Growth Parameters and Grain Yield of Rice (Oryza sativa L.) as Affected by Biofilm Biofertilizer Application

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Growth Parameters and Grain Yield of Rice *(Oryza sativa* L.) as Affected by Biofilm Biofertilizer Application

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ABSTRACT

Overuse of synthetic fertilizer causes a number of detrimental impacts on both human and environmental health. Hence, beneficial microbial biofilm-based Biofilm biofertilizers (BFBFs) have been developed to make agro ecosystems more eco-friendly. Accordingly, it has been revealed that the BFBFs can reduce current application of chemical fertilizers (CF) in rice even up to 50% without hampering grain yield in field experiments in research stations. Thus, the aim of the present study was to evaluate growth parameters and grain yield of rice after application of BFBF in farmers' fields. The experiment was designed in block design for paired comparison with uniform, consecutive paddy fields in 12 farmer fields in the Polonnaruwa district. The farmers' CF practice (N: P: K; 155:20:20) and BFBF practice (1 L BFBF with N: P: K; 59:15:16) were applied as treatments with 12 location replicates per treatment in the *Yala* 2018 season. Means of shoot and root dry weights per plant, thousand grain weight and yield of the two practices were evaluated. T-test was used for mean comparison. Results indicated that there is a significant increase ($P < 0.05$) in shoot (53%) and root (89%) dry weights per plant and thousand grain weight (18%) in BFBF practice compared to the farmers' CF practice. Further, the average grain yield of the BFBF practice was 5,112 kg/ha whereas that of farmers' CF practice was 4,238 kg/ha, a 21% increment in the grain yield. Hence, it can be concluded that the BFBF can enhance plant growth and grain yield while reducing farmers' use of CF in paddy fields.

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INTRODUCTION

Rice is the main food and nutritional energy source of more than half of the world's population. The usage of chemical fertilizer to enhance agricultural production has increased over time. Excessive use of chemical fertilizer gives rise to soil, water and air pollution, and health hazards (Ajmal et al., 2018). Many alternatives like biofertilizers are available to replace chemical fertilizers. Biofertilizers are natural fertilizers which are live inoculants of bacteria, algae, fungi alone or mixtures, and they enhance the availability of nutrients to the plants (Al Abboud et al., 2014). As a novel improvement in biotechnology, useful microbial communities in biofilm mode have been developed *in vitro* to be applied as biofertilizer, which are called BFBF (Seneviratne et al., 2009). A biofilm is a gathering of microorganism adherent to each other and/or surfaces and embedded in a matrix of polymers (Seneviratne et al., 2008). The gathering leads to metabolic cooperation between them (Seneviratne et al., 2009). A biofilm contains microbial cells and tacky extracellular polymeric substances, which give arrangement and safety to the microbial community. Various types of biofilms have been produced by using rhizosphere fungi and N_2 fixing bacteria from different genera, in order to be used as biofertilizers in agriculture (Buddhika et al., 2016). BFBFs have been tested for different types of crops in agricultural research centers at several districts in the country. Previous studies demonstrated that BFBFs in fields of research stations can cut down CF usage for rice without reducing grain yield (Buddhika et al., 2016). However, there has been no critical evaluation of the effects of BFBF application in farmers' fields for rice. Therefore, this study was carried out to evaluate the effect of BFBF application on growth parameters and grain yield of rice in farmers' fields and the potential of reducing CF requirement in rice.

MATERIAL AND METHODS

Experimental Location

A field experiment was carried out in 12 farmer fields in Polonnaruwa (DL), with an average annual temperature of 30°C and with an average annual precipitation of 1,800 mm. This study was conducted using a 3.5 months old rice variety, Bg 300. In each location, two consecutive (uniform) paddy fields with BFBF practice and farmers' CF practices were established and seed paddy was broadcasted. Each paddy field had an area of about 1 acre. Two treatments with 12 location replicates were applied to determine the most effective treatment; a) BFBF practice – 1 L BFBF with N:P:K; 59:15:16, and b) Farmers' CF practice – N:P:K; 155:20:20.

Sample Collection

Four rice plant hills with rhizosphere soil were randomly uprooted at 50% flowering stage from each paddy field. Seed samples were collected from three 2 x 2 m crop cuts at physiological maturity stage and sundried.

Data collection

At 50% flowering stage, root and shoot dry mass were determined and at the physiologically maturity stage, thousand grain weight and yield were determined. First, soil and plant debris were removed carefully from roots and the plants were washed carefully without damaging the root system. The plant roots and shoots were separated and oven dried at 65°C until a constant weight was given. Then, the weights of the root and shoot were measured using a top loading balance. Thousand grains were counted and were oven-dried at 40°C until a constant weight was given. Then, thousand grain weight was measured using an analytical balance. The grain yield was obtained from the crop cuts, and it was calculated per hectare.

Data Analysis

Means of all the variables of BFBF practice and farmers' CF practice were calculated. A

T-test was done to compare the data. Data were analyzed statistically using Minitab 17 version.

RESULTS AND DISCUSSION

Growth Parameters

BFBF application showed a significantly higher ($P < 0.05$) shoot dry weight compared to the farmers' CF practice (Table 1). In BFBFs, enhanced microbial action produces plant growth promoters such as Indole acetic acid (IAA), thus helping plant growth and development (Bandara et al., 2006). Therefore, BFBF helps to increase plant growth during the vegetative phase (Seneviratne et al., 2008). BFBF application showed a significantly higher ($P < 0.05$) root dry weight compared to the farmers' CF practice. This is because of the better hormonal regulation for root growth with the increased soil microbial action of the BFBF (Seneviratne et al., 2008). Root growth is essential in improving nutrient uptake.

Yield Parameters

BFBF application showed a significantly higher thousand grain weight (Table 2) compared to the farmers' CF practice. Application of BFBF improves seed filling, and hence thousand grain weight while reducing number and weight of unfilled grains per panicle compared to the CF (Wickramasinghe et al., 2018).

Table 1: Dry matter accumulation in shoot and root of BFBF practice and farmers' CF practice

Treatment	Shoot dry weight (g/plant)	Root dry weight (g/plant)
BFBF (n=12)	11.88a±1.45	4.25a±0.71
CF (n=12)	7.79b±0.83	2.25b±0.43

Mean ± SE. Values in each column followed by the same letter are not significantly different at 0.05 probability level according to t-test.

Table 2: Thousand grain weight (g) and grain yield (kg/ha) of BFBF practice and farmers' CF practice

Treatment	Thousand GW (g)	Grain yield (kg/ha)
BFBF	20.93a ±1.14	5,112a ±129
CF	17.73b ±1.17	4,238b ±111

Mean ± SE. Values in each column followed by the same letter are not significantly different at 0.05 probability level according to t-test (n = 12).

CONCLUSION

Application of BFBF on rice improved the grain yield, thousand grain weight, shoot and root dry weights of the plant while reducing the requirement of chemical fertilizers. Thus, it can be concluded that BFBF is an eco-friendly alternative to reduce chemical fertilizer usage, while increasing grain yield in large scale paddy cultivation.

REFERENCES

Ajmal, M., Ali, H. I., Saeed, R., Akhtar, A., Tahir, M., Mehboob, M. Z., &Ayub, A. (2018). Biofertilizer as an alternative for chemical fertilizers. *Nawaz Sharif Medical College, University of Gujrat, Gujrat, Punjab*.

Al Abboud, M. A., Ghany, T. A., &Alawlaqi, M. M. (2014). Role of biofertilizers in agriculture: a brief review. *Mycopath*, *11*(2).

Bandara, W. M. M. S., Seneviratne, G., &Kulasooriya, S. A. (2006). Interactions among endophytic bacteria and fungi: effects and potentials. *Journal of biosciences*, *31*(5), 645-650.

Buddhika, U.V.A., Seneviratne, G., Ekanayake, E.M.H.G.S., Senanayake, D.M.N., Igalavithane, A.D., Weeraratne, N., Jayasekara, A.P.D.A., Weerakoon, W.L., Indrajith, A., Gunaratne, H.M.A.C., Kumara, R.K.G.K., De Silva, M.S.D.L., Kennedy, I.R. (2016) Biofilmedbiofertilizers application in agroecosystems. In: V.K. Gupta, D. Thangdurai, G. D. Sharma (eds.), Microbial Bioresources, CAB International, Wallingford, United Kingdom, pp. 96-106.

Seneviratne, G., Kecskés, M. L. and Kennedy, I. R. (2008) Biofilmedbiofertilisers: Novel inoculants for efficient nutrient use in plants. Kennedy, I.R., Choudhury, A.T.M.A, Kecskés, M.L. and Rose, M.T. (eds) Efficient nutrient use in rice production in Vietnam achieved using inoculant biofertilisers. Proceedings of a project (SMCN/2002/073) workshop held in Hanoi, Vietnam, 12–13 October 2007. ACIAR Proceedings No. 130, 137pp.

Seneviratne, G., Thilakaratne, R. M. M. S., Jayasekara, A. P. D. A., Seneviratne, K. A. C. N., Padmathilake, K. R. E., & De Silva, M. S. D. L. (2009). Developing beneficial microbial biofilms on roots of non-legumes: A novel biofertilizing technique. In *Microbial Strategies for Crop Improvement* (pp. 51-62). Springer, Berlin, Heidelberg.

Wickramasinghe, W.M.D.M., Seneviratne, G., Benaragama, D.I.D.S. (2018). Role of biofilm biofertilizer on growth, yield and nutrition of rice. In: 10th Annual Research Symposium Proceedings, 83. Rajarata University Sri Lanka.