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Yield and yield attributes of rice cultivar 'Bg 250' as affected by the chemical and bio-fertilizers

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Abstract

Usage of chemical fertilizers in rice cultivation becoming threatens to the ecosystems of the world. Bio-fertilizer is one of the alternative sources in the rice cultivation with less harm to the human and environment. An experiment was conducted at the Rice Research Station, Sammanthurai, Sri Lanka during '*Yala'* 2017 to evaluate the possibility of replacing the chemical fertilizers with bio-fertilizers in the production of rice. Bio-fertilizer consisted of *Azotobacter chrocooccum, Azospirillum bresilensis, Bacillus polimixa, Bacillus megaterium* and other *Bacillus spp*. in a liquid base medium was used for this study. The experiment was laid out in Randomized Complete Block Design with five treatments and four replications. The treatments were T_1 - No any fertilizers (Control), T_2 – 100% chemical fertilizer, T_3 – 50% chemical + 50% bio-fertilizers, T_4 – 50% bio-fertilizer, T_5 – 100% bio-fertilizer. Rice cultivar 'Bg 250' seedlings were transplanted in plastic pots at 12 days old. Bio-fertilizer was prepared for application by mixing with cow dung and cow urine. Prepared bio-fertilizer was applied in the late evening and water was stagnated inside the plastic pots. Combine application of 50% chemical and 50% bio-fertilizer has given the highest values in panicle length (21cm), 1000 grain weight (25.2g), yield ($2.5 tha^{-1}$) and the highest amount of unfilled grains were obtained in the control treatment (29). Lowest values of panicle length, 1000 grain weight, yield was found in no fertilizer treatment (Control). The lowest amount of unfilled grains were found in where the treatment received 100% bio-fertilizer. Based on these results it was

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concluded that the combined application of 50% chemical and 50% bio-fertilizers has produced the better performances with regard to panicle length, 1000 grain weight and yield in the rice cultivar 'Bg 250'. It could, therefore, be stated that bio-fertilizer in combination with chemical fertilizer could be used as an alternative way in the production of rice to boost the yield with reduced hazards to human health and environment.

Keywords: Bio-fertilizer; Panicle length; Thousand grain weight; Unfilled grains; Yield

1. Introduction

Rice (*Oryza sativa* L.) is an important staple food that provides 60-70% body calorie intake of the consumers (Barah and Pandey, 2005). To ensure the food security in rice-consuming countries of the world, the production of rice should be increased by 50% in the year 2025 but, this additional rice production should be done on less land with less usage of water, labour and agrochemicals. As same as to achieve the estimated targets of 680 and 771 million tonnes by 2015 and 2030 respectively, the productivity of rice fields should be increased through adopting the new improved technologies (Badawi, 2004). Rice production depends on several factors such as climate, physical conditions of the soil, soil fertility, water management, sowing date, cultivar, seed rate, weed control and fertilization. Nitrogen fertilizer is a major essential plant nutrient and key input for increasing crop yield (Yoseftebar *et al.,* 2012). With the increase in rice production, application and need of the chemical fertilizers are also increasing simultaneously as it can give more reliable supportive boosts to increment of crop yield (Saikia *et al.,* 2012).

Wihardjaka and Abdurachman (2007) indicated that long-term intensive utilization of rice lands will decrease the productivity of soil and environment. The use of high input of agrochemicals will impose a pressure on soil and environment reduce soil nutrients and cause the negative impact on the environment. Heavy usage of agrochemicals form residues on soil, crops and environment. On the other hand, the decrease of relatively fertile rice field due to land conversion into non-agricultural usage produces threat in maintaining food sufficiency. Bio-fertilizers provides better nutrient uptake and increased tolerance towards drought and moisture stress. Bio-fertilizers differ from chemical and organic fertilizers in the sense that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi relatively simple and having low installation cost. Bio-fertilizers by overall produced higher growth rates and yield development of rice production compared with chemical fertilizers (Alam and Seth, 2014). Therefore, bio-fertilizers can solve the problem of feeding an increasing global population at a time when agriculture is facing various environmental stresses and changes.

Hence the present study was conducted to evaluate the effects of chemical and bio-fertilizers on the yield and attributes of 'Bg 250' rice cultivar. To compare the yield and yield attributes of 'Bg 250' rice cultivar with the application of chemical and bio-fertilizers. To find out the most suitable fertilizer/s to obtain optimum yield performance of 'Bg 250'.

2. Materials and Methods

This experiment was conducted during the season of '*Yala*' 2017 at Rice Research Station, Department of Agriculture, Sammanthurai, Sri Lanka. A number of 20 plastic pots with 16 inches diameter and 10 inches

height were used for this study. Pots were prepared with two holes at the bottom and by filling with the soil obtained from the paddy land owned by Rice Research Station, Sammanthurai. An amount of 100g rice cultivar ‘Bg 250' seeds were taken from the Rice Research Station and those seeds were water soaked for 24 hours and incubated for 48 hours. Nicely sprouted seeds were spread on a seedling tray. After 12 days healthy and uniform seedlings were transplanted on already prepared sand-filled plastic pots at the rate of 12 seedlings per pot.

2.1. Preparation of bio-fertilizer

‘GRO BIO-FERTILIZER' consisted of *Azotobacter chrocooccum, Azospirillum bresilensis, Bacillus polimixa, Bacillus megaterium* and other *Bacillus* spp. in a liquid base medium was used at the rate of 500 $mlha^{-1}$. This culture was mixed with 10kg of cow dung, 5 litres of cow urine and 10 litres of water and kept under the shade and cool place for rapid multiplication of microorganisms.

2.2. Application of bio-fertilizer

Incubated bio-fertilizer was applied at three days after transplanting and near to booting stage. It was applied in the late evening time to ensure the optimum growth of microorganisms in the soil. Water was stagnated inside the pots after the application of bio-fertilizer.

2.3. The treatment structure

The experiment consisted of five treatments and each treatment was replicated four times. The treatment structure is given below:

T1 - No chemical or bio-fertilizer was added - Control

T2 - 100% chemical fertilizer (Urea - 225$kgha^{-1}$, TSP - 55$kgha^{-1}$ and MOP 60$kgha^{-1}$) was added.

T3 - 50% chemical fertilizer (Urea - 113$kgha^{-1}$, TSP - 28$kgha^{-1}$ and MOP - 30$kgha^{-1}$) + 50% bio-fertilizer (250$mlha^{-1}$) were added.

T4 - 50% bio-fertilizer (250$mlha^{-1}$) was added.

T5 - 100% bio-fertilizer (500$mlha^{-1}$) was added.

2.4. Experimental Design

This experiment was laid out in the Randomized Complete Blocked Design (RCBD) with five treatments and four replications. A number of 20 pots were used for this study and each pot contained 12 rice seedlings.

2.5. Yield attributes

2.5.1 Length of the panicle

A number of five plants were randomly selected from each replicate of the treatments. The panicle length of the selected plants was measured in cm by a measuring scale. The measurement was made from the bottom node of the panicle to the tip of the newly formed spikelet on the panicle.

2.5.2 Unfilled grains per panicle

A number of ten panicles were randomly selected from each replicate of the treatments and the number of unfilled grains was counted.

2.5.3 1000 Grains weight

A number of ten panicles were randomly selected from each replicate of the treatments and the rice grains were collected from these panicles. The weight of 1000 grains (g) was measured by an electronic balance.

2.6 Yield

A number of five plants were randomly selected from each replicate of the treatments. The seeds were collected from these plants and were sun-dried and the yield was determined.

2.7 Analysis of data

The data measured were statistically analyzed using the Analysis of Variance (ANOVA) to detect the significance if any at treatment level. The difference between treatment means was compared by Duncan Multiple Range Test (DMRT) using SAS package version 9.1.

3. Results and Discussion

3.1. Panicle Length

It was found that there were significant ($p<0.05$) differences between the chemical and bio-fertilizer treatments. The highest panicle length was obtained in combined application of 50% chemical and 50% bio-fertilizer application and it was on par with 100% chemical fertilizer, 50% bio-fertilizer and 100% bio-fertilizer treatments. The lowest was found in the control treatment (Table 1). It was revealed that chemical and bio-fertilizer application enhanced the panicle length of rice cultivar 'Bg250'. The highest panicle length in treatment receiving combined chemical and bio-fertilizer may be due to the continuous supply of nutrients during panicle emergence with the beneficial association of roots with biofertilizers. The nutrient levels with bio-fertilizers were significantly affecting panicle length of the rice crop.

These results are in agreement with the findings of Yuvaraj (2016), he has proved that the highest panicle length was observed in the treatment receiving the combined application of chemical fertilizer with bio-fertilizer (*Azotobacter*, Phosphorus Solubilizing Bacteria, Plant Growth Promoting Rhizobacteria) which was statistically at par with treatment received chemical fertilizer with *Azospirillum*, Phosphorus Solubilizing Bacteria, Plant Growth Promoting Rhizobacteria.

3.2. Unfilled Grains

There were significant ($p<0.05$) differences between treatments in the unfilled grains per panicle of rice cultivar 'Bg 250' plant during the ripening stage. It was found that highest number of unfilled grains were observed in the plants received no any fertilizers (control) and the lowest was found in the 100% bio-fertilizer treatments (Table 1). Hence, it could be stated that bio-fertilizer application has reduced the number of

unfilled grains per panicle in rice plants. It may be due to that microorganisms presents in the bio-fertilizer increased the grain filling period of rice plants.

These results are in agreement with the findings of Gomaa *et al.* (2015) who have stated that inoculation of rice with mixed blue-green algae + mycorrhizal inoculation encourages the increase of filled grains per panicle when compared to control treatments. This finding may be because of mixed blue-green algae and mycorrhizal inoculation which plays in the assimilation of rice plants that reflected on enhancing these characteristics. Also, they could be attributed to the role of plants phytohormones like Indol Acetic Acid, Gibberellic Acid and Cytokinin which promote plant growth, cell division and breaking the apical dominance; hence encouraging the photosynthesis and assimilation accumulation (El-Khawas, 1990). Similar results, more or less, were obtained by Radwan *et al.* (2008) and Wijebandara *et al.* (2009). Hamidi *et al.* (2009) have reported that high N rates significantly delay the duration of the vegetative and reproductive periods and could be the possible reason for the lengthening of grain filling duration.

Table 1. Effects of chemical and bio-fertilizers on the panicle length and unfilled grains per panicle of rice cultivar 'Bg 250'

Treatments	Panicle Length (*cm*)	Unfilled Grains
T1	15.7 ± 0.12b	29 ± 0.46a
T2	20.0 ± 0.15a	26 ± 0.19b
T3	21.0 ± 0.37a	21 ± 0.94c
T4	19.8 ± 0.14a	25 ± 0.12b
T5	20.2 ± 0.26a	19 ± 1.12c

*Values in the same column followed by the same letter do not differ significantly ($p<0.05$).
*Values are the means ± standard error of 20 plants in 4 replications.

3.3. 1000 Grains Weight

There were significant ($p<0.05$) differences between the treatments in the 1000 grain weight of rice plants during ripening stage. The highest 1000 grain weight was observed in plant received combine application of 50% chemical and 50% bio-fertilizers and the lowest was found in plants received no any fertilizers. However, there were no significant ($p>0.05$) difference between the treatments received 100% chemical fertilizer, 100% bio-fertilizer, combined application of 50% chemical and 50% bio-fertilizers.

Studies by Saba *et al.* (2013) have revealed that the maximum 1000 grain weight was recorded in the treatment received inorganic and bio-fertilizers as the combination and which was statistically on par with the treatment received combined fertilizers with different ratios. The minimum and statistically similar grain weight were recorded in treatment received inorganic fertilizers with different combinations. Significantly heavier grains obtained in combined treatments were probably due to supply of an adequate amount of nutrients at grain developmental stage. Moreover, the use of 50% recommended dose nitrogen was equally effective as the 100% recommended dose, which ultimately saved 50% nitrogen fertilizer due to the addition of bio-fertilizer. It means that less inorganic N fertilizer would be required for getting the same weight of seed, thereby potentially saving carbon emissions from fertilizer manufacture (Pan *et al.*, 2009).

3.4. Yield

There were significant ($p<0.05$) differences between treatments in the yield of rice cultivar 'Bg 250'. The highest yield was obtained in the treatment received 50% chemical and 50% bio- fertilizers as combined and the lowest was found in the control treatment. Hence, the combined application of fertilizers has boosted the rice yield compared to other treatments. Studies of Singh *et al.* (2015) were on par with this study. They have shown that grain yield of rice was significantly ($p<0.05$) influenced with different treatment combinations of chemicals fertilizers with bio-fertilizers. The maximum grain yield was observed with combined chemical and bio-fertilizer application as compared to control. It has increased the grain yield by 12 percent over farmer practices. Mukhopadhyay *et al.* (2013) have reported that the highest grain yield for rice was obtained when bio-fertilizer was applied with 60 % of recommended nitrogen. The result showed that incorporated chemical and biological fertilizer obtained highest kernel number per cob compared to the sole application of them.

Table 2. Effects of chemical and bio-fertilizers on the 1000 grain weight and yield of rice cultivar 'Bg 250'

Treatments	1000 grain weight *(g)*	Yield (tha^{-1})
T1	22.7 ± 0.04c	1.0 ± 0.06d
T2	24.6 ± 0.12a	2.0 ± 0.03b
T3	25.2 ± 0.29a	2.5 ± 0.05a
T4	23.8 ± 0.20b	1.7 ± 0.04c
T5	25.0 ± 1.21a	1.9 ± 0.09b

*Values in the same column followed by the same letter do not differ significantly ($p<0.05$).
*Values are the means ± standard error of 20 plants in 4 replications.

4. Conclusions

The application of 50% chemical and 50% bio-fertilizers has given the best yield performances with relation to panicle length, 1000 grain weight and yield in rice cultivar 'Bg 250' compared to other treatments. 100% bio-fertilizer application has given the lowest unfilled grains compared to other treatments. Therefore, yield production of rice grains could be steadily increased through the application of bio-fertilizer with less hazard to the environment and also health hazard would be greatly reduced.

References

Alam, S. and Seth, R. K., 2014. Comparative study on effect of chemical and bio-fertilizer on growth, development and yield production of paddy crop (*Oryza sativa* L.). International Journal of Science and Research. 3(9), 411-414.

Badawi, T. A., 2004. Rice-based production systems for food security and poverty alleviation in the Near East and North Africa: new challenges and technological opportunities. Proceedings of FAO Rice Conference. Rome, Italy. Pp.12-13.

Barah, B. C. and Pandey, S., 2005. Rainfed rice production systems in Eastern India: An on farm diagnosis and policy alternatives. Indian Journal of Agricultural Economics. 60(1), 110-136.

El-Khawas, M. A., 1990. Effect of *Azotobacter chrooccocum* and *Azosprillum brasilience* inoculation under graded levels of nitrogen growth and yield of wheat. Plant and Soil.69:61-67.

Gomaa, M. A., Radwan, F. I., Kandil, E. E. and Shawer, M. A. M., 2015. Impact of Micronutrients and Bio-Fertilization on Yield and Quality of Rice (*Oryza sativa* L.). Middle East Journal. 4(4), 919-924.

Hamidi, A. I. D. I. N., Chaokan, R., Asgharzadeh, A. H. M. A. D., Dehghaoshoar, M., Ghalavand, A. and Malakouti, M. J., 2009. Effect of plant growth promoting rhizobacteria (PGPR) on phenology of late maturity maize (*Zea mays* L.) hybrids. Iranian Journal of Crop Sciences. 11(3), 249-270.

Mukhopadhyay, M., Datta, J. K. and Garai, T. K., 2013. Steps toward alternative farming system in rice. European journal of agronomy. 51, 18-24.

Pan, G., Zhou, P., Li, Z., Smith, P., Li, L., Qiu, D. and Chen, X., 2009. Combined inorganic/organic fertilization enhances N efficiency and increases rice productivity through organic carbon acumulation in a rice paddy from the Tai Lake region, China. Agriculture, ecosystems and environment. 131(3), 274-280.

Radwan, F. I., El-Seoud, A. I. and El-Ham A. B., 2008. Response of two rice cultivars to blue green algae. A Mycorrhizal inoculation and mineral nitrogen fertilizer. Journal of Plant Science and Biotechnology. 2(1), 29-34.

Saba, N., Awan, I. U., Baloch, M. S., Shah, I. H., Nadim, M. A. and Qadir, J., 2013. Improving synthetic fertilizer use efficiency through bio-fertilizer application in rice. Gomal University Journal of Research. 29(2), 33-38.

Saikia, S. P., Bora, D., Goswami, A., Mudoi, K. D. and Gogoi, A., 2012. A review on the role of Azospirillum in the yield improvement of non-leguminous crops. African Journal of Microbiology Research. 6(6), 1085-1102.

Singh, R. K., Kumar, P., Prasad, B. and Singh, S. B., 2015. Effect of bio-fertilizers on growth, yield and economics of rice (*Oryza sativa* L.). International Research Journal of Agricultural Economics and Statistics. 6(2), 386-391.

Wihardjaka and Abdurachman, 2007. Effects of long term fertilization on rainfed agriculture. Staple Production. 26 (3), 199-205.

Wijebandara, D. M., Raine, D. I. Dasog, G. S., Patil, P. L. and Hebban, M., 2009. Response of rice to nutrients and bio-fertilizer under conventional and system on rice intensification methods of cultivation in Tungabhadra Command of Kamataka Department of soil Science and Agriculture, Chem., University, India. Journal of Agriculture and Soil. 22(4), 741-753.

Yoseftebar, S., Fallah, A. and Daneshiyan, J., 2012. Comparing yield and yield components of hybrid rice (GRH1) at different applications of nitrogen fertilizer. International Journal of Biology. 4(3), 60-65.

Yuvaraj, K., 2016. Effect of bio-fertilizers and inorganic fertilizers on soil health, growth and yield of rice (*Oryza sativa* L.) crop. Doctoral dissertation, Punjab Agricultural University Ludhiana.