller count (11.7). In FARO 68, irradiation dose of 100 and 200 Gy significantly increased tillering (14.0 and 12.5, respectively) (Table 6). Results showed a significantly higher tillering in rainfed FARO 67 exposed to 100 Gy (18.2), in comparison to the irrigated field. A significantly higher ($p < 0.05$) number of productive tillers was observed in rainfed FARO 67 at 100 Gy (16.7) (Table

7). The variability in tillering suggests that gamma rays may have disrupted apical dominance or enhanced the expression of genes promoting lateral shoot development. The presence of this variability gives room for the selection of plants with high tillering ability, which is directly correlated to yield. This finding is similar to the reports of Mem *et al.* (2025), who reported significant variability in tillering of gamma-irradiated rice. The non-significant variability in the number of tillers in the irrigated field is in line with the report of Indrawanis (2025), who

reported that gamma rays did not influence tillering in rice plants. This could be because gamma ray irradiation is random; some characters may undergo changes while other characters may not change (Mardiyah *et al.*, 2021). The higher tillering observed

under rainfed conditions compared to irrigated fields suggests the sensitivity of tiller development to moisture availability, as plants typically prioritise survival, limiting tiller formation as a resource conservation strategy (Guan *et al.*, 2010).

Table 6: Tiller count of gamma-irradiated rice varieties under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	13.8 ^b	12.0 ^a	12.9	13.6 ^{ab}	11.6 ^a	12.6
100 Gy	18.2 ^a	13.3 ^{a*}	15.8	14.0 ^a	11.1 ^a	12.6
200 Gy	14.4 ^b	12.4 ^a	13.4	12.5 ^a	13.0 ^a	12.8
300 Gy	11.7 ^c	12.1 ^a	11.9	11.1 ^b	11.3 ^a	11.2
Varietal mean	14.5	12.5		12.8	11.8	
SE	0.699					
S × V	0.859					
S × D	0.003**					
V × D	0.28					
S × V × D	0.373					

A significant increase ($p < 0.05$) was observed in the number of tillers per plant in rainfed FARO 67 at 100 Gy (18.2), while the dose of 300 Gy significantly decreased tiller count (11.7). In FARO 68, irradiation dose of 100 and 200 Gy significantly increased tillering (14.0 and 12.5, respectively) (Table 6). Results showed a significantly higher tillering in rainfed FARO 67 exposed to 100 Gy (18.2), in comparison to the irrigated field. A significantly higher ($p < 0.05$) number of productive tillers was observed in rainfed FARO 67 at 100 Gy (16.7) (Table 7). The variability in tillering suggests that gamma rays may have disrupted apical dominance or enhanced the expression of genes promoting lateral shoot development. The presence of this variability gives room for the selection of plants with high tillering ability, which is directly correlated to yield. This finding is similar to the reports of Mem *et al.* (2025), who reported significant variability in tillering of gamma-irradiated rice. The non-significant variability in the number of tillers in the irrigated field is in line with the report of Indrawanis (2025), who reported that gamma rays did not influence tillering in rice plants. This could be because gamma ray irradiation is random; some characters may undergo changes while other characters may not change

(Mardiyah *et al.*, 2021). The higher tillering observed under rainfed conditions compared to irrigated fields suggests the sensitivity of tiller development to moisture availability, as plants typically prioritise survival, limiting tiller formation as a resource conservation strategy (Guan *et al.*, 2010).

A significantly higher ($p < 0.05$) panicle length was observed in irrigated FARO 67 exposed to 200 Gy (27.9 cm) and FARO 68 exposed to 100 Gy (26.0 cm). Irradiation dose of 300 Gy significantly decreased panicle length in irrigated FARO 67 and FARO 68 (20.3 and 17.9 cm, respectively) (Table 8). Pairwise comparison revealed higher panicle length in rainfed FARO 67 at 0 and 300 Gy (31.6 and 30.7 cm, respectively), and in rainfed FARO 68 at 300 Gy (22.1 cm), in comparison to the irrigated plants. Contrary to the reports of Suliartini *et al.* (2023), who observed that panicle length decreased with an increase in gamma irradiation; notable increase was observed in panicle length of some of the mutant lines under irrigated field, which might be because gamma irradiation positively and negatively influenced some yield components of plants, depending on plant variety, irradiation dose and interaction with environmental factors.

Table 7: Number of productive tillers of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	11.0 ^b	10.2 ^a	10.6	10.6 ^a	9.6 ^a	10.1
100 Gy	16.7 ^a	9.2 ^{a*}	13	11.2 ^a	9.7 ^a	10.5
200 Gy	11.4 ^b	9.7 ^a	10.6	10.6 ^a	9.9 ^a	10.3
300 Gy	9.8 ^b	9.0 ^a	9.4	9.4 ^a	9.9 ^a	9.7
Varietal mean	12.2	9.5		10.5	9.8	
SE	0.622					
S × V	0.172					
S × D	0.000***					
V × D	0.953					
S × V × D	0.021*					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

Table 8: Panicle length (cm) of gamma-irradiated rice under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	31.6 ^a	23.2 ^{b*}	27.4	23.2 ^a	21.6 ^b	22.4
100 Gy	29.9 ^a	25.4 ^b	27.7	24.4 ^a	26.0 ^a	25.2
200 Gy	30.9 ^a	27.9 ^a	29.4	23.8 ^a	19.1 ^b	21.5
300 Gy	30.2 ^a	20.3 ^{c*}	25.3	22.1 ^a	17.9 ^{c*}	20
Varietal mean	30.7	24.2		23.4	21.2	
SE	0.842					
S × V	0.272					
S × D	0.000***					
V × D	0.000***					
S × V × D	0.002**					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

This study revealed a significant increase in grains per panicle of rainfed FARO 67 at 100 and 200 Gy (193.1 and 194.9, respectively). Irradiation doses of 100 – 300 Gy significantly increased grains per panicle in rainfed FARO 68, with the highest observed at 300 Gy (173.0). No significant difference ($p > 0.05$) was observed in grains per panicle of both varieties in the irrigated field. Pairwise comparison revealed a significantly higher grains per panicle in the rainfed plants (Table 9). Results revealed no significant differences in test weight of FARO 67 and FARO 68 among the treatment groups in both the

rainfed and irrigated fields. Also, significantly higher test weights were observed in the rainfed plants, except FARO 68 exposed to 200 Gy (Table 10).

Significant variability observed in the number of grains per panicle could be due to increased physiological activities at the genetic level as a result of the ionizing effect of the radiation. Similar findings have been reported by Himawan *et al.* (2025). The significant increase observed is in line with the reports of Masruroh *et al.* (2016), who have reported an increase in panicle grain number in irradiated rice.

Table 9: Grains per panicle of gamma-irradiated rice varieties under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	127.4 ^b	105.3 ^{a*}	116.4	116.3 ^b	107.1 ^a	111.7
100 Gy	193.1 ^a	94.7 ^{a*}	143.9	140.7 ^a	105.1 ^{a*}	122.9
200 Gy	194.9 ^a	108.2 ^{a*}	151.6	133.7 ^a	83.0 ^{a*}	108.4
300 Gy	137.1 ^b	92.3 ^{a*}	114.7	173.0 ^a	121.0 ^{a*}	147
Varietal mean	163.1	100.1		140.9	104.1	
SE	12.7					
S × V	0.29					
S × D	0.012*					
V × D	0.207					
S × V × D	0.061					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

Table 10: Test weight (g) of gamma-irradiated rice varieties under contrasting water regimes

Dose	FARO 67			FARO 68		
	Rainfed	Irrigated	Mean	Rainfed	Irrigated	Mean
0 Gy	765.0 ^a	667.0 ^{a*}	716	787.0 ^a	679.0 ^{a*}	733
100 Gy	795.0 ^a	650.0 ^{a*}	722.5	766.0 ^a	693.0 ^{a*}	729.5
200 Gy	800.0 ^a	672.0 ^{a*}	736	739.0 ^a	689.0 ^a	714
300 Gy	779.0 ^a	649.0 ^{a*}	714	795.0 ^a	682.0 ^{a*}	738.5
Varietal mean	784.8	659.5		771.8	685.8	
SE	30.5					
S × V	0.87					
S × D	0.887					
V × D	0.94					
S × V × D	0.7					

Means followed by the same letter (s) within the same column are not significantly different at $p > 0.05$. Means on the same row followed by asterisk (*) are significantly different at $p < 0.05$. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001. S: season, V: variety and D: dose, SE: standard error.

The higher grains per panicle and test weight observed in the rainfed plants could be attributed to the availability of sufficient soil moisture in rainfed conditions during critical growth stages such as panicle initiation, flowering and grain filling. Si *et al.* (2023) suggested that adequate water supply is important for photosynthesis, nutrient uptake and proper grain filling, which leads to a higher grain per panicle and test weight in the rainfed plants.

CONCLUSION

This study has demonstrated gamma irradiation as a potent mutagen for creating variability in

agromorphological traits of FARO 67 and FARO 68 rice varieties, and low irradiation doses of 100 and 200 Gy are the most potent. The findings revealed that the rice varieties responded differently to irradiation depending on the dose and environmental conditions. This offers the potential to broaden the narrowed genetic base of rice and support future breeding programmes by providing new mutant lines with improved agronomic traits and yield attributes for different agricultural systems.

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