



INFLUENCE OF BORDEAUX MIXTURE AND CLYBIO ON GROWTH AND YIELD OF INDIAN SPINACH (*Basella alba* L.)

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Abstract

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during the period of May to July 2023. The single factor experiment was laid out in Completely Randomized Design (CRD) with three replications to determine the growth and yield of Indian Spinach (*Basella alba* L.). The experiment consisted of three treatments, namely: T₁: Control; T₂: Bordeaux Mixture (three times with ten days interval) and T₃: Clybio (three times with ten days interval). Significant variations were observed in all treatments when data pertaining to various growth and yield parameters were collected, where the average tallest plant (187.3 cm), maximum SPAD value (37.9), maximum leaf area (252.6 sq cm), stem diameter (21.4 mm), maximum root weight (39.4 g), highest yield per plant (484.9 g) and highest yield per ha (17.81 ton) were found in (T₃: Clybio) application, while the shortest plant (42.8 cm), minimum SPAD value (30.3), minimum leaf area (112.1 sq cm), lowest yield per plant (420.5 g) and lowest yield per ha (15.6 tons) were found in Bordeaux Mixture (T₂). On the basis of the whole experiment, it can be concluded that Clybio as a bio-fertilizer, possesses the inherent potential to enhance the growth and yield of Indian spinach, thereby indicating its capacity to exert a positive influence on the overall development and productivity of this leafy green crop.

Key words: Indian spinach, biostimulator, clybio, leaf area.

Introduction

Indian Spinach (*Basella alba* L.) is a widely cherished leafy vegetable in Bangladesh, appreciated for its adaptability to diverse soil and climatic conditions, (Mondal *et al.*, 2011). It is grown in practically all backyard gardens as well as in open fields in Bangladesh. Notably, it's tender shoots and leaves boast significant nutritional value, rich in essential salts and vitamins. Indian spinach is a perennial vine that grows quickly. It is widely grown and known as a popular summer-season vegetable all over the world. The Bangladesh Agriculture Research Institute has developed high-yielding Indian spinach varieties known as BARI puishak 1 and BARI puishak 2, which are widely cultivated by local farmers for commercial purposes. Regrettably, a prevailing issue in Bangladesh's Indian spinach farming is the indiscriminate use of chemical pesticides and fertilizers, which pose risks to both human health and the environment. To address this concern, a study has introduced an organic stimulant, Clybio, as a safer alternative. Clybio, a Japanese organic fungicide, is a composite blend of yeast fungus, bacillus natto, and lactobacillus. It has demonstrated the ability to enhance vegetable yield and quality while effectively controlling fungal pathogens. The unscientific application of pesticides and synthetic fertilizers in agriculture has far-reaching consequences, including health hazards and environmental degradation, leading to soil quality deterioration and a negative impact on vegetable flavor. Recognizing the need for safe food production, the Bangladeshi government advocates reducing or discontinuing the use of synthetic fertilizers. Soil health is pivotal in ensuring safe food production. Consequently, this study was initiated to assess the impact of Bordeaux mixture and Clybio on the growth and yield of Indian spinach, offering an eco-friendly alternative to conventional farming practices. Considering these factors, the current study was designed to evaluate the influence of the Bordeaux mixture and Clybio on the growth and yield of Indian spinach.

Materials and methods

The experiment was conducted at Horticulture Farm, Sher-e-Bangla Agricultural University during the period of May - July 2023. Experiment was laid out in Completely Randomized Design (CRD) with three replications. The experiment was setup in half plastic drum, soil was prepared by mixing 5 kg dry cow dung with 25 kg sandy loam soil each drum. Three seeds were sown in each half drum. After 7 days of seed germination, single seedling per drum was kept and the rest of the seedling was removed. The experiment was consisted of three treatments namely; T₁: Control (No treatment); T₂: Bordeaux Mixture (three times with ten days interval) and T₃: Clybio (three times with ten days interval). Treatments were applied to plants three times every ten days from seven days after seed

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germination.

Bordeaux mixture preparation: Bordeaux mixture was prepared by adding 5-liter water in 100g copper sulphate and again 5-liter water in 100 g lime were soaked overnight. These two solutions are mixed well in a large bowl to form a Bordeaux mixture (Plate 1). **Clybio application:** Clybio was collected from Compass Corporation, Bangladesh and was applied as recommended by Compass Corporation (4ml/ L) for this experiment (Plate 2).

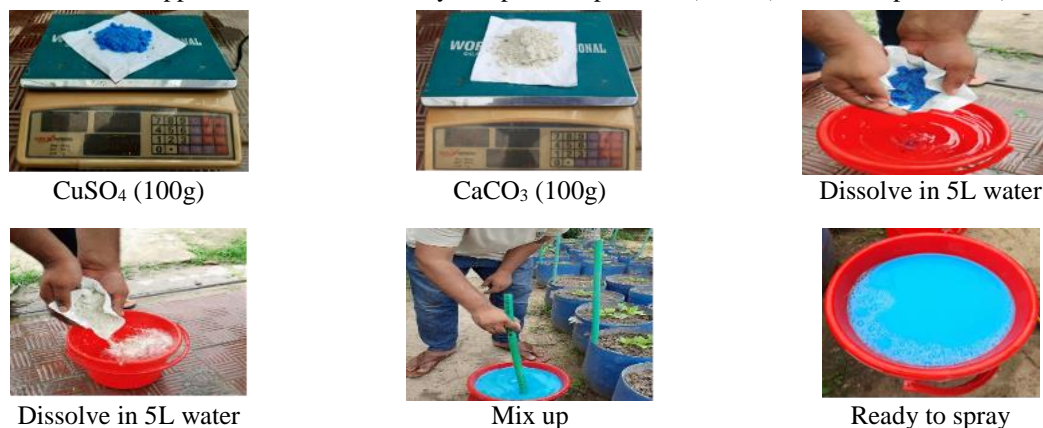


Plate 1. Bordeaux mixture composition and preparation



Plate 2. Clybio application method

Irrigation and weeding were done when it was necessary. Light trap was used to control the insect infestation during the production period. Data on plant height, SPAD value, leaf area, stem diameter, root weight, yield per plant and disease observation were collected during the research period. Final harvest was done at 45 days after sowing. Plant height was measured at 15, 25, 35, and 45 days after sowing (DAS). The plant height was measured distance from the soil surface to the tip of the highest leaf in centimeter. Measurement of SPAD value using a hand-held SPAD-502 Plus (KONKA MINOLTA) meter. For each evaluation, the content was measured in 3 times from three leaves at different positions per plant and the average was used for analysis. Leaf areas were measured using Top instrument machine and was expressed in sq cm. The diameter of the stem for each of the three plants was measured using a digital slide caliper at last harvest stage in millimeters (mm). Stem and root fresh weights were calculated using a digital balance. The number of leaves per plant was counted from the three selected plants and their average was taken as the number of green leaves per plant. Pest infestation was observed on eye estimation. Yield per plant was calculated by averaging the yields of three plants per treatment and yield per hectare were calculated as ton per hectare. 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, as Gomez and Gomez (1984) proposed, was employed at a significance level of 5%.

Results and discussion

Plant height: A significant variation was found on plant height with different treatments at different days after sowing. It was found tallest plant height (187.3 cm) at final harvest (45 DAS) with T₃, whereas the lowest plant height (140.3 cm) with T₁ (Fig.1). The vegetative and reproductive growth potential of plants is responsible for superior plant height. Furthermore, the probable reason could be that the optimum amount of Clybio application resulted in increased physiological growth of spinach. It improved the plant's ability to utilize light, water, and nutrients, leading to the development of more established plants. Similar findings reported by (Fahad *et al.*, 2006). They proved how exogenously applied growth regulators improve the morpho-physiological development of plants. Soil microbes to the ecosystem is reviewed, with particular emphasis on the role of plant growth-promoting rhizobacteria, arbuscular mycorrhizal fungi, and endophytic bacteria in providing necessary nutrients for plant growth (Miransari *et al.*, 2011).

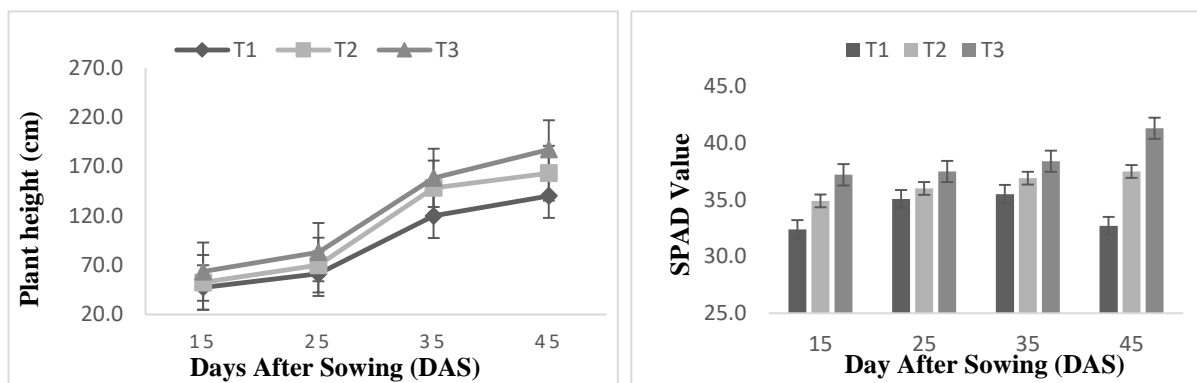


Figure 1. Influence of Bordeaux mixture and Clybio on plant height (T₁: Control, T₂: Bordeaux Mixture, T₃: Clybio).

Figure 2. Influence of Bordeaux mixture and Clybio on SPAD values of Indian Spinach leaves (T₁: Control, T₂: Bordeaux Mixture, T₃: Clybio).

SPAD value: A significant variation was found among the treatments. The highest recorded SPAD value (41.3) in T₃, and the lowest value (32.7) in T₁ application (Fig. 2). The content was measured three times from three distinct leaves for evaluation, with the average being used for analysis. The SPAD meter readings correlate with the amount of green in the leaf. Treatments such as T₁, T₂, and T₃ show the SPAD value. It's may be the effect of Clybio. The development and increased chlorophyll content are facilitated by the vital amino acids, vitamins, and phytohormones that are promoted by the yeast-derived substance Clybio (Taha *et al.*, 2020).



Plate 3: Variations of leaf area with different treatments at final harvest

Leaf area: A significant variation was found in leaf area with different treatments (plate 3). Highest leaf area was measured (252.6 sq. cm) at final harvest with T₃ application, whereas the lowest value of leaf area (112.1 sq.cm.) in T₁ application (Table 1). The most probable cause could be that, leaf grown more physiologically after absorbing the certain amount of Clybio treatment.

Stem Diameter: Among the treatment, T₃ showed the highest stem diameter (21.4 mm) while T₁ showed the lowest (17.4 mm) stem diameter at final harvest (Table 1). Clybio is the unique and complex microbe that contains bacteria like Lactic acid bacteria, Bacillus natto bacteria and yeast fungus and the improving tendency of plant growth and development (Uddin *et al.*, 2021).

Root weight: Significant variations found in root weight due to the different treatments. The highest root weight (39.4 g) at final harvest with T₃ treatment, whereas the lowest value of root weight (28.9 g) in T₁ treatment (Table 1). Microbes are beneficial to plant growth through colonizing plant roots and inducing mechanisms by which plant growth increases (Miransari *et al.*, 2011).

Disease infestation: Significant variations in disease infestation due to the different treatments were observed. The highest percentage of infected leaves was found in T₁ (10.0) and the lowest percentage of infected leaves was found in T₃ (1.6) at final harvest (Table 1). Observing the plant, we can claim that the T₃ treatment performed very well in the case of disease observation during harvesting time. Clybio is a special complex microorganism that includes yeast fungi, bacteria like Lactic acid bacteria, Bacillus natto bacteria, and bacteria that are improving plant diseases.

Table 1: Influence of Bordeaux mixture and Clybio on leaf area, stem diameter, root weight, disease infestation of Indian Spinach

Treatment*	leaf area (sq. cm)	Stem diameter (mm)	Root wt. (g)	Disease infestation (%)	Fresh wt. /Plant (g)	Yield (t/ha)
T ₁	112.1 c	17.4 b	28.9 b	10.0 a	420.5 b	15.6 b
T ₂	116.9 b	17.5 b	38.3 a	5.3 b	426.1 b	15.7 b
T ₃	252.6 a	21.4 a	39.4 a	1.6 c	578.2 a	21.2 a
CV%	0.52	6.9	3.6	14.4	1.16	1.1
LSD	2.4	3.7	3.7	2.3	15.9	0.38

* T₁: Control, T₂: Bordeaux Mixture, T₃: Clybio

** According to the 0.05 threshold of provability, means in a column with similar letters are statistically the same, whereas those with differing latter differ significantly

Fresh wt./plant: The significant variation is noted by the application of treatments where, highest weight per plant (578.2 g) was recorded in T₃ application while T₂ performed well and weight per plant was recorded (426.1g), (Table 1). Lactobacillus bacteria which help to nitrogen fixation and accumulation of auxin and cytokinin that trigger plant growth, flowering stage (Higdon *et al.*, 2020); Bacillus solubilize soil P, enhance nitrogen fixation, and produce siderophores that promote its growth (Hashem *et al.*, 2019); yeast stimulates plant hormones like auxins, gibberellins, cytokines, synthesis of vitamins, antifungal and antibiotic compounds, ability to solubilize minerals like phosphorus and other nutrients that enhances plant growth, enhance photosynthesis (Agamy *et al.*, 2013). Bordeaux mixture is a combination of copper sulfate, lime, and water, and is an effective fungicide and bactericide that has been used for decades to control diseases for crop production, these natural minerals provide long-lasting protection to plants against diseases and yield losses due to disease (Teng *et al.*, 1984). In addition, a presence of critical nutrients as calcium and copper (Uddin *et al.*, 2021) increased crop development and yield (Nurul *et al.*, 2014).

Calculated Yield: The plant yield differences among the treatments with respect to stem weight. The significantly highest plant yield was recorded in the T₃ (21.2 t/ha) treatment and T₁ (15.6 t/ha) was recorded significantly the lowest yield (Table 1), which is attributed mainly due to the less effectivity of the treatment per plant, minimum yield, and poor response of these treatments in environmental conditions (Akther *et al.*, 2019).

Conclusion: The Indian Spinach (*Basella alba* L.) treatments T₃ (apply clybio for three times with ten days interval) demonstrated good yield performance and the potential for higher growth, highest quality, and high yield of Indian Spinach based on the aforementioned description. Hence, it is advisable to propose the use of Clybio at a concentration of 4 ml/L to stimulate Indian spinach production, potentially motivating farmers to consider cultivating this crop during the summer.

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