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Bio-Green Foliar Spray Enhances Rice Growth and Productivity in Cambodia

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ABSTRACT: The use of bioproducts as biostimulants to stimulate plant growth and to increase yields as an alternative to chemical fertilizers are currently being promoted for cost-effective, sustainable and environmentally friendly agricultural practices of crop production systems. The objective of the study was to determine plant growth and productivity of rice responded to Bio Green application. A short growing period (90 – 95 days) OM-5451 rice variety was used in this study. The rice plants were cultivated in the randomize-completed block with two treatments and six replications in plot of 2 m * 2 m. Di-ammonium phosphate (DAP) fertilizer was applied once at rate of 100 kg/ha. For treatment, Bio-green with a solution of 1% (v/v) was weekly applied as foliage spray; and without Bio-Green as control. The results showed the grain yield was 3.7 t/ha in the treatment and 2.83 t/ha in the control, indicating that 36.4% of the grain yield was increased. The Bio-Green could be significantly used as plant biostimulants to promote plant growth and grain yield in rice in Cambodia.

Key words: Bioproduct, Cambodia, fertilizer, fertility management, organic rice, *Oryza sativa*.

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INTRODUCTION

Rice (*Oryza sativa* L.) is widely grown in rainfed lowlands during the wet season in the Mekong region of Cambodia. Common constraints on rice crop production are limited nutrient availability (available N, P, K), low organic matter contents and low cation exchange capacity; the optimal rate of fertilizer application depends on the soil type (White *et al*, 1997; Seng *et al*, 2001; Kato & Katsura, 2014). A rate of 140-60-60 kg per hectare of N-P_2O_5-K_2O is required for dry-season rice production to achieve the best yield on any soil groups (Kong *et al*, 2019). Inorganic fertilizer is the major component of the rice production cost in Cambodia (Srean *et al*, 2018). As such, farmers increase amount of inorganic fertilizers per hectare while also raising production costs year by year (Vuthy *et al*, 2014).

Adapting cost-effective, sustainable and environmentally friendly agricultural practices of crop production systems to improve crop yields and the quality of food derived from plants has increasingly gained attention (Madende & Hayes, 2020). Organic farming using natural preparations that improve the general health, vitality, and growth of plants and minimize environmental and ecological risks are currently preferred options (Pylak *et al*, 2019). Any product derives from a living organism or its metabolites is biopreparation or biobased products (Singh

et al, 2003). The bioproducts can be used as biostimulants to stimulate plant growth and to increase yields as an alternative to chemical fertilizers; e.g. plant biostimulants produced from fish processing waste have potential applications (Madende & Hayes, 2020).

The Bio Green, having recently been discovered by a Cambodian researcher (Dr. Touch Visalsok), is one of the bio-based products with its main ingredient being fish amino acids and natural hormones. Previous studies have demonstrated that amino acids and amides play important roles in plant growth by stimulating nitrate and ammonium uptake, nitrate reduction, ammonium incorporation, protein metabolism and N remobilization via metabolic pathways of plant nitrogen metabolism (e.g. Muller & Touraine, 1992; Causin, 1996; Sun *et al*, 2020). The objective of this study was to determine plant growth and productivity of rice as a result of the Bio Green foliage spray.

MATERIALS AND METHODS

The experiment was conducted in dry season, starting from December 2020 to March, 2021 at the Research and Training Farm (13°00'26.5"N; 103°18'49.0"E) of the National University of Battambang, Cambodia. The soil of experimental plot was classified as Brown Hydromorphic group by Croker (1962) or Toul Samroung soil group by White *et al* (1997), with clay (~50%) soil texture; more details on soil chemical and physical properties were described in Srean *et al* (2012). Daily climate characteristics during the experimental period from December, 2020 to March, 2021, included air temperature, relative humidity and rainfall are presented in Fig. 1.

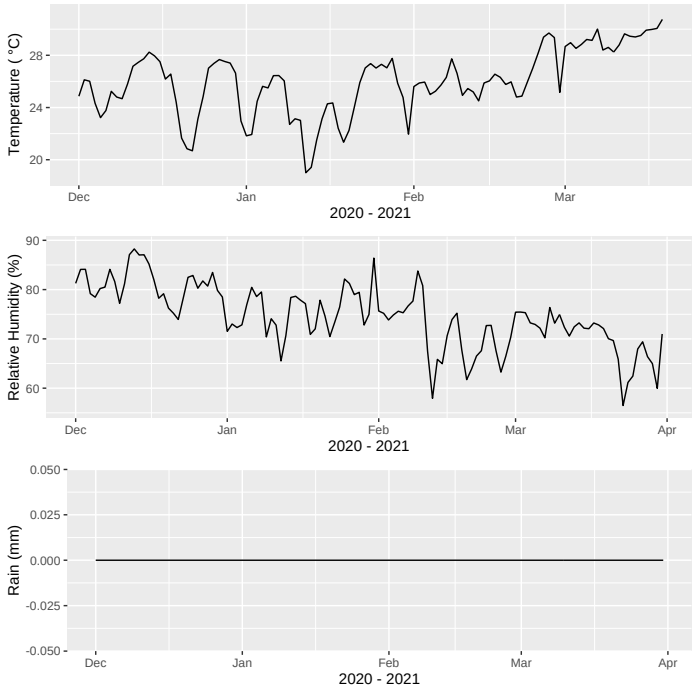

Fig. 1: Daily climate characteristics including average air temperature (°C), relative humidity (%), and rainfall (mm) from December, 2020 to March, 2021. The data were collected at the Research and Training Farm, National University of Battambang.

The randomize-completed block design was employed with two treatments and six replications in plot of 2 m * 2 m (Fig. 2). The soil of experiment plots was ploughed twice before being separated into 12 small plots (6 plots for control group and 6 plots for treatment group). Vietnam long grain white rice, i.e. OM 5451 rice variety with a relatively short growing period (90 – 95 days) was used in this study. Rice seeds were shocked in water for 24 hours and kept for another 48 hours to germinate. The germinated seeds with amount of 150 kg/ha, were directly sown to the experimental plot manually. Di-ammonium phosphate (DAP) fertilizer was applied once at rate of 100 kg/ha or equal to 60 g per 4 m^2 land area when the rice plants were 7 days old. The Bio-Green, locally made from fish and food waste, was used to test its effect on the rice growth and productivity.

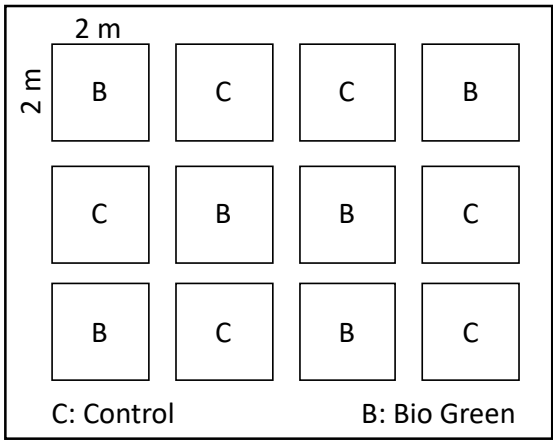

Fig. 2: Layout of the experimental plots; B: treatment group with Bio-Green application, and C: control group with no Bio-Green application.

For the treatment (B) plots, 1.2 mL Bio Green was diluted with 120 mL water and sprayed on plant leave weekly for over 9 weeks, starting at 8 days old of the rice plants till flowering stage. For the control (C) treatment, no Bio Green was applied. Main ingredient of the Bio-Green was fish amino acids and plant hormones, and given by Dr. Visalsok Touch, the Bio Green Co., LTD.

To evaluate the agronomics traits of rice plants in response to the Bio-Green fertilizer application, 5 plant tillers per plot were sampled to measure plant height, number of hills per square metre, number of panicles per tiller, panicle length, number of filled grain per panicle, and grain yield per hectare. For the grain yield, 2 m^2 in each plot was harvested. The harvested grain weight was adjusted to 14% moisture level, and then converted to tons per hectare. To test the significant difference in means of each variable between control and treatment groups, Wilcoxon test (Wilcoxon, 1945) for the nonparametric test of two samples was applied, using R statistic software, version 3.6.3 (Team, 2020). All the plots were performed using 'ggplot2' R package (Wickham, 2011).

RESULTS AND DISCUSSION

There was not significant difference in the number of hills per square metre between the treatment and control groups (Fig. 3), indicating that the rice plants in the experimental plots were well established with homogeneity, and no negative impact of the Bio-Green application on plant growth. The results of Wilcoxon's test in the Figure 3 showed the plant height, number of panicles per tiller, panicle length, and number of filled grains per panicle were slightly affected by the Bio-Green application, with a better growth and productivity being observed in the treatment group. The grain yield was found to be significantly affected by the Bio-Green application ($P < 0.1$); the grain yield was greater (36.4%) in the treatment group compared to the control group.

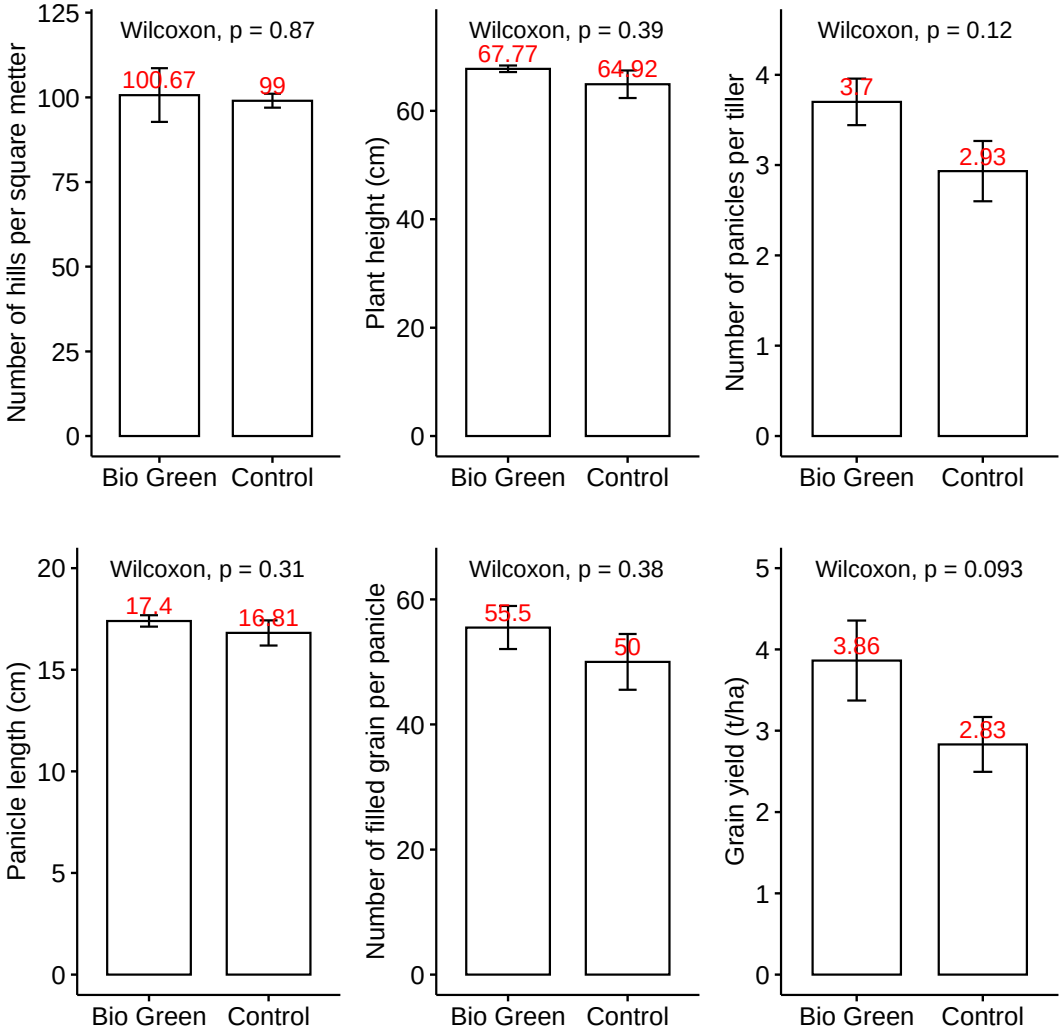

Fig. 3: The agronomics traits of rice plants responded to the Bio-Green fertilizer application. The error bars on the plots indicated standard error.

It was obvious from this study that the Bio Green foliar application on short-term experiment of rice cultivation remarkably enhanced the rice grain yield up to 36.4%, compared to the control, which could be attributed to the plant growth (plant height) and productivity (number of panicles, panicle length, and number of filled grain). The Cambodian Agricultural Research and Development Institute (CARDI, 2012) has reported that inorganic fertilizers could improve grain yield up to 31% compared to the control treatment or 20% compared to the farmer practice, based on the 30 on-farm trials across Cambodia. Srean *et al* (2016) has also showed that one-fourth of recommendation rate dose of soil applied inorganic-fertilizers could be substituted by inorganic foliar fertilization in rice crop; and the sole foliar fertilization improved 32.4% of the grain yield compared to the control treatment.

The Bio Green, containing fish amino acids and natural hormones, could contribute the enhancement of plant growth through metabolism and increased nitrogen-uptake for plant growth. Several studies have showed that amino acids and amides play important roles for metabolic

pathways of plant nitrogen metabolism for plant growth in the regulation of nitrate and ammonium uptake, nitrate reduction, ammonium incorporation, protein metabolism and N remobilization (e.g. Muller & Touraine, 1992; Causin, 1996; Padgett & Leonard, 1996). The application of these amino acids, as growth stimulants, has practical implications in the production of rice crops due to enhancement of chlorophyll content, photosynthetic rate, stomatal conductance, and transpiration rate for plant growth (Sun *et al*, 2020). Meyyappan *et al* (2021) have demonstrated that fish meal extract spray, used as organic preparations foliar spray along with inorganic fertilizers, improved rice grain yield. Fish by-products can be used as plant biostimulants to improve nutrient uptake, nutritional efficiency, plant yields and the quality of products and can be an alternative to conventional chemical fertilizer use (Madende & Hayes, 2020).

CONCLUSION

Overall, the Bio Green, made of locally available bioproducts and/waste products, could be used as an effective natural fertilizer to improve plant growth and grain yield in rice. The fish amino acids and natural hormones containing in the fertilizer might act synergistically with chemical fertilizers to enhance rice productivity. Cambodian rice farmers as well as rice production companies might benefit from the Bio Green application. A longer growing period rice varieties and other crops are recommended for the future studies on the effects of Bio Green on their growth and production.

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