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GROWTH AND YIELD RESPONSES OF RED AMARANTH TO LOCALLY SOURCED LIQUID MANURE

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Abstract

The experiment was conducted at Horticultural farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period of September to November 2023. The experiment was laid out with single factor experiment using a completely randomized design with three replications to study the Growth and Yield responses of Red Amaranth (*Amaranthus cruentus* L) to liquid manure. The treatments under this study were; T_1: Control (Only Water), T_2: Vermi Tea; T_3: SAU- MLM, T_4: SAU-NLM, T_5: SAU-PLM. Significant variation of growth and yield parameters were found among the treatments. Among the treatments. The tallest plant (44.3 cm), maximum root length was (13.3cm), maximum leaf area (38.2 sq. cm), maximum leaf number (14.0), maximum fresh weight per plant (22.1g), highest weight of plants per 506.25 sq. cm (274.9 g) and highest yield per ha (54.3 ton) was found in T_5 while shortest plant (25.1 cm, minimum root length (4.8cm), minimum leaf area (16.4 sq. cm), minimum leaf number (8.6), minimum weight of plants/506.25 sq.cm. (77.5 g) and the lowest yield per ha (15.6 t) was found in T_1 at final harvest (30 days after showing). Considering the overall analysis, it becomes evident that T_5 consistently exhibits superior outcomes when compared to the other treatments. The superior performance of T_5 suggests that it could be the optimal choice for maximizing agricultural productivity while maintaining a focus on human well-being and environmental sustainability. This treatment option not only results in higher yields, indicating potential economic benefits, but it also contributes to the overall safety and health considerations for individuals involved in the agricultural processes.

Key words: Lal shak, Agroecological farming, safe food and organic.

Introduction

Red amaranth (*Amaranthus cruentus*) is acknowledged for its simplicity of cultivation and its remarkable abundance of nutrients. This leafy vegetable has gained popularity in Southeast Asia and is now gaining traction worldwide due to its appealing color, delicious taste, and high nutritional content. The nutritional endowments of amaranths provide evidence that the plants deserve some scientific attention. Lysine and sulfur-containing amino acids have been found in their leaves (Dodok *et al*., 1997). Many vegetables and cereal grains lack these amino acids. Additionally, the leaves are high in carbohydrates, several vitamins, including beta-carotene and vitamin C, and minerals such as iron, calcium, manganese, and zinc (Gamel *et al*., 2006). Due to the necessity to increase agricultural yields, the usage of inorganic fertilizers for red amaranth cultivation has increased dramatically in Bangladesh in recent years. Nevertheless, there are a lot of drawbacks to this tendency. Overuse of chemical fertilizers has resulted in contamination of the environment, deterioration of the soil, and health issues. Organic manures provide a way for reducing the indiscriminate use of chemical fertilizers and help to maintain soil health, which has a positive impact on organic matter recycling (Manoj *et al*., 2020). The use of organic fertilizers, either bulky or liquid organic manures, plays an important role in sustaining soil health as well as the productivity of crops (Verma et al., 2018). The advantageous bacteria, which aid in nitrogen fixation and phosphate solubilization, will thrive in the liquid organic manures. The beneficial microorganisms will survive in the liquid organic manures and are helpful in phosphate solubilization, nitrogen fixation, etc. Upon their application, they will enhance the soil microbial population and their activity to a greater extent in the soil and, in turn, have a positive effect on the growth and development of crops (Boraiah *et al*., 2017). In contrast to bulky organic manures, liquid organic manures dissolve easily in water and are more easily absorbed by plants. Moreover, its ease of application through irrigation systems makes it a convenient and efficient choice for farmers, offering a viable alternative to synthetic fertilizers while supporting long-term soil health and sustainability in agriculture. In these circumstances, the study was conducted to evaluate the impact of various liquid manures on the growth and productivity of red amaranth.

Methods and materials

The experiment was conducted at the Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka, from September to November 2023. To study the growth and yield performance of red amaranth to local based liquid

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manure. The experiment was accomplished with three replications following completely randomized design (CRD). The treatments included in this study were as follows: **T_1**: Control (only water), **T_2**: Vermi Tea; **T_3**: SAU-MLM (Mixed Liquid Manure), **T_4**: SAU-NLM (Natural Liquid Manure), and **T_5**: SAU-PLM (Probiotic Liquid Manure). To prepare the planters, half drums were utilized, filled with a mixture of dry cow dung and sandy loam soil. Care was taken to ensure the removal of any gravel, stones, or other unwanted materials from the soil. Following the necessary preparations, seeds were broadcasted, allowing them ample time to sprout and grow.

Preparation of liquid manure and its method of application:

T_1: Control (no manure, only water application)

T_2: 10 kg of vermicompost was mixed with 100 liters of water and left for 7 days to make vermi-tea. The solution was stirred with a stick once in a day to prepare the vermi tea well. One-part vermi tea mixed with 5 parts water was used when it was used as the treatment. (Vermi compost: water 10:**100**; **Application:** 1:5 V/V)

T_3: The SAU-MLM liquid manure was prepared by mixing 10 parts vermicompost with one part of mustard oil cake and one part of bone meal in 100 liters of water. The solution was stirred with a stick once in a day to prepare the SAU-MLM well. One-part MLM mixed with 5 parts water was used when it was used as the treatment. (Vermi compost: Oil cake: bone meal: water=10:1:1:**100**; **Application:** 1:5= MLM: water, V/V)

T_4: SAU-NLM liquid manure was prepared by mixing 10 parts of fresh cow dung mixed with 10 parts of urine and 1 part of molasse and the mixture was mixed well with 100 liters of water. The solution was stirred with a stick once in a day to prepare the SAU-NLM well. One-part NLM mixed with 5 parts water was used when it was used as the treatment. (Fresh Cow dung: Fresh Urine: Jaggery: Water=10:10:1:**100**; **Application:** 1:5; NLM: Water, V/V)

T_5: To prepare the SAU-PLM; 10 parts of cow dung mixed with 10 parts of urine mixed with 1 part molasses and 1 part of besan flour. This mixture mixed well with 100 liters of water. The solution was stirred with a stick once in a day to prepare the SAU-PLM well. One-part NLM mixed with 5 parts water was used when it was used as the treatment. (Fresh Cow dung: Urine: Jaggery: Chick pea/ Gram Besan: Soil: Water=10:10:1: 1:1:100; **Application:** 1:5; PLM: Water, V/V)

Regular intercultural activities were carried out for the better growth and development of the crops. When the seeds were sown in the half drum, they were initially given a light amount of water. Subsequently, irrigation was provided accordingly, based on the plants' requirements. During the course of this experiment, a light trap was utilized in conjunction with the application of neem oil at five-day intervals in order to mitigate the impact of insect infestations**.** Data were taken on various growth and yield related parameters to evaluate the treatments effects on growth and yield of red amaranth.

Yield calculation method:

The statistical analyses were conducted using the STATISTIX 10 statistical program. The analysis of variance (ANOVA) was conducted to assess the differences between treatments. The Least Significance Difference (LSD) test at a significance level of 5%.

Results and Discussion

The experimental results on growth and yield parameters obtained during the period of study were presented as follows;

Plant height: Significant variation was found among all the treatments. (Fig1) DAS, and 30 DAS, as depicted in Figure 1. The tallest plants were recorded in T_5 (13.2, 39.3, 44.3) cm at 10 DAS, 20 DAS, and 30DAS. T_5 consistently exhibited the greatest height among all treatments throughout the entire duration (Plate 1). The plant height in T_1 at 10DAS, 20 DAS, and 30DAS was recorded as the lowest, measuring 8.3cm, 21.3cm, and 25.1cm, respectively. Among all the treatments, T_1 consistently exhibited the lowest plant height.

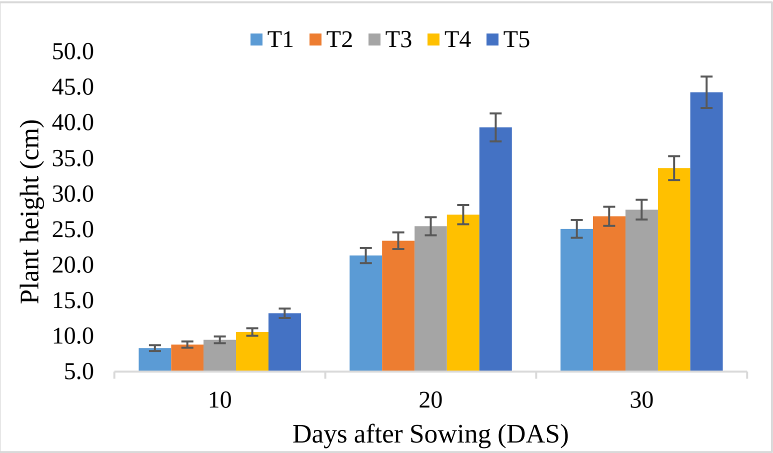

Figure 1. Influence of different liquid manure on plant height.
(T_1: control (only water); T_2: Vermi Tea; T_3: SAU-MLM; T_4: SAU-NLM and T_5: SAU-PL)

Root length: A significant variation of root length among the treatments was observed in the root length of Red Amaranth at the harvest stage (Plate 1). According to Table 1, T_5 exhibits the greatest average root length measurement at 13.3 cm, a finding that holds statistical significance. In contrast, T_1 shows the lowest mean value of 4.8 cm. Additionally, T_4 demonstrates the second highest mean root length at 8.5 cm.

Leaf area: A significant variation was observed in the Leaf area of Red Amaranth among the treatments at the harvest time in the table 1, T_5 (38.2 sq. cm) has the highest mean leaf area value. Similar opinion was found that application of liquid manure it can produce bigger leaves and denser canopy (Maity et al., 2020). Conversely, T_1 (16.4 sq. cm) has the lowest mean value.

Table 1. Influence of different liquid manure on root length, leaf area, leaf number and yield.

Treatments	Root length (cm)	Leaf area (sq. cm)	Leaf no.	Fresh wt./plant (g)	Yield/ 506.25sq. cm	Yield (t/ha)
T_1	4.8 c	16.4 e	8.6 b	3.3 c	77.5	15.6 e
T_2	5.5 c	21.0 d	13.0 a	9.5 b	156.8	30.9 d
T_3	4.4 c	32.2 c	13.0 a	10.1 b	181.2	36.2 b
T_4	8.5 b	34.2 b	12.6 a	12.7 b	166.2	34.2 c
T_5	13.3 a	38.2 a	14.0 a	22.1 a	274.9	54.3 a
CV%	12.1	1.2	6.5	11.2	1.1	1.8
LSD	2.5	1.2	2.2	3.6	2.9	1.7

Here, T_1: control (only water); T_2: Vermi Tea; T_3: SAU-MLM; T_4: SAU-NLM and T_5: SAU-PLM

Leaf number: The leaf number of Red Amaranth varied significantly among the treatments at the harvest stage (Plate 1). According to Table 1, T_5 exhibited the highest leaf number value (14.0), distinguishing it as the top performer, whereas T_1 recorded the lowest significant leaf number value (12.0).

Plate 1: Plant height and root length with different treatments

Fresh weight of plant: A significant variation was observed in fresh weight per plant due to the different treatments. The highest average weight per plant at harvest time was found in T_5, measuring 22.1g, while the lowest weight was recorded in T_1, at 3.3 grams. Among the treatment T_2, T_3, and T_4 did not display any significant variance, but T_1 showcased a substantial distinction when compared to T_2, T_3, T_4, and T_5. Upon examining the data, it can be concluded that the T_5 treatment exhibited remarkable success in terms of fresh weight during the harvest period.

Leaf color variation: The colorimetric measurement of the red amaranth leaves with the different liquid manure treatments were measured using a precision colorimeter IWAVE. Variation in leaf color attributes (L*: lightness; a*and b*: two cartesian coordinates; C*: Chroma; h_{ab}: hue angle) based on CIELab scale with standard observer 100 and standard illumination D65 (CIE 1986; McGuire 1992). The receptive data for each of the treatments were presented in Table 2 and it that the T_5 treatment produced much more vivid red color in compare the other treatments.

Table 2. Colorimetric measurement of leaf color variation of red amaranth influenced by different liquid manures treatments

Treatments	L*	a*	b*	c*	h_{ab}
T_1	27.7	2.1	9.6	9.8	77.9
T_2	28.5	7.4	5.6	9.3	36.9
T_3	26.3	8.6	3.1	9.1	20.2
T_4	26.7	9.5	3.4	10.1	20.1
T_5	27.1	8.3	4.0	9.2	25.7

L: lightness; a*and b*: two cartesian coordinates; C*: Chroma; h_{ab}: hue angle

**here, T_1: control, only water; T_2: Vermi Tea; T_3: SAU-MLM; T_4: SAU-NLM and T_5: SAU-PLM

Yield: A significant variation was observed in yield per ha due to different treatment. The significantly highest plant yield ton per hectare was recorded in the T_5 (54.6 t/ha). The T_1 (15.6 t/ha) has recorded significantly the lowest yield per hectare which is attributed mainly due to the less effectivity of the treatment per plant, minimum yield, and poor response of these treatments in environmental condition. T_5 encompasses a blend of cow dung, urine, basan, and soil filled with thriving microbes. These microorganisms voraciously consume the basan, effectively serving as probiotics. The beneficial effects of Jeevamrut reported by Devakumar et al., (2008) was attributed to higher microbial load and growth harmones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield of crops. Jeevamrut contains cow dung, cow urine, Jaggary, pulse flour which almost similar composition of T_5 treatment of this experiment.

Conclusion

The T_5 treatments for Red Amaranth showcased impressive yield performance, indicating substantial potential for enhanced growth, superior quality, and increased yield of Red Amaranth, as described earlier. This unequivocally establishes that the performance of T_5 surpassed that of the other two treatments. Notably, T_5 exhibited maximum growth and yield at the time of harvest. This positive impact could prove particularly beneficial for farmers in Bangladesh, as it suggests that adopting T_5 could lead to improved outcomes in terms of crop yield and overall plant strength, contributing to enhanced agricultural productivity and economic well-being for farmers in the region.

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