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SHORT TERM GROWTH OF RED AMARANTH (*Amaranthus gangeticus*) BY USING UREA FERTILIZER AND GIBBERELLIC ACID

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ABSTRACT

The study was conducted in agricultural research field at Noakhali Science and Technology University, Noakhali, Bangladesh during March 2021 to enhance the production of red amaranth (*Amaranthus gangeticus* cv: RM) by using urea fertilizer with gibberellic acid. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising four treatments with three replications. The treatment combinations were T_0 (Urea 0 kg ha^{-1} and 0 ppm GA_3), T_1 (Urea 200 kg ha^{-1}), T_2 (60 ppm GA_3), T_3 (Urea 200 kg ha^{-1} and 60 ppm GA_3), respectively. The growth and yield characters of red amaranth showed significant variation for different treatments of urea and gibberellic acid. The maximum plant height (37.1 cm), leaf number (13.83), leaf breadth (4.8 cm), leaf length (8.0 cm), shoot diameter (0.583 cm), fresh plant weight (9.73 g), dry weight per plant (0.775 g), yield per hectare (15.58 t/ha) were measured from treatment T_3 (urea fertilizer + gibberellic acid) at harvest (22 days after sowing). The maximum benefit cost ratio (BCR = 3.653) was recorded from treatment T_3 (urea fertilizer + gibberellic acid). Thus, it is concluded that the combined application of urea fertilizer with gibberellic acid would be optimum for short term growth and better yield of red amaranth.

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INTRODUCTION

Red amaranth (*Amaranthus gangeticus*) belongs to the family Amaranthaceae. Red amaranth is a popular vegetable grown in tropical and subtropical regions of the world. It plays an important role in nutrition and food security. Amaranth can be grown throughout the year and can be harvest in a very short time. However, its growth and development are slower in the winter than in the summer and rainy season (Bose *et al*., 1993). *Amaranthus gangeticus* is the most commonly cultivated species in Bangladesh. Because of its cheapest price, quick growth, and high production potential, amaranth is a famous and significant vegetable in Bangladesh (Hossain, 1996). As a result, it is regarded as a possible future auxiliary food crop in Bangladesh (Teutonic and Knorr, 1985). In Bangladesh, red amaranth cultivation increasing day by day (BBS, 2010). The red amaranth production in Bangladesh is lower than that of other amaranth producing countries (Talukder, 1999). Reducing the harvesting time of leafy vegetable cultivation is a priority of some agricultural researchers. Therefore, the researchers are trying to cultivate short growth leafy vegetables. This can be achieved through the use of chemically synthesized inputs like fertilizers, and plant growth regulators. Urea is the most common nitrogenous fertilizer plays vital role on leaf color, promotes vegetative growth, and improves the quality of produce including leafy vegetables (Chakhartrakan, 2003).

Gibberellic acid is one of the most common plant growth hormones. Gibberellins are known to stimulate plant growth and development, and the most common form of gibberellin is gibberellic acid. Gibberellic acid is a tetracyclic diterpenoid substance, which means it comprises four rings of atoms, twenty carbon atoms, and four methyl groups in one molecule (Gupta and Chakrabarty, 2013). Gibberellic acid has been used as a plant growth regulator in agriculture. Increased inter-node extension, increased leaf growth, and greater apical dominance are the most characteristic effects of gibberellic acid on shoot growth (Brian, 1959). However, several studies stated that application of N, P, K or organic manure increased yield of red amaranth but there is no report about the effect of urea fertilizer with gibberellic acid on yield of red amaranth. In Bangladesh, most of the farmers think that urea is the only fertilizer source for crop growth but they have no knowledge about plant growth hormone. Plant growth hormones also help to plant growth and development. These facts suggested that there is a wide scope of increasing red amaranth production through the combine use of urea fertilizer and gibberellic acid. The present experiment was conducted with the aim to investigate the effects of urea and gibberellic acid on the growth and yield quality of red amaranth.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at Agricultural Research Field, Noakhali Science and Technology University, Noakhali, Bangladesh in March, 2021 in the agro-ecological zone Young Meghna Estuarine Floodplain (AEZ 18). The soil textures of the experimental site were sandy loam and pH 7.2.

Experimental Methodology

Red amaranth (*Amaranthus gangeticus*) cv. RM was used as test variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising four treatments with three replications. The unit plot size was 1m ×0.25 m. The treatments were T_0 (Urea 0 kg ha^{-1} and 0 ppm GA_3), T_1 (Urea 200 kg ha^{-1}), T_2 (60 ppm GA_3), T_3 (Urea 200 kg ha^{-1} and 60 ppm GA_3). The land properly loosened with spade and big clods were broken into small clods and properly prepared for seed sowing. The land was fertilized with Cow dung, TSP, MoP at the rate of 5 ton, 100 kg, 150 kg per hectare, respectively. The entire amount of Cow dung, TSP, MoP was applied during land preparation. The seed was treated with Carbendazim. The red amaranth was sown during kharif-1 season by broadcasting method. The treatments were applied after ten days of seed sowing. Here, gibberellic acid was applied in plants by foliar application and urea fertilizer applied in soil. Irrigations were given by hand sprayer when needed. Red amaranths were harvested 22 days after sowing.

Data Collection

Data on plant height, number of leaves, leaf length and leaf breadth, shoot growth accompanied with dry and fresh weights, yield of red amaranth were recorded from six plants being randomly selected from each plot.

Statistical Analysis

The mean values for all the parameters were calculated and the analysis of variances for the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the least significant difference (LSD) test at 1% levels of probability (Gomez and Gomez, 1984). Then BCR (Benefit Cost Ratio) based profitability was assessed.

RESULTS AND DISCUSSION

Plant height

Plant height is an important growth contributing character of red amaranth. The application of urea fertilizer and gibberellic acid affected plant height significantly ($p<0.01$) demonstrated in Table 1. The highest plant height (37.1 cm) was recorded in treatment T_3 followed by treatment T_2 (30.31 cm), T_1 (26.11cm) and T_0 (16.41 cm), respectively. This result showed that the application of urea fertilizer with gibberellic acid produced the maximum plant height of red amaranth. Akter *et al*. (2020) reported that exogenous application of gibberellic acid increased the plant height of the vegetables. Application of urea also increased the plant height of red amaranth (Miah et al., 2013).

Leaf number

A large number of leaves indicate better growth and development of a crop. It is also positively related to the yield of red amaranth. As shown in Table 1, urea fertilizer and gibberellic acid induced differences among the number of leaves (per plant) were significant ($p<0.01$). The highest number of leaves (13.83) was found in treatment T_3 (urea fertilizer + gibberellic acid), and the lowest (9.667) number of leaves was obtained in T_0. The result showed that the application urea fertilizer with gibberellic acid produced maximum number of leaves. It was reported that application of gibberellic acid enhances division, elongation and proliferation of shoot cells and accelerated the vegetative growth of the plants (Ayyub *et al*., 2013). The number of leaves per plant of red amaranth was significantly increased by treatment of urea fertilizer (Miah *et al*., 2013).

Leaf breadth

In current experiment, application of urea fertilizer and gibberellic acid, the breadth of the leaves of the plant differed significantly ($p<0.0l$) demonstrated in Table 1. The highest leaf breadth (4.8 cm) was measured in the treatment T_3 (urea fertilizer + gibberellic acid). On the inverse, the lowest leaf breadth (2.767 cm) was found in the treatment T_0 followed by treatment T_2 (4.4 cm), and T_1 (4.3cm), respectively. Application of urea fertilizer with gibberellic acid increased leaf breadth of red amaranth. The leaf breadth of lettuce improved by the application of gibberellic acid (Akter *et al*., 2020).

Table 1. Effect of urea fertilizer and gibberellic acid on vegetative growth of red amaranth

Treatment	Plant height (cm)	No. of leaves per plant	Leaf breadth (cm)	Leaf length (cm)	Shoot diameter (cm)
T_0	16.417^{d}	9.667^{c}	2.7667^{b}	4.117^{c}	0.25^{c}
T_1	26.117^{c}	11.00^{bc}	4.3^{a}	6.333^{ab}	0.433^{b}
T_2	30.317^{b}	12.00^{b}	4.4^{a}	5.567^{bc}	0.3667^{b}
T_3	37.1^{a}	13.833^{a}	4.8^{a}	8.00^{a}	0.583^{a}
CV (%)	3.538	4.102	6.909	10.266	5.772
LSD $_{(0.01)}$	2.943	1.443	0.850	1.865	0.0713
Level of significance	**	**	**	**	**

T_0 = Urea 0 kg ha^{-1} and 0 ppm GA_3, T_1 = Urea 200 kg ha^{-1}, T_2 = 60 ppm GA_3, $T_{3=}$ Urea 200 kg ha^{-1} + 60 ppm GA_3

** = Significant at 1% level of probability

Leaf length

The effect of urea fertilizer and gibberellic acid on leaf length is shown in Table 1. Considering the treatments, significant ($p<0.01$) variation was recorded in leaf length. The longest leaf (8.0 cm) of red amaranth was measured in T_3 (urea fertilizer + gibberellic acid), and the shortest (4.11 cm) was recorded in the treatment T_0 followed by the treatment T_1 (6.33 cm), and T_2 (5.567 cm), respectively. This result showed that the application of urea fertilizer with gibberellic acid increased the leaf length of red amaranth. Leaf length of lettuce increased by the application of gibberellic acid (Akter *et al*., 2020).

Shoot diameter

Table 1 exhibited that the application of urea fertilizer and gibberellic acid influenced shoot diameter significantly ($p<0.01$). The highest shoot diameter (0.583 cm) was observed in T_3 (urea fertilizer + gibberellic acid), and the lowest (0.25 cm) one was recorded in T_0. The result showed that the urea fertilizer application with gibberellic acid increased shoot diameter of red amaranth. This could be the application of GA_3 which increased the vegetative growth of the plant through cell division and cell elongation. Exogenous application of GA_3 elevated division, elongation and proliferation of shoot cells that accelerated the vegetative growth of the plants (Ayyub *et al*., 2013). Shoot diameter of red amaranth was significantly increased by the use of urea fertilizer (Miah *et al*., 2013).

Fresh plant weight

The effect of urea fertilizer and gibberellic acid on plant fresh weight was significant ($p<0.0l$). As shown in Table 2, highest fresh plant weight (9.73 g) as measured in T_3 (urea fertilizer + gibberellic acid) and the lowest weight (1.69 g) was found in T_0 followed by the treatment T_2 (5.313 g), and T_1 (4.236 g), respectively. This result suggested that the application of urea fertilizer with gibberellic acid increased the fresh plant weight of red amaranth. Plant height, number of leaves, leaf area and shoot diameter was found to be increased with the exogenous application of GA_3 which helped to enhance the fresh weight of leafy vegetable (Miceli *et al*., 2019). Fresh plant weight of lettuce increased by the application of gibberellic acid (Akter *et al*., 2020). Toungos *et al*. (2018) also reported that increases the fresh weight of vegetable amaranths by the application of Nitrogen fertilizer.

Table 2. Effect of urea fertilizer and gibberellic acid on the yield attributes and yields of red amaranth

Treatment	Fresh plant weight (g)	Dry plant weight (g)	Yield/ha (t/ha)
T_0	1.697^{d}	0.25^{c}	2.715^{d}
T_1	4.236^{c}	0.36^{b}	6.778^{c}
T_2	5.313^{b}	0.32^{bc}	8.501^{b}
T_3	9.738^{a}	0.775^{a}	15.58^{a}
CV (%)	6.794	8.190	6.794
LSD $_{(0.01)}$	1.079	0.106	1.726
Level of significance	**	**	**

T_0 = Urea 0 kg ha^{-1} and 0 ppm GA_3, T_1 = Urea 200 kg ha^{-1}, T_2 = 60 ppm GA_3, $T_{3=}$ Urea 200 kg ha^{-1} + 60 ppm GA_3
** = Significant at 1% level of probability

Dry plant weight

The effect of urea fertilizer and gibberellic acid on plant dry weight was significant ($p<0.0l$). As shown in Table 2, highest dry weight per plant (0.775 g) was measured in T_3 (urea fertilizer + gibberellic acid), and lowest (0.25g) was found in T_0 followed by the treatment T_2 (0.32g), and T_1 (0.36 g), respectively. The result showed that the application of urea fertilizer with gibberellic acid increased plant dry weight of red amaranth. Plant dry weight of amaranth positively influenced by nitrogen fertilizer (Roy, 2008).

Yield (per hectare)

The effect of yield of red amaranth was demonstrated in the Table 2. All the treatments corresponding to red amaranth yield per hectare was significant (p<0.0l). The highest yield (15.58 ton/ha) was observed in T_3 (urea fertilizer + gibberellic acid), and the lowest yield (2.71 t/ha) was recorded in T_0. The study was also found 6.778 t/ha yield in T_1 (Urea 200 kg ha^{-1}), and 8.501 t/ha in T_2 (60 ppm GA_3) which both are smaller than T_3 (urea fertilizer + gibberellic acid). The results showed that the application of urea fertilizer with gibberellic acid produced the highest number of leaves, fresh weight and fresh yield which revealed maximum yield per hectare of red amaranth. The application of gibberellic acid was found to be more pronounced in increasing vegetable production (Tsiakaras *et al*., 2014; Aliyu *et al*., 2018).

Table 3. Effect of urea fertilizer and gibberellic acid on economic performance of red amaranth cultivation

Treatment	Gross income (Tk/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	BCR (Benefit Cost Ratio)
T_0	17136	21800	4664	0.786
T_1	50736	26200	24536	1.936
T_2	55216	25100	30116	2.199
T_3	107408	29400	78008	3.653

T_0 = Urea 0 kg ha^{-1} and 0 ppm GA_3, T_1 = Urea 200 kg ha^{-1}, T_2 = 60 ppm GA_3, T_3 = Urea 200 kg ha^{-1} + 60 ppm GA_3, BCR= Benefit Cost Ratio.

Economic analysis of red amaranth production

The partial budget analysis on the effect of urea fertilizer and gibberellic acid on red amaranth production is presented in Table 3. The highest gross income Tk. 1,07,408/ha was found in T_3 (urea fertilizer + gibberellic acid) and the highest BCR (3.653) was found in T_3 (urea fertilizer + gibberellic acid).

CONCLUSION

The results of this study indicated that combined application of urea fertilizer with gibberellic acid has significant impact on the growth parameters of red amaranth like plant height, leaf number, fresh and dry weight of plant and the yield parameters also showed significant effect on yield (15.58 kg/ha) and BCR (3.653). Comparative results of various parameters studied in the present investigation suggested that yield and BCR is highly potential in T_3 (urea fertilizer + gibberellic acid). However, the present study was conducted in summer season (2021) at NSTU research field, and further experiment need to be studied in different environments. Finally, the BCR suggests that the treatment T_3 (urea fertilizer + gibberellic acid) has the potentiality to increase the growth and yield red amaranth.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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