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Effect Of Different Doses Of Gamma Irradiation And Stock Leaf Retention On The Success, Survivability And Stionic Growth In Veneer Grafting Of Mango CV, BAU AAM -14 (Banana Mango)

Md. Shamsul Alam[1], Mohammad Nurun –Nabi Mazumder[2], Mehedi Hassan[3], Md. Sabbir Hossain Sunny[4]

Senior Scientific Officer, Horticulture Division, Bangladesh Institute Of Nuclear Agriculture (BINA), Mymensingh
Principal Scientific Officer And Head, Horticulture Division, Bangladesh Institute Of Nuclear Agriculture (BINA), Mymensingh
Scientific Officer, Electronics And Health Physics, Bangladesh Institute Of Nuclear Agriculture (BINA), Mymensingh

Abstract
The present study was conducted to investigate the effect of different doses of gamma irradiation and retention of root stock leaf on the success (%), survivability (%) and stionic growth in veneer grafting of mango cv. BAU aam -14 (Banana mango). The experiment was conducted at the Germplasm Centre of Horticulture Division at the Bangladesh Institute of Nuclear Agriculture (BINA) during the period from April, 2024 to September, 2024. The experiment consisted of (i) four different doses of gamma irradiation viz., 0, 5 Gy, 10 Gy and 15 Gy and (ii) stock leaf retention viz., stock with leaf and stock without leaf below the union. The days required to bud break and leaf emergence, percentage of success, number of new leaves, leaf area, increased length and increased stionic height and survivability were significantly influenced by different doses of gamma irradiation and retention of stock leaf. In case of different doses of gamma irradiation, the highest percentages of success (82.24%) % survivability (77.89%), minimum days required to bud break (15.50days), time required to leaf emergence (20.1days),maximum leaf number of new growth(30),leaf area of new growth (1192.66 cm^2), increased scion length (25.33cm) as well as increased stionic height (31.25cm) were achieved in 10 Gy gamma rays exposed on scion at 120 days after grafting (DAG) while the lowest was observed in 15Gy gamma rays exposed on scion of success (58.33%) % survivability (52.33%), maximum days required to bud break (23.80days), time required to leaf emergence (7.62days), minimum leaf number of new growth(11.96),leaf area of new growth (901.33 cm^2), increased scion length (21.41cm) as well as increased stionic height (28.33cm) were obtained at 120 days after grafting (DAG). On the other hand, in respect of retention of stock leaf, stock with leaf below the union demonstrated the highest percentages of %success (71.25%), % survivability (62.87%), minimum days required to bud break (18.35days), time required to leaf emergence (23.56 days),maximum leaf number of new growth(35),leaf area of new growth (1207.98 cm^2), increased scion length (24.44cm) as well as increased stionic height (28.54cm) were recorded at 120 days after grafting (DAG), while the lowest values were found on all the mentioned parameters in stock without leaf below the union. The interaction effect of different doses of gamma irradiation and retention of stock leaf was statistically insignificant with few exceptions but their combined effects were significant. The highest percentages of success (78.48%) % survivability (70.51%), minimum days required to bud break (16.50 days), time required to leaf emergence (20.41days),maximum leaf number of new growth(31.90),leaf area of new growth (1078.58 cm^2), increased scion length (26.34cm) as well as increased stionic height (25.84cm) were achieved in 10 Gy gamma rays exposed on scion with stock leaf retention below the union at 120 days after grafting (DAG) while the lowest values was obtained on all the mentioned parameters from 15Gy gamma rays exposed on scion before operation and stock without retention of leaf below the union.

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I. Introduction

Mango *(Mangifera indica* L.) is one of the most popular and commercially important fruits in Bangladesh and called as the "King of fruits". It belongs to the family Anacardiaceae. In Bangladesh mango ranks first in terms of area and third in production (Hossain *et al*.,2023). In Bangladesh, Bangladesh produced a

total of 2,508,973 metric tonnes of mango. This production was achieved across 2,05,034 hectares of land (BBS, 2024) resulting an average yield of 2.56t/ha. This yield is much lower compared to that of the neighboring countries like India (8.95t/ha) (Ghosh, 1998: Hossain *et al*., 2023) and the Philippines (9.41t/ha) (Espino and Javier, 2022). Recently a dwarf and prolific regular bearing variety, known as "BAU aam-14 (Banana)" has been registered from Bangladesh Agricultural University (BAU)-Germplasm Centre and cultivated in this country. Desired mango plants can be propagated successfully by different vegetative methods such as veneer and cleft grafting etc.Venner grafting is better than cleft grafting in respect of success, survivability and growth of the mango grafts (Nooruzzaman, 2003). Various factors influence the success, survivability and growth of the mango grafts viz., scion conditions such as maturity, health, age of scion etc., rootstock conditions such as maturity, health, leaf retention etc. and time of grafting operation i.e. climatic conditions etc. gamma irradiation before grafting operation and retention of stock leaf are very important factors (Dhakal and Hoda, 1987; Ram, 1993). Research work in respect of retention of stock leaf in veneer grafting of mango cv. BAU aam-14 (Banana) is scanty in Bangladesh.

Gamma radiation can affect mango grafting success and growth, with lower doses potentially promoting growth while higher doses can be detrimental. Studies have shown that gamma irradiation can influence graft success, bud break and various growth parameters like shoot length, bud number, and leaf number. While some research indicates that low doses (e.g., 10 Gy) can enhance germination and seedling growth, according to a study on Magnolia champaca, higher doses can lead to negative impacts, including reduced fresh weight and plant height. The irradiation with gamma rays of a product consists in its exposure to a source of isotopes for a time sufficient for have absorption of radiation dose required (Candole.1984). Among the gamma radiation sources, the Cobalt-60 is the most used because it is an insoluble metal in water, with larger environmental safety.

Considering these facts in mind the present piece of research work was undertaken to study the effect different doses of gamma irradiation and retention of stock leaf on the success, survivability and stionic growth in veneer grafting of mango cv. BAU aam-14 (Banana). The investigation was undertaken to fulfill the following objectives: i) To find out the optimum doses of gamma rays for the best success in grafting; ii) to find out the necessity of stock leaf retention for the highest graft success and stionic growth and iii) to study the interaction if any between gamma rays and retention of stock leaf on the graft success, survivability and stionic growth in mango cv. BAU aam -14 (Banana mango)

II. Experimental Materials

The present study was conducted to investigate the effect of gamma irradiation and retention of root stock leaf on the success and stionic growth in veneer grafting of mango cv. BAU aam -14 (Banana mango). The experiment was conducted at the Germplasm Centre of Horticulture Division at the Bangladesh Institute of Nuclear Agriculture (BINA) during the period from May, 2024 to September, 2024. The experiment consisted of (i) four different doses of gamma irradiation viz., a) 0 Gy i.e. just before grafting (D_0), b) 5 Gy gamma irradiation exposed on scion before grafting (D_1), c) 10 Gy gamma irradiation exposed on scion before grafting (D_2) and 15 Gy gamma irradiation exposed on scion before grafting operation (D_3) and (ii) stock leaf retention viz., a) stock with leaf and b) stock without leaf below the union. Experimental materials were mango rootstocks and scions. About one year old seedlings developed in the nursery beds were used as rootstocks. The scions of mango were collected from the Germplasm Centrte of Bangladesh Institute of Nuclear Agriculture (BINA) Mymensingh. Scions were exposed with 60Co γ-rays. Thus, there were 8 treatment combinations. The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. To accomplish the grafting operations different tools and materials such as grafting knife, secateur, polythene cap, polythene paper to use as strip were used. The data were collected on the following parameters: days required to bud break, time required to leaf emergence, graft success, leaf number on new growth, leaf area on new growth, increased scion length, increased stionic height, and graft survivability .The data obtained from the experiment on various parameters were analyzed by Analysis of Variance Method (ANOVA).The mean separation was done by LSD as described by Gomez and Gomez (1984)

III. Results And Discussion

The results on the different parameters are presented in Tables and Figures for ease of discussion under the following subheading and possible interpretation have been given whenever necessary

Main effect of different doses of gamma radiation

The effect of different irradiation levels (0, 5Gy, 10 Gy and 15 Gy) on days required to bud bread, time required to leaf emergence, percentages of graft success, leaf number on new growth, leaf area on new growth, increased scion length, increased stionic height and percentages of graft survivability were influenced significantly. The highest percentages of success (82.24%), % survivability (77.89%), minimum days required

to bud break (15.50days), time required to leaf emergence (20.1days),maximum leaf number of new growth (30),leaf area of new growth (1192.66 cm^2), increased scion length (25.33cm) as well as increased stionic height (31.25cm) were achieved in 10 Gy gamma rays exposed on scion at 120 days after grafting (DAG) while the lowest was observed in 15 Gy gamma rays exposed on scion of percentages of success (58.33%), % survivability (52.33%), maximum days required to bud break (23.80days), time required to leaf emergence (27.62 days) (Table 1), minimum leaf number of new growth (11.96), leaf area of new growth (901.33 cm^2), increased scion length (21.41cm) as well as increased stionic height (28.33cm) were obtained at 120 days after grafting (DAG) (Table 2). This is might be due to fact that optimum dose (e.g., 10 Gy) enhanced % success and seedling growth, higher doses leaded to negative impacts, including reduced graft success and stionic growth. The significant decrease in graft success (%),survivability (%) and stionic growth were probably due to the effect of gamma irradiation on mersitematic tissues., chromosomal aberrations and inhibition of DNA replication and synthesis of growth regulators, interference of irradiation with the synthesis of enzymes, damage of cell constituents at molecular level and altered enzyme activity (Khan and Goyal, 2009; Asare *et al*., 2017; Yusuf and Nair, 1974). Doses above caused an inverse effect in the growth of the plants being similar the results of Arthur *et al.,* 2011. He reported that to emphasize is that these plants may exhibit changes in their characteristics as the increase or de- crease in vegetative growth and may result in obtaining of some improved genotypes, smaller and with higher production than plants obtained from non-irradiated grafts or control plants.

Table 1. Main effect of different doses of gamma irradiation and retention of stock leaf on the time required to bud break, leaf emergence, percentages of graft success and survivability

Doses of gamma irradiation	Time required to bud break(days)	Time required to leaf emergence (days)	% graft success (40 DAG)	% graft survivability (120 DAG)
Control(D_0)	21.55	25.24	65.51	59.68
5 Gy (D_1)	17.22	21.22	75.00	72.54
10 Gy (D_2)	15.50	20.01	82.24	77.89
15 Gy (D_3)	23.80	27.62	58.33	52.33
LSD (0.05)	1.77	1.94	1.68	1.24
Level of significance	**	**	**	**
Retention of rootstock leaf				
SLR	18.35	23.56	71.25	62.87
SWLR	26.47	30.25	65.45	58.96
LSD (0.05)	1.35	1.84	1.73	0.84
Level of significance	**	**	**	**

DAG= Days after grafting
SLR-Stock with leaf below the union
SWLR-Stock without leaf below the union
**= Significant at 5% level of probability

Main effect of retention of rootstock

Days required to bud break were significantly varied ($P<0.01$) due to the influence of retention of stock leaf. In respect of retention of stock leaf, stock with leaf below the union demonstrated the highest percentages of success (71.25%) % survivability (62.87%), minimum days required to bud break (18.35 days), time required to leaf emergence (23.56 days)(Table1), maximum leaf number of new growth(35), leaf area of new growth (1207.98 cm^2), increased scion length (24.44cm) as well as increased stionic height (28.54cm) were recorded at 120 days after grafting (DAG), while the lowest values were found on all the mentioned parameters in stock without leaf below the union (Table 2).The maximum time (days) required to bud break and days required to leaf emergence to stock without leaf below the union may be due to reduce the photosynthetic rate and juvenility of rootstocks. Significance variation in percentage of success, % survivability and stionic growth of grafts might be due to the increased photosynthetic rate and juvenility of rootstock (Ram, 1993) . He reported that success can be improved within leaves are retained below the point where the rootstock is cut, when the grafting portion of the root stock is a new flush and when the stem is pinkish- green.

Table 2. Main effect of different doses of gamma irradiation and retention of stock leaf on the number of leaves of new growth, leaf area of new growth, increased scion length and increased stionic height

Defoliation period of scion before grafting	Leaf number of new growth at				Leaf area of new growth (cm^2) at				Increased scion length (cm) at				Increased stionic height (cm) at			
	30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG
Control(D_0)	5	9	19	29	101.07	317.94	554.96	913.367	2.2	4.3	8.6	22.32	2.2	5.5	11.22	30.25
5 days(D_1)	6	10	23	32	195.26	331.44	757.57	1207.91	2.3	2.4	9.2	34.51	2.5	9.3	15.32	35.66
10 days(D_2)	7	12	25	35	186.56	375.17	749.96	1192.64	2.4	5	12.2	25.33	2.3	6.3	12.32	31.25
15 days(D_3)	5	8	18	30	108.81	312.90	677.69	1147.59	2.5	4.3	10.3	23.41	2.0	5.3	11.23	28.33
LSD (0.05)	1.42	1.45	1.61	1.196	2.365	66.20	3.888	4.217	0.78	0.88	1.02	1.34	0.98	1.02	1.32	1.45
Level of significance	**	**	**	**	**	NS	**	**	**	**	**	**	**	**	**	**
Retention of rootstock leaf																
SLR	5	11	22	35	165.02	375.41	742.48	1207.98	2..01	6.32	12.24	24.44	4.25	8.36	15.35	28.54
SWLR	4	10	20	32	130.82	293.31	627.61	1022.78	2.45	6.87	13.45	26.54	3.25	7.56	12.32	25.35
LSD (0.05)	1.29	1.35	1.63	0.73	1.672	46.810	2.749	2.982	0.22	0.58	0.66	1.01	0.87	0.78	1.28	1.45
Level of significance	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

DAG= Days after grafting
SLR-Stock with leaf below the union
SWLR-Stock without leaf below the union
**= Significant at 5% level of probability

Combined effect of different doses of gamma irradiation and retention of stock leaf on the percentages of graft success, percentages of graft survivability, time required to bud break, leaf emergence, leaf number of new growth, leaf area of new growth, increased scion height and increased stionic height

The interaction effect of different doses of gamma irradiation and retention of stock leaf was statistically insignificant with few exceptions but their combined effects were significant. The highest percentages of percentages of success (78.48%), % survivability (70.51%), minimum days required to bud break (16.50 days), time required to leaf emergence (20.41days) (Table 3), maximum leaf number of new growth (31.90),leaf area of new growth (1078.58 cm^2), increased scion length (26.34cm) as well as increased stionic height (25.84cm) (Table 4) were achieved in 10 Gy gamma rays exposed on scion with stock leaf retention below the union at 120 days after grafting (DAG) while the lowest values was obtained on all the mentioned parameters from 15 Gy gamma rays exposed on scion before operation and stock without retention of leaf below the union.This is might be due to gamma irradiation and rootstock leaf retention both influenced mango grafting success and growth. Low doses of gamma radiation stimulated growth and development, while rootstock leaf retention affected the overall health and vigor of the grafted plant (Sharma, 1987).

Table 3. Combined effect of different doses of gamma irradiation and retention of stock leaf on the percentages of graft success, time required to bud break and leaf emergence and % graft survivability

Treatment combinations		Time required to bud break (days)	Time required to leaf emergence (days)	% graft success at (40 DAG)	% graft survivability at (120 DAG)
Defoliation period of scion before grafting	Stock leaf retention				
Control(D_0)	SLR	17.98	21.98	67.23	63.51
	SWLR	22.74	26.60	59.21	58.21
5 days(D_1)	SLR	16.78	20.82	69.77	65.02
	SWLR	21.71	25.63	61.54	61.31
10 days(D_2)	SLR	16.50	20.41	78.48	70.51
	SWLR	21.26	25.17	67.84	67.12
15 days(D_3)	SLR	18.80	22.67	59.45	57.15
	SWLR	23.56	27.30	51.15	50.90
LSD (0.05)		1.972	1.846	1.56	1.788
Level of significance		**	**	**	**

SLR=Stock with leaf below the union.
SWLR= Stock without leaf below the union.
DAG= Days after grafting
**= Significant at 1% level of probability

Table 4. Combined effect of different doses of gamma irradiation and retention of stock leaf on the number of leaves on new growth, leaf area of new growth, increased scion length and increased stionic height

Treatment combinations		Leaf number of new growth at				Leaf area of new growth (cm^2) at				Increased scion length (cm) at				Increased stionic height (cm) at			
Defoliation period	Stock leaf	30 DA	60 DA	90 DA	120 D	30 DA	60 DA	90 DA	120 DAG	30 DAG	60 DAG	90 DA	120 DAG	30 DAG	60 DAG	90 DA	120 D

of scion before grafting	retention	G	G	G	AG	G	G	G				G				G	AG
Control (D_0)	SLR	6.18	14.25	20.42	27.87	113.24	335.79	595.74	995.58	3.70	7.28	12.01	24.75	3.80	7.48	12.31	27.16
	SWLR	5.34	13.15	20.22	26.51	88.89	300.09	514.18	831.15	2.42	6.04	10.75	23.50	2.51	6.20	11.04	25.84
5 Gy (D_1)	SLR	9.01	11.87	22.19	29.38	217.80	358.12	810.08	1283.16	3.60	7.13	12.17	25.45	3.70	7.33	12.48	27.81
	SWLR	8.13	10.05	21.95	29.17	172.71	304.76	705.05	1132.66	2.32	5.86	10.91	24.19	2.41	6.06	11.21	26.55
10 Gy (D_2)	SLR	9.50	16.80	24.75	31.90	205.81	459.69	823.29	1306.71	4.12	9.50	16.15	27.59	4.22	9.70	16.48	29.97
	SWLR	8.91	15.19	23.11	30.29	167.30	290.64	676.62	1078.58	2.84	8.23	14.89	26.34	2.93	8.43	15.21	28.87
15 Gy (D_3)	SLR	7.01	15.30	26.25	35.95	123.24	348.03	740.81	1246.45	3.01	5.94	11.25	23.41	3.28	6.13	11.54	25.84
	SWLR	6.00	14.31	25.16	33.96	94.39	277.76	614.58	1048.72	1.73	4.67	9.99	22.25	1.81	4.85	10.27	24.58
LSD (0.05) (0.01)		1.894 2.629	2.061 2.860	1.825 2.533	1.728 2.399	3.3444 4.642	93.6212 9.90	5.4987 7.613	5.9638 8.277	1.8412 2.555	1.8362 2.548	1.8002 2.499	1.7952 2.492	1.3411 1.861	1.3511 1.875	1.3311 1.848	1.2361 1.715
Level of significance		**	**	**	*	**	**	**	**	*	**	**	**	**	**	**	**

DAG=Days after grafting

** =Significant at 1% level of probability

SLR = Rootstock with leaf below the graft union

SWLR = Rootstock without leaf below the graft union

IV. Summary

To know the suitable gamma radiation dose to exposed on scion before grafting operation and to find out the necessity of stock leaf retention for the highest graft success and stionic growth in mango cv. BAU aam -14 (Banana mango), an experiment was carried out at the Germplasm centre of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from May, 2024 to September,2024. The experiment consisted of I) four different doses of gamma irradiation to exposed on scion viz, 5 Gy,10 Gy and 15 Gy and just before grafting operation and II) stock leaf retention viz., stock with leaf and stock without leaf below the graft union. The two factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Thus the total there was 240 number of graft (4 x 2x 3x10). Nearly one year old seedlings rootstocks uniform in size and growth of unknown cultivar of mango were used in the experiment .On the other hand, scions having diameter similar to root stocks were collected from selected mother plants of 4-5 years old (cv. BAU aam -14 (Banana mango). Selected scion shoots were exposed 5 Gy, 10 Gy and 15 Gy gamma rays before grafting using cobult 60CO gamma irradiation sources. On the other hand, the rootstocks selected for grafting portion for the treatment of rootstock with leaf and in case of rootstock without leaf all the leaves were removed just before the grafting operation.

In case of scion irradiation, 10 Gy before grafting operation took the minimum time to bud break and leaf emergence (15.50 days and 20.01 days, respectively) while scions irradiated 15 Gy before operation took the maximum time (23.80 days and 27.62 days , respectively). The highest percentages of success was achieved in scions irradiated 10 Gy before grafting operation (82.24% at 40 DAG) while the lowest was observed in scions irradiated 15 Gy before operation (58.33% at 40 DAG) . At 120 days after grafting operation, scions irradiated 10 Gy before operation gave the highest increase in scion length, stionic height and leaf area of new

growth and percentage of graft survival (25.33, 31.25cm, 1192.64 cm2 and 77.89% respectively) whereas the lowest results were recorded in scions irradiated 15 days before operation.

In case of retention of stock leaf, the highest results were always observed in stock with the retention of leaves below the graft union in respect of all parameters. The earliest bud break and leaf emergence were recorded in stock with leaf (18.25 and 23.56 days respectively) while the latest was observed stock without retention of leaf (26.47 days and 30.25 days, respectively). Similarly, the highest success, number of new leaves, leaf area, increased scion length, increased stionic height and final survival were achieved in stock with leaf (71.25 at 40 DAG, 35 leavess, 1207.98 cm, 24.44 cm, 28.54 cm and 62.87% at 120 DAG, respectively).while the lowest results were found in stock without leaf (64.45% tat 40 DAG,32 leaves,1022cm26.54 cm, 28.54cm and 58.96% at 120 DAG, respectively).

The interaction effect between the irradiation period of scion and retention of stock was insignificant except leaf area of new growth and graft success but their combined effect significantly influenced all the parameters except increased stock length.

The highest percentages of success (78.48%), % survivability (70.51%), minimum days required to bud break (16.50 days), time required to leaf emergence (20.41days),maximum leaf number of new growth(31.90),leaf area of new growth (1078.58 cm^2), increased scion length (26.34cm) as well as increased stionic height (25.84cm) were achieved in 10 Gy gamma rays exposed on scion with stock leaf retention below the union at 120 days after grafting (DAG) while the lowest values was obtained on all the mentioned parameters from 15 Gy gamma rays exposed on scion before operation and stock without retention of leaf below the union.

V. Conclusion

Scions should be irradiated either 10 Gy before grafting operation and the rootstocks should retain leaves below the graft union for the highest success, survivability and stionic growth in mango cv BAU aam - 14(Banana).

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