POTENTIAL OF *Nostoc* sp. AS A BIOFERTILIZER ON GROWTH AND YIELD OF PADDY - *Oryza sativa*

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Introduction

Fertilizers play a crucial role to enhance the crop growth as well as the crop production. Until the recent past, most of the farmers have been solely dependent on inorganic fertilizers. Over application of inorganic fertilizers leads to several problems such as different environmental and health issues [1]. The changing global and local socio-political conditions demand shift fertilizer usage from sole inorganic to other alternative ways.

Biofertilizers are the ecofriendly novel tools in agriculture. Microalgae act as nutrient-rich bio resources. Cyanobacteria, also known as blue-green algae, are one of the most popular prokaryotic groups that can photosynthesize and fix atmospheric nitrogen. Incorporating nitrogen fixing cyanobacteria which are rich in macro and micro nutrients to the paddy fields would enhance the productivity, thus it would provide sustainable and ecofriendly solutions to the prevailing fertilizer related issues in paddy cultivation. However, cultivation of cyanobacteria also requires medium which demands chemicals. There has been research on cultivation of different cyanobacteria in a range of waste water [2].

In this background, this current study was conducted with the overall objective of assessing the potential of cultivating *Nostoc* sp. in kitchen wastewater and use the freshbiomass in combination with either Department of Agriculture (DOA) recommended inorganic or organic fertilizer on the growth and yield of paddy.

Materials and Methods

Nostoc sp. already isolated from local environments was obtained from the Microbiology and soil ecosystems research laboratory, at the National Institute of Fundamental Studies, Hantana Road, Kandy.

Semi mass culturing

Nostoc sp. was cultured in 10 L aspirator bottles to obtain sufficient amount of wet biomass in selective diluted kitchen wastewater up to four weeks. Waste water (5 L) consisting of rice wash water and dhal wash water and tap water at the ratio of 4:1:15 was used for cultivation. This ratio was selected from a preliminary study with different ratios of waste water.

Pot experiment

A pot experiment was conducted to assess the potential of wastewater grown *Nostoc* sp. as biofertilizer for paddy cultivation. The treatments are detailed in Table 1. The experimental design was CRD with three replicates. Each pot was

filled with two kg of soil, sampled from a paddy field, air dried and passed through a 2 mm sieve. The soil was low humic gley associated with reddish brown lattosolic group. For organic treatments, compost was applied to the soil at the rate of 0.5 kg m^{-2} while for inorganic treatments N, P, K fertilizers recommended by the DOA, Sri Lanka were applied as Urea (90 kg/ac) , TSP (22 kg/ac) and MOP (24 kg/ac). Paddy variety Bg 251 was transplanted after 14 days of germination. The pots were maintained at flooded condition. The available N as ammonium, nitrate and P and K of the soil was 8.22 µg/g, 14.614 µg/g, 11.26 µg/g and 22.4 µg/g respectively.

Application of Nostoc sp*. as a biofertilizer*

Wet inoculum of the Nostoc sp*.* was measured and applied at the rate of equivalent dry mass of 1 g kg^{-1} on to the prepared pots according to the treatments mentioned in Table 1.

Application of Liquid fertilizer

The filtered biomass was sonicated, and from that twenty percent of the cell extract of *Nostoc* sp*.* was used as the liquid fertilizer. The first spray was done at 14 days after transplanting. Twenty milliliters of liquid fertilizer were sprayed per plant using a hand sprayer twice a week according to the treatments. Liquid fertilizer was applied for leaves and stems upto four weeks.

Table 1: Treatment Structure

Treatment	Combination
T1	Control (Without any fertilizer)
T2	100 % IF
T3	100 % Compost
T4	50 % IF except N + 2 g *Nostoc* + 20 % *Nostoc* foliar application
T5	50 % Compost + 2 g *Nostoc* + 20 % *Nostoc* foliar application

IF – Inorganic Fertilizer

Plant height and number of leaves were measured at two weeks intervals. Fresh and dry weight of shoot and the grain yield were also measured.

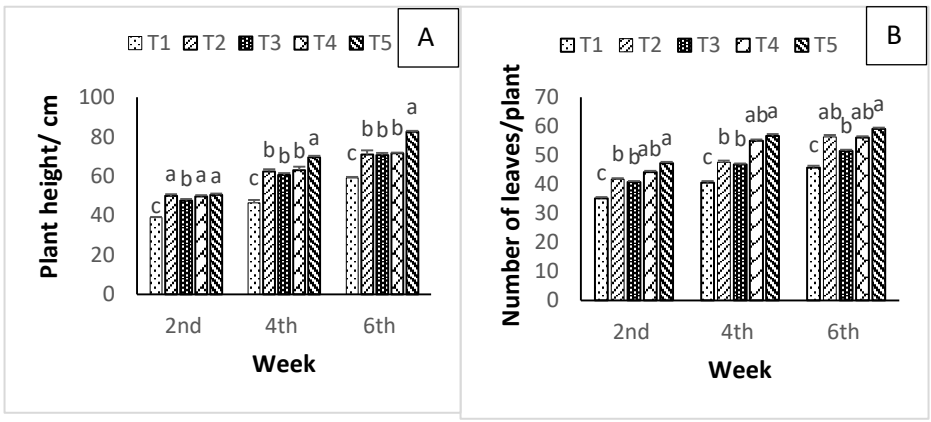
Data analyses were performed by using SAS statistical analytical system (University version) with Duncan mean separation at P=0.05 significance level.

Results and Discussion

The effect of different treatments on plant height shown in figure 1(A). During the 6th week of transplanting, the highest plant height was recorded in T5. Further, it was significantly different from T2, T3 and T4. The lowest plant height was recorded in T1.

Figure 1(B) shows the number of leaves per plant with different treatments. During the 6th week significantly higher number of leaves was recorded in T5. However, it was not significantly different from T2 and T4. At that time the height of the T5 significantly different from T3. The lowest number of leaves was recorded in T1 (control).

Figure 1(C) displaying the fresh weight of the paddy plants in different treatments. The highest fresh weight was recorded in T5 (2 g *Nostoc* sp. + 50 % compost + 20 % foliar spray), however, it was not significantly different from T2 (100 % inorganic). Further, according to the figure 1(D) significantly higher dry weight of shoot was recorded in T5. It was found that the fresh weight of shoots of T2, T4 and T5 were similar, however, the dry weight was significanty higher in T5. It is interesting to note that in T4, the sole source of nitrogen is *Nostoc* sp., which was able to supply the nitrogen equally as inorganic fertilizer. Moreover, the higher growth performace of T5 indicates, that the nutrients supplied by 50% compost enhanced the growth, compared to T4, which is 50% inorganic except nitrogen. Figure 1(E) exhibit the grain yeild of the paddy plants for different treatments. Among all the treatments, grain yield was substantially highest for T5 (2 g *Nostoc* sp. + 50 % compost + 20 % foliar spray) and it was the lowest for T1 (control). T2 (100 % IF) and T4 (2 g *Nostoc sp*. + 50 % IF except N + 20 % foliar spray) also recorded a significantly higher yield except T5. However, the grain yield was not significantly different between T2 and T4.



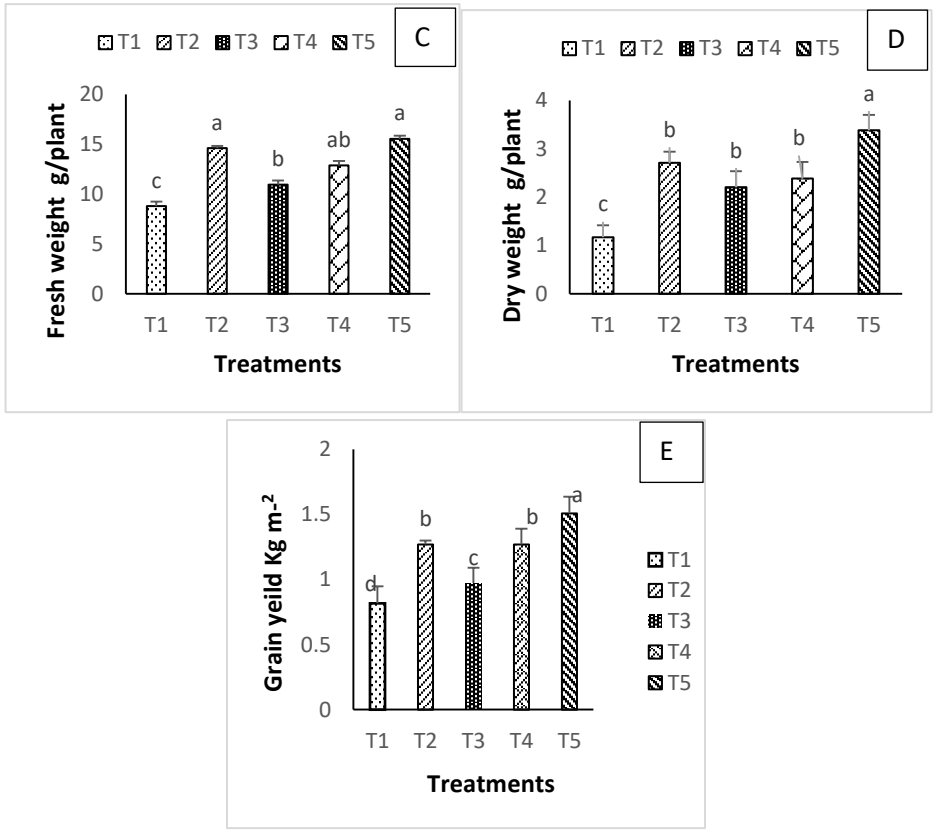


Figure 1. Average plant height (A), Number of leaves / plant (B), fresh weight of shoot (C), Dry weight of shoot (D), Average grain yield of paddy plants grown with different fertilizer treatments:T1-Control, T2-100 % Inorganic Fertilizer (IF), T3-100 % Compost, T4-50 % IF except N + 2 g *Nostoc* sp. + 20 % *Nostoc* sp. foliar application, T5-50 % Compost + 2 g *Nostoc* sp. + 20 % *Nostoc* sp. foliar application. Error bars correspond to the standard error of the mean. Different letters indicate significant differences ($\alpha<0.05$) according to Duncan's multiple range test.

A Previous study reported that incorporation of cyanobacteria species lead to enhance the growth as a result of plant-cyanobacteria association in the rhizosphere [3]. The cyanobacteria species secrete phytohormones which also contribute to improve the crop growth and yield [4]. Another study suggested that half a dose of recommended inorganic fertilizers with *Nostoc commune* was a better option for farmers while considering the cost as well as the quality and quantity of rice [5]. The current study found that combining compost with cyanobacteria species enhances grain yield rather than the sole use of chemical or organic fertilizers.

Conclusion and Recommendations

The results of this pot experiment reveal that the *Nostoc* species is a potential source of nitrogen for paddy cultivation. Further, this cyanobacterium could yield

an equivalent performance as that of DOA recommended inorganic fertilizer, when applied in combination with 50% inorganic fertilizers excluding nitrogen. The combination of compost and *Nostoc* sp. performed the best. Field experiments are required to confirm the effect of *Nostoc* sp. under field conditions. As collection of kitchen waste water of constant quality is difficult, study the use of any other industrial wastewater to grow *Nostoc* sp. is recommended in the future line of research.

References

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