한국환경농학회지 제24권 제1호 (2005)
Korean Journal of Environmental Agriculture Vol. 24, No. 1, pp. 66-70

Effect of Gamma Rays on the Growth Performance of Bangladesh Clone Tea

M. Aslam Ali,*, M. A. Samad[2], and M. K. Amin[3]

Graduate Training Institute (Crop Science), Bangladesh Agricultural University, Mymensingh; 2Dept. of Plant Breeding, Bangladesh Institute of Nuclear Agriculture, Mymensingh; 3 Dept. of Biotechnology, Bangladesh Agricultural University, Mymensingh

(Received February 28, 2005. Accepted March 22, 2005)

ABSTRACT : The experiment was carried out to investigate the effects of gamma radiation on the early growth performance and physiological traits of BT2 clone tea, the most promising cultivar released by Bangladesh Tea Research Institute. The fresh shoot cuttings were irradiated with seven different levels of gamma radiation such as 0, 10,20, 30, 40, 50 and 60 Gy from Cobalt 60Co source (Dept. of PlantBreeding, Bangladesh Institute of Nuclear Agriculture). Thereafter, the irradiated shoot cuttings were planted in polythene bags and kept under natural conditions. It was observed that callusing was initiated from 8th weeks after placement of tea shoot cuttings in the polythene bags and completed by 12th weeks. The morphological growth of tea shoot cuttings were recorded under varying levels of gamma radiation and growth stages. It was observed that the number of leaves, number of primary branches, base diameter, root length and total leaf area per plant significantly increasedwith the progress of time and increasing levels of gamma radiation, however, the plant height showed decreasing trend with the increasing levels of gamma radiation, which could be due to the change in chromosomal structure and genetic makeup. After 56 weeks of planting, the plant height, the number of leaves and primary branches per plant, base diameter, root length and total leaf area per plant recorded were 65.70 cm, 30.67, 7.33, 1.48 cm, 23.50 cm, and 1250.67 cm2 per plant respectively under the radiation level 60 Gy, whereas the corresponding figures of the above parameters at the control treatment were 76.21 cm, 18.33, 3.67, 0.92 cm, 17.75 cm and 778.33 cm2 per plant, respectively. A significant relationship was observed among the physiological growth parameters with the increasing levels of gamma radiation. The total dry matter gain, leaf area index, absolute growth rate and relative growth rate were significantly influenced with the rising levels of gamma radiation (up to 60 Gy), whereas the net assimilation rate of individual tea plant non-significantly responded as compared to those of control treatment. Finally after 56 weeks of planting, the maximum total dry weight gain, leaf area index, absolute growth rate, relative growth rate and net assimilation rate recorded under 60 Gay radiation level were 40.25 g/plant/week, 4.25, 1.18 g/week, 0.0621g/g/week and 17.07 g/m2/week respectively.

Key words: Gamma rays, BT2, leaf area, total dry matter production, absolute growth rate, relative growth rate, net assimilation rat

INTRODUCTION

Tea (Camellia sinensis L.) is a major cash crop and a vital export item/commodity of Bangladesh. Botanically, tea is a perennial shrub belonging to the family The aceae and accounts for about 0.81% of the GDP. Tea is cultivated mainly for leaf production. The tender leaves (upper two young leaves with a bud) are generally harvested for consumption purposes, because of their higher caffeine and poly phenol contents. Tea crop may be grown on a diverse ecological zones. In Bangladesh, tea is mainly grown in the hilly areas of greater Sylhet and Chittagong districts where hardly any other agricultural field crops could be cultivated successfully. In Bangladesh, the tea zones experience dry season from November to April, while the rainy season continues from May to October. It was observed that about 80% of the annual tea crop was harvested during June to September, when adequate rainfall was recorded. The cropping season of tea in Bangladesh is limited within nine months of the year (March to November) due to the adve-

*Corresponding author:
Tel: +82-55-751-54
E-mail: litonaslam@yahoo.com

rse climatic factors (Extreme variation in the day-night temperature, drought, rainless period, sharp fall in the base temperature), which encourages dormancy in tea shoots. The average production of made tea in our country is around 1151 kg/ha, which is very low as compared to other tea growing countries of the world such as 1795 kg/ha in India, 1382 kg/ha in Sri Lanka, 2285 kg/ha in Kenya and 1621 kg/ha in Japan[1)]. The inferior indigenous planting materials, adverse climatic conditions, highly weathered and extremely acidic soils with poor nutrients status may be responsible for such low yield in Bangladesh[2)]. There are some ways to develop better varieties of tea, such as, clonal selection from the existing plant population (mother bush), hybridization and the mutation breeding. Bangladesh Tea Research Institute so far has released 13 vegetative clones through clonal selection, which is time consuming and lengthy process[3)]. As the plant population of a single clone have the same genetic composition like the mother bush, therefore, they are more selective to environmental and cultural conditions which influence the adaptability and yield potentialities of the clone. The mutation breeding can play a vital role in developing an ideal clone tea having high yield potential, better cup quality, resistant against diseases, insects and drought[4)]. The induction of mutation in plant materials can be achieved either through physical or chemical mutagens. In India, the mutation breeding technique was initiated during 1967-68 at Tocklai to increase the genetic variability for crop improvement. It was found that the tea shoot cuttings irradiated with 2 to 6 KR gamma radiation, appeared to be the upper limit for survival as well as induction of mutation[5)]. Gamma radiation produces electromagnetic forces having short wave length (less than 0.01A0) but high energy. Cobalt 60 and Caesium-137 are the main sources of gamma rays. Gamma radiation may modify the tea plant architecture, tolerance to biotic and abiotic stresses through creating genetic variability in the available germ plasm of clonal tea, which will contribute towards higher yield and desirable improvement in quality. The effect may vary between two varieties of the same species due to different genetic makeup and growth behaviour[6)]. In Bangladesh, there is no specific research findings available for mutation breeding in tea species. Therefore, the present study was undertaken to assess the effects of gamma radiation on the morphological growth behaviour of a specific clone tea BT2, the most popular cultivar in Bangladesh Tea Industry.

MATERIALS and METHODS

The experiment was carried out at the Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, during the period from 15th September 2003 to November 2004. The experiment was conducted in poly thene bag. The soil used as a growth media in the poly thene bag was taken from BTRI, Srimangal. The soil was sandy loam type with pH 5.5. The sun-dried soil was thoroughly mixed with well decomposed cow dung at the ratio of 3:1. Thereafter, the poly thene bags (12 inch height and 3.8 inch diameter) were filled uniformly with mixed soils. Watering was done to settle the soil particles in poly bags and kept under shade for a few days before putting the shoot cuttings of BT2. The experiment was laid out in a Randomized Complete Block Design (RCBD) where each treatment was replicated three times. The shoot cuttings were collected from BTRI and were treated with different levels of gamma radiation such as T1 = control, T2 = 10 Gy, T3 = 20 Gy, T4 = 30 Gy, T5 = 40 Gy, T6 = 50 Gy, and T7 = 60 Gy from cobalt 60 (60Co) source, Bangladesh Institute of Nuclear Agriculture (BINA) laboratory, Mymen singh. Thereafter, the treated shoot cuttings were planted in the poly thene bags and kept under normal ambient air conditions. The poly bags were arranged in north south rows for proper penetration of sunlight all over the saplings. The destructive harvest methods were followed to measure the dry weight of tea plant at different growth stages. On the basis of morphological growth parameters the first harvest was done on 15th April 2004, when the saplings were 28 weeks old. The harvested saplings were then separated into leaf, stem and root. The dry weight of stem, leaf, and root of the sample plants were recorded after oven drying at 80+ 2oC for 72 hours. The final harvest was done on 15th November, 2004, when the saplings were 56 weeks old. In each harvest data on the morphological characters such as plant height, leaf area, number of leaves / plant, number of branches / plant, base diameter and root length were recorded properly. The leaf area of each tea sapling was measured with a leaf area meter (LICOR, Model LI-3000, USA). As the roots of the tea sapling were confined within the poly bag during the experimental period, therefore, the area covered by each sapling is equivalent to the area of poly bag. The formulae used to measure the leaf area index, absolute growth rate, relative growth rate and net assimilation rate of tea saplings for the successive harvests were developed by Roderick Hunt[7)].

STATISTICAL ANALYSIS

Data collected on different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance were done following MSTAT-C package programme and the mean differences among the treatments were compared with Duncan's New Multiple Range Test[8].

RESULTS AND DISCUSSION

It was observed that the plant height of tea sapling was gradually increased with the progress of time, however, the plant height showed decreasing trend with the increasing levels of gamma radiation (10-60 Gy) as compared to that of control treatment at all sampling dates (Table 1). The highest plant height (76.21cm) was recorded after 56 weeks of planting under control treatment, whereas the plant height was decreased to 65.70 cm under 60 Gy radiation level. It is assumed that higher levels of gamma radiation might have changed the chromosomal structure and genetic makeup of the tea cultivar BT2, which caused dwarf configuration. It was found that the seedling height of Chickpea was decreased with the increasing levels of gamma radiation[9]. It was also reported that plant height of Phaseolus vulgaris L. was decreased due to the increased level of gamma radiation[10]. Baluch et. al. [11]found that the plant height of Castor bean was decreased beyond the radiation level 30 krads. The number of leaves and primary branches per plant were gradually increased with the increasing doses of gamma radiation as compared to those of control treatment at all the sampling dates (Table 1).

After 56 weeks of planting, the highest number of leaves (30.67/plant) and branches (7.33/plant) were found under 60 GY radiation, whereas 18.33 leaves and 3.67 branches per plant were recorded at the control treatment. Hossain et al. [12]found that the number of compound leaf in Ipil-ipil was significantly increased with the increasing level of radiation (Up to 200 Gy radiation). Dutta et al., [13]found that tea seedlings (Hybrid of TV18 X BT3) possessed 9.20 primary branches per plant after 12 months of sowing in bed. Bandana et al., [14]also reported that Leucaena leucocephala seeds treated with 10 to 100 Gy gamma radiation resulted in maximum number of branches per plant.

The base diameter of individual tea sapling was also increased with the increasing levels of radiation and time increment (Table 1). After 56 weeks of planting, the maximum base diameter (1.48 cm) was recorded under 60 Gy radiation level, whereas the minimum base diameter (0.92 cm) was observed at control treatment. Dutta et al. [13]recorded the base diameter 0.87 cm in the hybrid cultivar of TV18 x BT3. Hossain et al. [12]found that Ipil-ipil seeds treated with 100 Gy gamma radiation resulted in increased diameter of hypocotyl significantly. The root length of tea sapling was also increased with the increasing levels of gamma radiation upto 60 Gy. The maximum root length (23.50 cm) was found under 60 Gy radiation level, whereas 17.75 cm long root was observed at control treatment after 56 weeks of planting. Hossain et al.[12]reported that the root length of Ipil Ipil was increased significantly under the rad-

Table 1. Morphological growth of tea saplings under different levels of gamma radiation

Levels of Gamma radiation (Gy)	Plant height (cm)		Number of primary branches per Plant		Number of leaves per Plant		Base diameter cm/ Plant		Total Leaf area cm^2/Plant		Root length cm/Plant	
	28 weeks Old	56 weeks Old	28 weeks Old	56 weeks Old	28 weeks Old	56 weeks Old	28 weeks Old	56 weeks Old	28 weeks Old	56 weeks Old	28 weeks Old	56 weeks Old
0	29.87a	76.21a	1.33b	3.67e	6.33e	18.33e	0.35g	0.92d	178.83d	778.33e	7.45f	17.75e
10	27.50b	74.60b	1.67ab	4.67d	7.33d	22.67d	0.40f	0.96d	195.67cd	932.50d	7.60de	19.20d
20	25.19c	72.33c	1.67ab	5.67c	7.33d	23.33cd	0.45e	1.15c	205.17cd	995.17cd	8.10cd	20.15c
30	24.21c	71.12d	2.0ab	6.33bc	8.33c	24.33cd	0.52d	1.20c	233.17c	1050.0bc	8.65bc	21.45b
40	21.51d	70.80d	2.33ab	6.67ab	8.67bc	25.33bc	0.55c	1.33b	271.67b	1091.6bc	8.90b	22.75a
50	20.03d	68.61e	2.33ab	6.67ab	9.33b	27.67b	0.60b	1.38b	301.67ab	1148.3ab	9.25ab	23.10a
60	18.13e	65.70f	2.67a	7.33a	10.67a	30.67a	0.65a	1.48a	335.17a	1250.67a	9.55a	23.50a
LSD 1 %	2.03	0.74	1.02	0.70	0.70	2.43	0.01	0.08	38.37	111.50	0.60	0.930

In a column, means having same letters are not significantly different at 1 % level of probability (DMRT) iation level 100 Gy. The leaf area of individual plant was increased with the increasing levels of gamma radiation at all the sampling dates. The maximum leaf area 1250.67 cm^2 per plant was recorded under 60 Gy radiation level after 56 weeks of planting, whereas the leaf area 778.33 cm2 per plant was observed at control treatment. Mika- utadze [15]reported that tea seeds treated with 10-15 Gy radiation resulted in the large leaves. Youssef et al. [16]also observed that Maleuca armillaris treated with 10 GY radia- tion resulted in increased leaf area, leaf length and leaf breadth. It was observed from figure 1 that the total dry matter production, leaf area index, absolute growth rate and relative growth rate were significantly influenced with the increasing levels of gamma radiation, however, the net assimilation rate non-significantly responded with the increasing levels of gamma radiation as compared to those of control treatment (Fig. 1)

The total dry matter gain for individual tea plant was increased with the increasing doses of gamma radiation (Fig. 1.). After 56 weeks of planting the maximum total dry matter gain was 40.25 g per plant under 60 Gy treatment, where as the minimum total dry weight 20.25 g per plant was recorded at control treatment. This could be due to the result of higher effective leaf area, leaf area index and net assimilation rate under 60 Gy radiation level as compared to those of control treatment. You ssef et al.[16]found that Maleuca armillaris treated with 20 Gy radiation resulted in maximum shoot dry mass. Ali et al. [17]found that the dry matter production in BT5 was 28.65 g per plant at 56 weeks after planting. The absolute growth rate of BT2 sapling was gradually increased with the increasing levels

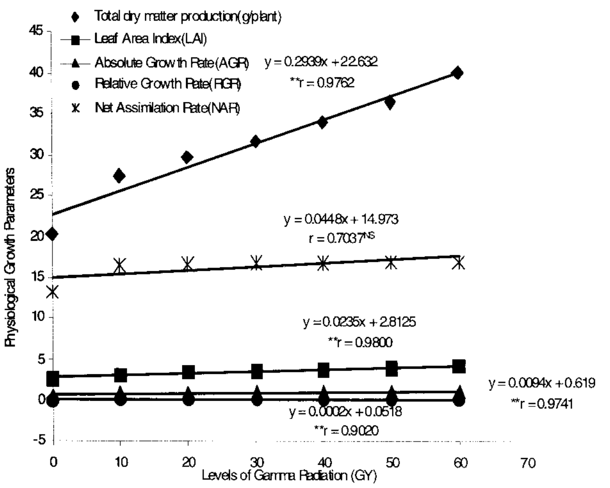

Fig 1. Physiological growth parameters of tea sapling (56 weeks old) under different levels of gamma radiation

of gamma radiation. The maximum and minimum absolute growth rate recorded were 1.1839 and 0.5392 g per week under the radiation levels 60 Gy and control (0) treatments respectively (Fig. 1). The gradual increase in total leaf area, leaf area index and total dry matter gain for individual tea plant under the increasing radiation levels (10-60 Gy) might have contributed to the continuous rise in absolute growth rate. The relative growth rate and net assimilation rate of tea saplings were also influenced by radiation levels. The relative growth rate was found maximum (0.0621 g/g/ week) under the radiation level 60 Gy, whereas the lowest relative growth rate (0.0485 g/g/week) was recorded at control treatment. It was also observed that the maximum and minimum net assimilation rate recorded were 17.07 g/m^2/week and 13.22 g/m^2/week under 60 Gy and '0' Gy radiation levels respectively (Fig. 1). Ali et al. [17]found the relative growth rate within 0.0414 g/g/week to 0.0456 g/g /week after 56 weeks of planting for different clones of Bangladesh tea. The lowest net assimilation rate (13.22 g/m^2 /week) was recorded at control treatment, which could be due to the lowest leaf area, least leaf area index and least number of branches as well as poor canopy architecture. On the contrary, the highest number of leaves and branches, maximum leaf area and leaf area index resulted in the peak net assimilation rate(17.07 g/m^2/week) under 60 Gy radiation level. Barua [18]found that the net assimilation rate for a typical assam type clone was 15.6 g/m^2/week, for china type clone 11.0 g/m^2/week and for intermediate type clone 12.8 g/m^2/week.

CONCLUSION

The study revealed that the increasing levels of gamma radiation (10 to 60 Gy) significantly influenced the morphological and physiological growth parameters of BT2 tea saplings as compared to those of control treatments, however, the plant height was in decreasing trend with the increasing levels of gamma radiation. This might be the result of changes in the structure and genetic makeup of chromosome, which needs to investigate in future under a wide range of gamma radiation.

ACKNOWLEDGEMENT

We wish to thank and express our great appreciation to the Director and staff of the Bangladesh Institute of Nuclear Agriculture and Bangladesh Tea Research Institute for their assistance and support extended during this study.

REFERENCES

1. Hudson, J. B. and Durairaj, J. 1998. Role of rejuvenation pruning in augmenting tea production in South India. Bull. of UPASI, Bull. No. 51, Int. Tea Committee Bull. Stat., 1997.
2. Sana, D. L. 1989. Tea science. Ashrafia Boi Ghar, 36, Bangla Bazar, Dhaka.
3. Alam, A. F. M. B., 1994. Influence of Improved Genetic Material Towards Higher Productivity of Tea in Bangladesh, Proc. of the International Seminar on "Integrated Crop Management in Tea: Towards Higher Productivity, Sri Lanka 1994, pp 33-49.
4. Sarwar, G., Alam, K., Malik, I. A. and Rajput, M. A. 1986. Studies on the effects of gamma radiation on Vigna radiata and Vigna mungo, Bangladesh Journal of Nuclear Agriculture 2:50-57.
5. Singh, I.D.(1984). Advances in Tea breeding in North-East India, In: Proc. PLACROSYM, Vol. IV, pp.88-106.
6. Zoz, N. N., Kozhannova, N. N. and T. V. Salijuikova. 1968. Different response of agricultural plants to the treatment with chemical mutagens. Genetic, 2:78-85
7. Hunt, R.. 1978. Plant growth analysis, Studies in Biology, No.96. Edward Arnold, London, pp 67.
8. Russel, O. F. 1986. MSTAT-C Package programe, Crop Department, Michigan University, USA.
9. Shamsuzzaman, K. M. 1997. Improvement of Chickpea through mutation breeding, Ph. D. Thesis, Department of Botany, Dhaka University. Bangladesh.
10. Carneiro-JE-de-s; Barbosa, H.M.; Cardoso, A. A. and Vieira, C. 1987. The sensitivity of seeds of Phaseolus vulgarisL. cv. Milionario 1732 to gamma radiation. Revista-Ceres, 34(193): 306-312.
11. Baluch, M. A. Natal, A. H. and Bukhari, M. A.1966. Studies on the effects of gamma radiation on Castor beans .Proceedings of Agril. Sypmosium, May 13-14.
12. Hossain, M.; Hossain, S. N.; Hossain, A. and Rahman, S. 1986. Effect of different doses of gamma radiation on growth and morphological characters of ipil-ipil plant. Bangladesh Sci. Conf. Rajshahi (Bangladesh) 2-6 Mar 1986. p. 42.
13. Dutta, M.J. and Sarwar, A. K. M. G. 1998. Comparative study on the early growth performances of four tea seed stocks, Tea J. of Bangladesh, 34 (1 & 2): 33-40.
14. Bandana B.; Mallick R. and Chatterjee A.K. 1987. Effect of gamma-irradiation on growth and biomass yield of Leucaena leucocephala. Indian-Forester, 113 (7):484-489.
15. Mikautadze, N.Z. 1986. Production of polyploidy forms of tea following gamma irradiation of seeds. Materially-5-S'ezda-Gruzinskogo-obshchestva-I-selektsionerov. p.100-106.
16. Youssef, E. M. A.; El-Alfy, T. and Hassan, A. K. 1998. Effect of various gamma irradiations and colchine treatments on growth behaviour any pigments and volatile oil products of Melaleuca armillaris Smith explants in vitro. Egyptian J. Hort., 25(3): 377-395.
17. Ali, M. A, Alam, A. F. M. B. and Shahiduzzaman, M. (1997). Study on the physiological growth parameters in clonal tea, In: Tea J. of Bangladesh, 33(1& 2), pp.1-11.
18. Barua, D. N. (1989). Science and practice in Tea culture, Tea Research Association, Calcutta, India, pp.371-395.