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Development Of Mutant From Lemon Leaves By Using Gamma Radiation And Leaf Cut Method Under Glass House And Field Condition

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Abstract
An experiment was conducted at the Horticulture division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from March 2024 to September 2024 to develop mutants from lemon leaves by using gamma radiation and leaf cut method under glasshouse and field conditions to find out the appropriate combination of irradiation dose and suitable environment on success, survivability, and growth of lemon. The experiment was consisted of two factors such as Environmental condition: (i) glass house and field condition and (ii) Nine gamma radiation levels (0 GY, 60 GY,80Gy,100Gy, 120 GY,140 GY,160 GY,180 GY and 200 GY).Mature leaves were collected from BINA Lebu-1 mother plants.Collected leaves were exposed by different doses of gamma radiation separately with 60 GY, 80GY, 100 GY, 120 GY, 140 GY, 160 GY,180 GY, 200 GY, and also a control at BINA from ^{60}Co gamma radiation sources. The experiment was laid out in RCBD with three replications. Total 18 treatment combinations of the environmental condition and radiation levels. Irradiated leaves of lemon were planted in the unit plots on 8 March 2023 in the afternoon with spacing of 15cmx15cm (row to row and leaf to leaf distance). Different environmental condition showed significantly influenced on almost all the mentioned parameters studied concerned with growth and growth contributing characteristics. The highest percentage of success and survivability was found in glass house condition and the lowest % success and %survivability was found in field condition.The glasshouse condition producedhigher number of roots(4.77), longer root length(9.24cm), diameter of shoot(4.95mm), higher number of leaves per plant(50.66) and field condition produced lower number of roots(3.55), smallest longer root length(7.14cm), lower diameter of shoot(2.26mm), lower number of leaves(43.00) per plant compared to the field condition. The application of 120GY irradiation level produced the highest number of roots (8.50), longest root length (16.1cm),the highest diameter of shoot (5.65mm), andthe highest number of leaves per plant (70.00) as compared to control. The combined effect of environmental condition and gamma radiations was statistically significant on the success, survivability and growth.120GY irradiation level in glasshouse condition produced the maximum roots (7.00), the longest root length (17.5.cm), the largest diameter of shoot (4.80mm), highest canopy volume (0.12m^3) and the maximum leaves per plant (73.00). Similarly, the lowest values were in respect of almost all the mentioned parameters were found at field condition with control treatment. Therefore, the overall results indicate that glasshouse condition with 120 GY might be an efficient and eligible practice for developing mutant from leaves.

Keywords: *Gamma radiation, Mutant, Environmental condition, Lemon leaf*

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I. Introduction

Citrus Species including lemon (Citrus limon) have played a vital role in human culture and agriculture for centuries (Nicolosi *et. al.*, 2000). Approximately 95411.89 metric tons of lime and lemons are produced year from 30248.22 acres of land, yielding 18.34 gs per fruit bearing trees (BBS,2022) whereas global production was 215,000 tons including 26.5 million tons in china, 3 million tons in EU and 1.9 million in turkey (UNDP,2018). In comparison to other countries, the yield is quite poor.Lemon is very important in respect of its nutritional values especially in Vitamin C (Stang, 2022). Induce mutation through gamma irradiation can cause changes in chromosome and genome, which bring to successful variation in the morphology of plant (Smith & Brown, 2017, Garcia AL 2021). Gamma ray, which is a physical mutagen, is a widely used method of having diversity on many plant species and creating new variations (Khan & Masood, 2019). Mutation breeding in lemon leaves through gamma radiation is a new technique. Leaf cuttings have been used for the vegetative propagation of citrus (Platt and Opitz, 1973; Debnath*et al.,* 1986; Singh *et al.,* 2013).Roots were formed at the petiole end. Different environmental conditions have significant effect of lemon production. The excessive heat and low temperature can retard the growth of lemon (Singh *et al.,* 2004). High temperatures affect citrus plants increasing transpiration, photosynthesis, destabilizing their cell membrane and increasing oxidative damage (Khan *et al.,* 2016; Jan *et al.,* 2012; Esnault *et al.,* 2010). The optimum temperature range for citrus sapling production is estimated to be 22-34▫C.Moreover low rainfall can also be an effect of lemon production (Wang *et al*., 2020).In order to achieve the following goals, the current study was conducted i) to investigate the effect of gamma radiation on the success, survivability, growth of lemon;ii) to find out the suitable environment for maximum success, survivability on the growth of lemon sapling; and iii) to find out the appropriate combination of irradiation doses and suitable environment on success, survivability, growth and yield of lemon sapling.

II. Materials And Methods

An experiment was conducted at the Horticulture division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from March, 2024 to September, 2024 to develop mutant from lemon leaves by using gamma radiation and leaf cut method under glass house and field condition to find out the appropriate combination of irradiation dose and suitable environment on success, survivability and growth of lemon. The experiment was consisted of two factors such as Environmental condition: (i) glass house and field condition and (ii) Nine gamma radiation levels (0 GY, 60 GY, 80Gy ,100Gy, 120 GY,140 GY,160 GY,180 GY and 200 GY). Mature leaves were collected from BINA Lebu-1 mother plants. Collected leaves were exposed by different doses of gamma radiation separately with 60 GY, 80GY, 100 GY, 120 GY, 140 GY, 160 GY,180 GY,200 GY and also a control. Healthy and insect- disease free mature lemon leaves were selected and whole leaves with petiole were collected from the two years old mother plants of BINA lebu-1. The collected leaves were irradiated by ^{60}Co source in the electronics section of BINA. Leaves were exposed to various doses of gamma-radiation from 60Co sources and with non-irradiated as a control dose. The absorbed irradiation doses were used as 0, 60, 80,100,120,140,160,180 and 200Gy. The experiment was laid out in RCBD with three replications. The whole experimental plot was divided into three equal blocks that were represented as replications according to the design. Each block was divided into 9 unit plots where 9 treatment combinations were allocated at random. The distance between blocks was 1m and between the plots was 0.5m. The unit plots were raised to about 20 cm with the soil of the drains. The size of each unit plot was 1mx1m. For each treatment combination per replication 56 cuttings were planted in each unit plot with spacing of 15cmx15cm. The spaces between the plots and blocks served to facilitate quick drainage of rain or irrigation water. Irradiated leaves of lemon were planted in the unit plots on 8 March, 2024 in the afternoon.One third of the portion of the leaves was pushed inside the soil at angle of 45° keeping distal end towards North. The soil around the cutting base was pressed just after their planting in the bed and then, the cuttings were watered by watering can. Intercultural operation was done as and when necessary. Data on the following parameters were recorded from each plot after 40 days of planting cuttings. Periodical data were taken from 10 cuttings are i) Time of root initiation; ii) Number of roots per cutting at 60, 75 and 90 days after planting of cutting, iii) Length of longest root per cutting at 60, 75 and 90 days after planting of cutting, iv)Time of shoot initiation ,v) Diameter of the shoot per cutting at 90, 120 and 150 days after planting of cutting vi)Length of the shoot per cutting at 90,120 and 150 days after planting of cutting, vii) Canopy volume of per plant at 150 days after planting of cutting, viii) Number of leaves per plant at 90, 120 and 150 days after planting of cutting , ix) Percent success & percent survivability at 150 days after plant of cutting. The recorded data for each parameter from the present experiment was analyzed statistically to find out the variation resulting from experimental treatment using MSTAT package program. The means for all treatments were calculated and analyses of variances of parameters under study were performed by F variance test at 5% and 1% levels of significance. The means of the parameter were separated by least significant difference test.

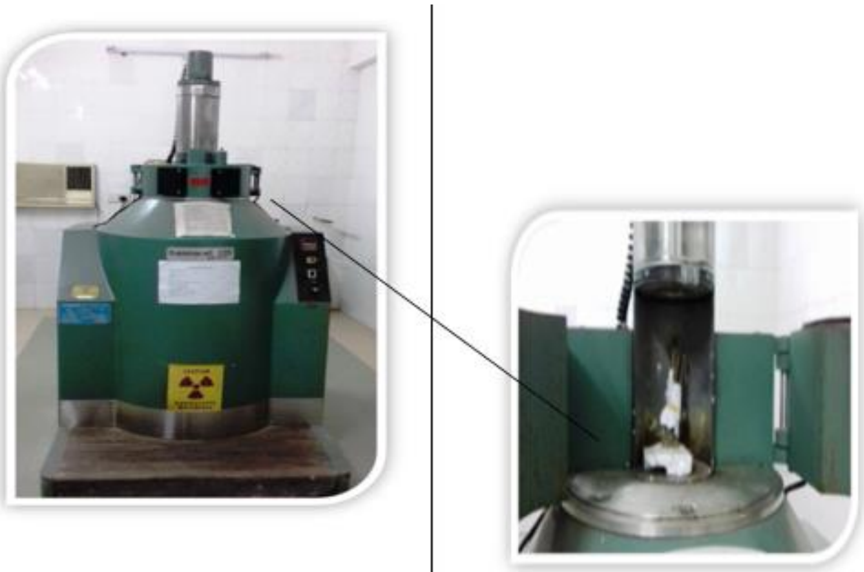

Plate 1: ^{60}Co gamma radiation source

a. Planting of lemon leaves in glasshouse

b. Planting of lemon leaves in open field

Plate 2: Photograph showing the planting of lemon leaves in glasshouse and open field condition

a. Length of root

b. Initiation of shoot

c. Plant in field condition

d. Plant in glasshouse condition

Plate3. Photograph showing the general view of experimental plat and collection of data

III. Results

Radiations, i.c. X-rays, gamma rays and ultraviolet rays have been widely used for producing mutations in crop plants. Among them gamma radiation has been frequently used to create variation in gene pools of crop plants on their cytological characteristics like cell division, resulting in cytological abnormalities and in a reduced frequency of dividing cells, which are ultimately reflected in reduced seedling growth and other morphological aberrations which vary from species to species and among different genotypes within the same species. To verify this concept a study was conducted in respect of growthand quality of lemon as influenced by two different environmental condition and gamma radiation doses.

Main effect of environmental condition

Time of root and shoot initiation, Canopy volume, percent success, percent survivability, length of longest root per cutting (cm), number of roots per cutting, diameter of shoots per cutting (mm) and number of leaves per cutting were significantly influenced by the environmental condition. The minimum time required to root and shoot (41.81 and 73.88 days) initiation in the glasshouse condition than the maximum time took for root and shoot initiation in the field condition (78.88).The earliest root and shoot initiation under glass house condition might be due to the favorable environment conditions with abundant supply of carbohydrate and other food materials prevailed at the time. The canopy volume was found higher in glass house condition (0.052m^3) and the lowest canopy volume was obtained in the field condition (0.026 m^3). This is might be due to early sprouting with abundant supply of carbohydrate and food materials present in the vigorous leave initially. The highest % success, % survivability, length of the longest root, number of roots per cutting, diameter of shoots and number of leaves per plant were recorded from glasshouse condition (59.05%, 54.24% (Fig.1),9.24cm(Fig.2), 4.77cm, 4.95mmand 50.66 (Fig.3) respectivelyand the lowest values were recorded on all the mentioned parameters from field condition(Table 1).

Table 1.Effect of environmental condition on time of root initiation, time of shoot initiation and canopy volume,no.of root/plant and diameter of shoot/plant at different days after planting

Variety	Time of root initiation at DAP	Time of shoot initiation	Canopy volume (m^3)	Number of roots/plants at DAP			Diameter of shoots/plant at DAP		
				60	75	90	90	120	150
C_1	41.81b	73.88b	0.052	2.11	3.33	4.77	2.01	3.81	4.95
C_2	48.88	78.889	0.026	1.44	2.44	3.55	0.83 b	1.34	2.26
$LSD_{0.05}$	0.56	0.90	0.0012	0.15	0.22	0.33	0.07	0.13	0.13
Level of significance	**	**	**	**	**	**	**	**	**
CV (%)	4.05	3.94	5.45	15.19	13.56	14.47	9.31	9.36	6.53

** = Significant at 1% level of probability
C_1 = Glasshouse condition, C_2 = Field Condition

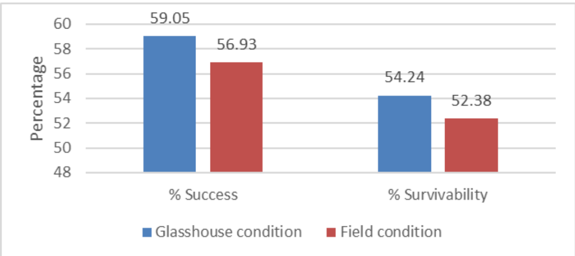

Figure1: % Success and % survivability of leaf cutting on different environmental condition

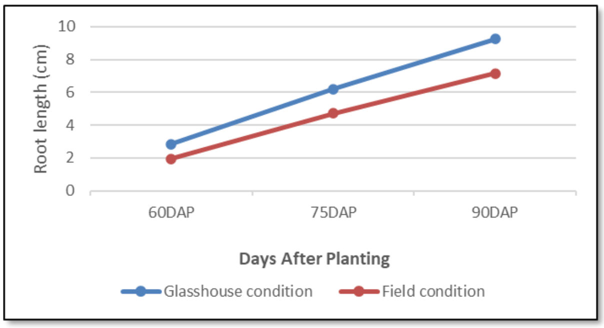

Figure4.2:Main effect of environmental condition on length of longest root.

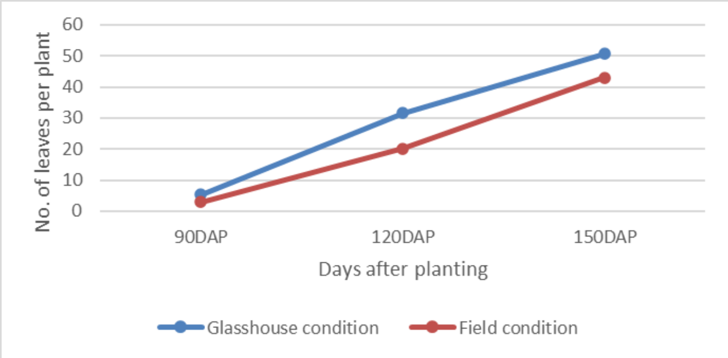

Figure 3:Main effect of environmental condition on no. of leaves per plant at different DAP. Vertical bars represent LSD at 5% level of significance

Main effect of different doses of gamma radiation

The effect of different irradiation levels (0GY, 60GY, 80 GY, 100GY, 120GY,140GY, 160GY, 180GY and 200GY)on time of root and shoot initiation, Canopy volume, percent success, percent survivability, length of longest root per cutting (cm), number of roots per cutting, diameter of shoots per cutting (mm) and number of leaves per cutting were influenced significantly.The maximum time of root initiation(40.00 DAP) was recorded from control treatment while the minimum time of root initiation (18.00DAP) was recorded from100 GY (Table 4). The maximum time of shoot initiation (75.00 DAP) was recorded from control while the minimum time of shoot initiation (36.00DAP) was recorded on 60 GY, 180 GY and 200 GY (Table 4). The canopy volume (0.091m^3) was recorded the highest in 120GY whereas the lowest canopy volume (0,003m^3) was recorded in control.The highest %success and %survivability (69.40%and 64.45%) was found in control plant whereas the lowest percentage success (48.10% and 41.38% respectively) was found in 200 Gy irradiation level(Fig. 4). In respect of the longest root per plant (16.1cm) (Fig. 5), the highest numbers of roots (8.50) per plant, diameter of shoot (5.65cm) per plant, number of leaves (70.00) per plant (Fig. 6), were obtained in 120 Gy radiation level and the lowest values were found on all the mentioned parameters in control treatment at 90 DAP (Table 2).

Table. 2. Effect of radiation on time of root and shoot initiation, canopy volume, no. of roots/plant and no. of shoots/plant at different days after planting.

Radiation	Time of root initiation	Time of shoot initiation	Canopy(m^3)	Number of roots/plants at DAP			Diameter of shoots/plant at DAP		
				60	90	120	90	120	150
D_0	40.00	75.00	0.003	1.50	2.00	2.50	0.40	0.70h	1.50
D_1	39.16	40.00	0.091	1.00	1.50	2.50	1.10	2.35	3.40
D_2	23.00	36.50	0.052	1.50	2.50	4.00	1.70	2.65	3.95
D_3	22.50	36.00	0.042	2.50	5.00	5.50	1.95	3.35	4.80
D_4	22.00	36.00	0.005	3.50	5.00	8.50	1.90	3.95	5.65
D_5	21.50	38.50	0.069	2.50	5.00	6.50	2.40	4.25	5.30
D_6	21.16	37.00	0.021	1.00	2.00	3.00	1.65	2.55	2.95
D_7	20.83	36.00	0.006	1.50	1.50	2.50	1.20	2.20	3.25
D_8	18.00	37.50	0.066	1.00	1.50	2.50	0.50	1.20	1.70
$LSD_{0.05}$	1.20	1.91	0.0025	0.32	2.00	0.71	0.16	0.28	0.27
Level of significance	**	**	**	**	**	**	**	**	**
CV (%)	4.05	3.94	5.45	15.19	13.56	14.47	9.31	9.36	6.53

** = Significant at 1% level of probability

Legend**:** D_0= Control, D_1= 60Gy, D_2=80Gy, D_3=100Gy, D_4=120Gy, D_5=140Gy, D_6=160Gy, D_7=180Gy, D_8=200Gy

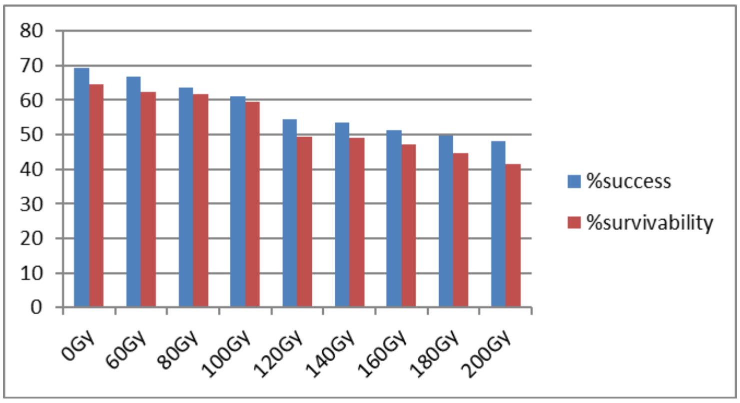

Figure 4.Percent success and survivability of lemon leaves propagation on different irradiation level. Vertical bar represents LSD at 5% level of significance

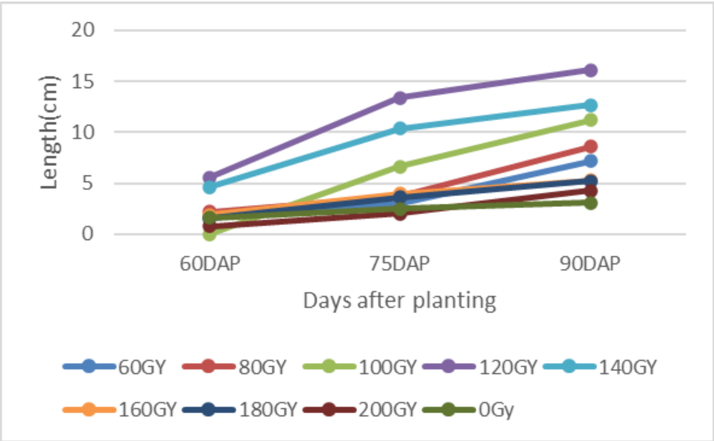

Figure 4. Main effect of gamma radiation levels on length of root per cutting of lemon. Vertical bar represents LSD at 5% level of significance

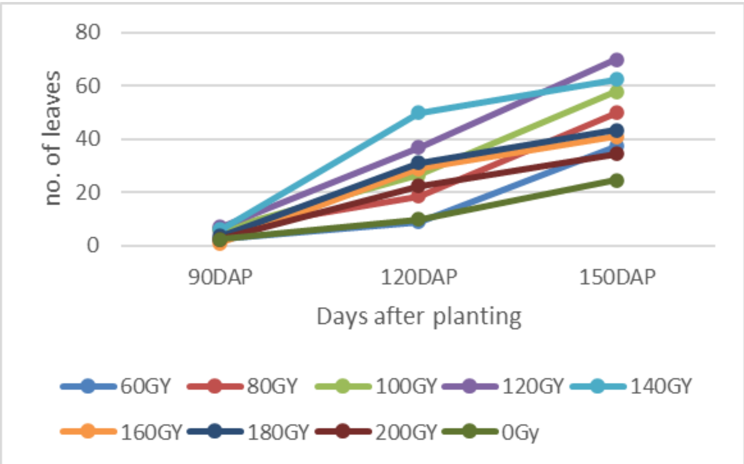

Figure 5.Main effect of gamma radiation levels on no.of leaves per plant of lemon. Vertical bar represents LSD at 5% level of significance

Combined effect of environmental condition and different levels of gamma radiation

The combined effect of environmental condition (glasshouse condition and field condition) and different levels of gamma radiation (0GY, 60GY, 80 GY, 100GY, 120GY, 140GY, 160GY, 180GY and 200GY) was significantly influenced on all the mentioned parameters. It was observed that the minimum time of root initiation (46.00) was obtained in V_1R_2 combination (glasshouse condition with 80 GY gamma radiation level) and the shortest time of root initiation (0.00) was obtained in $V_2R_{1,}$ (field condition with 200GY irradiation level) combination(Table 7). The maximum time of shoot initiation (80.00) and the highest canopy volume ($0.12m^3$) were obtained in V_1R_4 (glasshouse condition with 120 GY gamma radiation level) combination and the minimum time of shoot initiation (16.11days) and the lowest canopy volume (0.003m^3) was obtained in V_2R_8 (field condition with 200Gy irradiation level)combination at 150DAP (Table 7). The highest success percentage and percentage of survivability (Table 8),length of the longest root (Table 9), diameter of shoot (7.50mm) per plant (Table 11) and number of leaves (73.00) per plant (Table 12) were recorded in the glasshouse condition with 120 Gy irradiation level whereas the lowest values were obtained on all the mentioned parameters in the field condition with no irradiation (Table 8). The highest number of roots (10.00) was found in 0GY gamma radiation level in field condition while the lowest number (2.00) of root per cutting was produced by 140Gy irradiation level at 150 DAP (Table 10).

Table 2. Combined effects of variety and radiation on number of time of root initiation, time of shoot initiation and canopy of lemon propagation by leaf cuttings

Environmental Condition	Doses	Time of root initiation	Time of shoot initiation	Canopy (m^3)	No.of roots/plant at DAP			Diameter of shoots/plant at DAP		
					60	75	90	90	120	150
C_1 (Glass house condition)	D_0	40.00	70.00	0.004	1.00	2.00	2.00	2.10	3.50	4.70
	D_1	45.00	72.00	0.059	2.00	3.00	2.00	2.40	4.10	5.50
	D_2	46.00	73.00	0.70	3.00	6.00	2.00	2.80	5.20	6.70
	D_3	36.00	75.00	0.086	5.00	7.00	2.00	2.00	5.60	7.50
	D_4	38.33	80.00	0.120	3.00	6.00	2.00	3.40	5.90	7.10
	D_5	43.00	77.00	0.090	1.00	2.00	3.00	2.20	3.80	4.10
	D_6	42.33	74.00	0.033	1.00	1.00	3.00	1.60	3.20	4.40
	D_7	41.66	72.00	0.007	1.00	1.00	3.00	0.90	1.80	2.40
	D_8	44.00	72.00	0.006	2.00	2.00	3.00	0.70	1.20	2.20
C_2 (Field condition)	D_0	40.0e	80.00	0.003	1.00	1.00	3.00	0.10	1.20	2.10
	D_1	38.21	76.11	0.026	1.00	2.00	4.00	1.00	1.20	2.40
	D_2	36.22	73.26	0.034	2.00	4.00	5.00	1.10	1.50	2.90
	D_3	34.21	71.22	0.047	2.00	3.00	5.00	1.80	2.30	3.80
	D_4	40.00	65.22	0.063	2.00	4.00	5.00	1.40	2.60	3.50
	D_5	21.21	58.00	0.049	1.00	2.00	6.00	1.10	1.30	1.80
	D_6	19.00	56.11	0.010	2.00	2.00	7.00	0.80	1.20	2.10
	D_7	17.00	55.44	0.005	1.00	2.00	8.00	0.10	0.60	1.001
	D_8	16.11	53.25	0.004	1.00	2.00	10.0	0.10	0.20	0.80l
	$LSD_{0.05}$	1.70	2.71	0.0036	0.45	0.65	1.00	0.22	0.40	0.39
	Level of significance	**	**	**	**	**	**	**	**	**
	CV (%)	4.05	3.94	5.45	15.19	13.56	14.47	9.31	9.36	6.53

** = Significant at 1% level of probability

Legend: D_0= Control, D_1= 60Gy, D_2=80Gy, D_3=100Gy, D_4=120Gy, D_5 =140Gy, D_6=160Gy, D_7=180Gy, D_8=200Gy

Table 3. Combined effects of variety and radiation on percent success and survivability, length of longest root/plant, no. of leaves/plant at different days after planting of lemon

Environmental Condition	Doses	% Success	% Survivability	Length of longest root/plant at DAP			No. of leaves/plant at DAP		
				60	75	90	90	120	150
C_1 (Glass house condition)	D_0	70.50	63.50	2.10	3.70	8.20	3.00	11.00	47.00
	D_1	67.80	65.10	2.30	4.20	9.60	8.00	21.00	53.00
	D_2	64.20	62.70	2.00	7.70	12.2	7.00	29.00	60.00
	D_3	66.30	60.40	6.50	14.9	17.5	7.00	44.00	73.00
	D_4	55.70	50.50	5.50	11.5	13.7	10.0	57.00	64.00
	D_5	54.10	50.30	2.00	4.10	6.40	2.00	37.00	45.00
	D_6	52.30	48.40	1.80	4.50	6.20	5.00	39.00	45.00
	D_7	50.90	45.20	1.20	2.40	5.90	3.00	31.00	41.00
	D_8	49.70	42.06	2.10	2.90	3.50	3.00	16.00	28.00
C_2 (Field condition)	D_0	68.30	61.50	1.20	2.30	6.20	2.00	7.000	28.00
	D_1	65.60	63.80	2.10	3.20	7.60	4.00	16.00	47.00
	D_2	62.90	60.50	1.20	5.60	10.3	5.00	24.00	56.00
	D_3	64.10	58.50	4.60	11.9	14.7	7.00	30.00	67.00
	D_4	53.50	48.30	3.80	9.30	11.7	2.00	43.00	61.00
	D_5	52.70	48.10	1.80	3.80	4.20	0.00	21.00	37.00
	D_6	50.10	46.20	1.30	2.80	4.20	2.00	23.00	42.00
	D_7	48.70	43.90	0.40	1.60	2.70	2.00	14.00	28.00
	D_8	46.50	40.70	1.10	2.10	2.70	2.00	4.000	21.00
	$LSD_{0.05}$	2.28	2.13	0.41	0.90	1.22	0.96	3.16	2.33
	Level of significanc	**	**	**	**	**	**	**	**

	e								
	CV (%)	2.37	2.41	10.35	9.92	8.96	14.09	7.35	3.00

** = Significant at 1% level of probability, D_0= Control, D_1= 60Gy, D_2=80Gy, D_3=100Gy, D_4=120Gy, D_5 =140Gy, D_6=160Gy, D_7=180Gy, D_8=200Gy

IV. Discussion

This chapter comprises the discussion of the result obtained from the experiment. A comparison of different literature with the obtained result is shown in followings. The interpretations are shown in the following headlines.

Percent success & survivability

The percentage of success and survivability was higher in glass house condition and lower in open field condition. The success percentage was higher in control and lower in 200Gy. In addition, the percentage of survivability was higher in control has whereas lower survivability percentage was observed in 200Gy. There was a gradual decrease of success and survivability with the increase of radiation doses. The inhibition of propagation at high doses could be due to the damage in seed tissue, chromosomes and subsequent mitotic retardation and the severity of the damage depend on the doses used (Thapa,1999).

Canopy volume

It is revealed that glass house conditions resulted in more canopy volume of plant which was significantly higher than that under open field conditions. This might be due to modification in environmental factors like temperature and soil moisture in the glass house condition due to partial shade. The absolute light conditions may have an injurious effect on growth of seedlings due to increase in temperature and decreased moisture in soil. The present findings are in agreement with the findings of Muller (1988) who reported that maximum plant height was recorded in citrus in 40 per cent shade.The highest canopy volume (50.54 cm) was recorded in 120Gy and the lowest canopy volume (44.93 cm) was recorded in control which was very closer (44.68 cm) to 200Gy at 150 DAT (Table. 4.8). This might be inhibition of auxin synthesis due to low doses apparently while larger doses can destroy auxin activity directly (Dwelle, 1975; Chervin *et al.,* 1992; Liu *et al.,* 2008). As a result, plant growth retarded by the high dose of radiation.

Diameter of shoots

It is obvious from the data that shoot diameter of plant grown under glass house conditions was significantly higher than the plant grown in open field conditions. This might be due to favorable temperature and moisture conditions for growth of the seedlings and protection from insect pests and diseases inside the glass house. The full sunlight conditions might have an injurious effect on growth of plant due to increased temperature and decreased moisture in soil whereas shade inside the screen house increased the growth. These findings are in line with Rodriguez *et al.,*. (2001) who reported that shade increased stem diameter in coffee (Coffeaarabica L.).The diameter of shoot was decreased with the increase in radiation doses after 120GY level. It is a known fact that higher production of leaves causes increased photosynthetic activities leading to more cumulating of carbohydrate and there after production of the largest shoot. This is in agreement with the reports of others (Anon., 1983; Mohanty*et al.,* 1990)

Number of leaves

The result revealed that number of leaves was significantly high in glass house grown than in open field grown. This might be due to more favorable growth condition in glasshouse condition e.g. partial shade and less insect pest damage which resulted in more leaves under glass house condition than in the open field condition. Similar result was reported by Singh *et al.*, (2004) which was on growth performance of rough lemon seedlings under screen house condition. In addition, the no. of leaves was seen thehighest in 120 GY level and other levels of irradiation also showed significant variation. This may be due to the morphological changes and seedling growth of irradiated plants. It was strongly agreed with Maxic *et al., (*1966).

Moreover, combined effect also showed significant differences and glasshouse condition with 120GY irradiation level had the highest number of leaves. This was influenced by stimulation of different biological processes in leaves followed by cytological changes by the application useful doses. Some authors have referred it as concept of hormenesis, the (e.g., faster germination, increased growth of leaves, that accurse when seeds are subjected pre- irradiation with low doses of a radiation source (Thapa,1999).

Length of longest root

The longest root was found in the glasshouse condition. This could be happened due to controlled environmental condition in glass house. Moreover,the highest growth of root was in the 120Gy gamma irradiation level. The root length was shortest in 200 Gy. There was a gradual increase in the root length with the increase of dose but after 120Gy the root length became shorter with increasing doses. This result agreed with Wangn, 2020. who reported that the high doses of temperature decrease root length.

V. Summary And Conclusion

The experiment was conducted at the Horticulture division, Bangladesh Institute of Nuclear Agriculture,Mymensingh during the period from March 2024 to July 2024. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications to assess the effect of pattern of environmental condition and gamma radiation on development of mutant from lemon leaves by using gamma radiation and leaf cut method under glass house and field condition to find out the appropriate combination of irradiation dose and suitable environment on success, survivability and growth of lemon.The result of experiment showed that all the parameters studied were significantly influenced. Leaf cutting in glasshouse condition produced higher number of roots(4.77), longer root length(9.24cm), diameter of shoot(4.95mm), higher number of leaves per plant(50.66) and field condition produced lower number of roots(3.55), smallest longer root length(7.14cm), lower diameter of shoot(2.26mm), lower number of leaves(43.00) per plant. Percent success and survivability are also higher in the glasshouse condition than in the field condition.

On the effect of different radiation levels, all the parameters were significantly influenced. In case of all parameters; 120GY irradiation level produced the highest number of roots (8.50), longest root length (16.1cm), highest diameter of shoot (5.65mm), highest number of leaves per plant(70.00). The lowest number of roots(0.71), lowest root length (0.86cm), lowest diameter of shoot (0.26mm) and lowest number of leaves (1.65) per plant were observed in the no gamma radiation level. The graph follows a pattern in which it is seen that the parameters show effective result with the increase of radiation at 120GY level. But there was a gradual decrease after that level and at 200GY irradiation level the response of parametersare almost same as the control. In contrast, although all parameters showed best result in 120Gy.

All of the metrics were considerably altered by the combined effect of varied radiation levels and environmental condition. In terms of all characteristics, the 120GY irradiation level in glasshouse condition produced the most roots (7.00), the longest root length (17.5.cm), the largest diameter of shoot (4.80mm),highest canopy volume (0.12m^3) and the most leaves per plant (73.00). The lowest number of roots (2.00), root length (1.22cm), shoot diameter (0.27mm),lowestcanopy volume (0.003m^3) and number of leaves (21.00) per plant were recorded in the absence of gamma radiation in field condition. The following inferences could be drawn from the summary of the experiment:

The percentage of success and percentage of survivability were positively influenced by different environmental conditions. Between the environmental factors tested glasshouse condition had given the higher success. In case of radiation, the success percentage (69.40%) was the highest in control as well as survival percentage (64.45%) also showed the same value.The treatment combination with the best glasshouse condition and the irradiation dose 120Gy gave the maximum values for most of all the parameters studied in the propagation of lemon plant from lemon leaves.

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