The Effect of Additional Effective Microorganisms in Vegetative Growth of Aerobic Paddy

M Shahbuddin1, D Shahbuddin2, N Amirullah3 S M S Syed-Azmi3 and S M Abdul-Rahman3

1Department of Biotechnology and Biochemical Engineering, Kulliyyah of Engineering, International Islamic University of Malaysia, Jalan Gombak, 53100 Kuala Lumpur.
2Department of Plant Science, School of Biological Sciences, Universiti Sains Malaysia, 11700 Pulau Pinang.
3Plantation Technology and Management, Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA, Jalan Lembah Kesang 1/1-2, Kampung Seri Mendapat, 77300 Merlimau, Melaka

*Corresponding author: munirashah@iium.edu.my

Abstract. The influence of effective microorganisms (EM), microbial inoculant containing yeasts, fungi, bacteria and actinomycetes was evaluated in field trials of Aerob I paddy cultivation in Jasin, Melaka. Aerobic paddy is a new way of rice cultivation in areas where water resources have been scarce and affected by the climate change. As water shortage and climate change is becoming severe, the technology of growing rice with aerobic rice systems need to be further refined or developed to ensure the quality of rice production in water-short areas. The objective of this study was to determine the effect of additional EM on the growth pattern, and to evaluate the efficiency of EM uptake on the aerobic plant. This experiment was carried out by using random controlled Randomized Controlled Block Design (RCBD) consisted of three treatments with two replications in four blocks. Aerobic seed cv. Aeron1 was used as planting materials and has been applied by three different treatments of EM during vegetative growth. The treatment for this study was T1= 1.8 g NPK with urea (control) while T2 was 1.8 g NPK and T3, with 0.9 g NP with 100 mL of EM respectively during 15 (early vegetative stage) and 45 DAS (late vegetative stage). The RCBD experimental design was used with two replications in each treatment in four blocks. There are three series of harvesting (35, 50 and 60 DAS) was conducted throughout this study. The growth parameter studied was shoot and root dry biomass, number of tillers, RGR at each of harvesting. Our finding revealed that the application of EM did not improve plant growth parameter but the growth pattern of T2 and T3 showed steady improvement, although not significant compared to T1. The application of EM at different growth stages did not enhance the relative plant growth rate of Aeron 1 under aerobic condition, but in comparison to T1 and T2, T3 treatment with 50% reduction of NPK and EM could significantly reduce the cost of land management and fertilizer.

1. Introduction
Regenerative agriculture that utilizes the principles of natural ecosystems and sustainability are now receiving attention due to burgeoning environmental pollution crises and climate change in many parts of the world. Accumulation of chemical fertilizer, weed killer and pesticides use over the time is putting stress to water and soil to cope, causing eutrophication, algal bloom and mass extermination of
animals and native plants. An organic fermented fertilizer; EM-compost was produced from agricultural residues; rice-hull and olive dough with beneficial effective microorganisms; EM. The effect of EM-compost on paddy field fertility and rice quality in comparison with conventional farming was investigated.

The objectives of this work are to study the applications of effective microorganisms at different growth stages of Aaron 1 aerobic rice. Addition of effective microorganisms in agriculture was reported to improve yield and soil condition, as well as reducing the use of chemical fertilizer, which contribute to eutrophication and accumulation of nutrients. EM was reported to significantly improved soil organic matter, total N and K in the soil with the application of organic manure compared to control plot in long-term fertilizer experiment [1]. In the study, plots that were treated with EM had higher content of soil organic matter, total N, alkaline hydrolysable nitrogen, available P, and available K. EM compost which can accelerated decomposition of organic materials. The use of EM in plantation decompose the organic materials releasing beneficial soluble substances such as amino acids, sugars, alcohol, hormones and similar organic compounds that can be easily absorbed by plant. It enhances soil fertility by regulation of soil pH to weak acid, salinity; ECe and Na as well as its anti-oxidizing effect [2]. Other study had reported that long-term soil amendments with compost EM accelerated wheat growth compared to those without EM mentioned that wheat and maize straw yields productivity were significantly increased in farmyard EM manure plot than in untreated plot. Similar observation was reported in the study with soybean shoot biomass [3]

2. Materials and Method

2.1 Experiment Design
We use Randomized Complete Block Design (RCBD) to control variation in an experiment by calculating for spatial effects in field. The field was divided into uniform blocks where treatment will be added at random to indiscriminate the differences between treatments. The experiment consisted of three treatment s whereas T1 = application of 1.8 g NPK and 0.9 g urea (control), while T2 = application of 1.8 g NPK and 0.9 g urea with application of 100 mL of EM during 15 (early vegetative stage) and T3 = application of 0.9 g NPK and 0.9 g urea with application of 100 mL of EM during 45 DAS (late vegetative stage)

2.1.1 Land Preparation

i) Location
Research studies was conducted at UiTM Jasin ShareFarm located in Universiti Teknologi MARA (Melaka) Kampus Jasin at Melaka, Malaysia (2.2212° N and 102.4523° E).

ii) Soil pH analysis
To determine the soil pH, we took 5 random samples from the plot to the lab. 20 g of soil was weighed and transferred into 100 mL beaker and 40 mL distilled water was added and stirred well with a glass rod for 30 minutes with intermittent stirring. Then, pH electrode was placed in the beaker and read by the pH meter.

iii) Plot preparation
The individual planting bed was set-up with size 1feet x 1feet x 1feet with total 18 planting beds in each block. The gaps between each individual block are fixed at 2 feet.

2.2 Sowing

2.2.1 Seed variety The paddy variety used in this research was aerobic paddy cultivar Aeron 1. This variety was obtained from MARDI Seberang Perai.
2.2.2 **Sowing** The seeds were soaked in clean water for 24 hrs and then placed on a wet tissue paper for another 24 hrs to break the dormancy. The seeds then sown within 1 cm depth from soil surface with five seeds in every planting bed. Each bed was planted with 3 seedlings, and were thinned out to two leaves after two weeks.

2.3 **Maintenance**

2.3.1 **Watering** Watering schedule for planting beds was done twice a day, in the morning and evening except on rainy days.

2.3.2 **Weeding** Weeding is an important maintenance activity in plantation. The removal of weeds is useful because these unwanted plants compete with the crop for space, water and nutrients. All the unwanted plant in beds and between the planting beds has been removed every a week interval to avoid abundant of unwanted plant surrounding the paddy plant.

2.4 **Preparation and Application of EM**

EM solution was prepared from scratch using fermentation process to produce the stock solution which will be used in this study. To activate the EM stock solution, molasses was added to water in ratio 1:1:500 (mL) and mixed thoroughly. EM then was applied to the bad at early stage of vegetative or at 14 DAS (T2) and late vegetative stage or at 44 DAS (T3).

2.5 **Data Collection**

In this study, observations were done in 3 series of harvesting along the paddy vegetative stages. Which are 35 DAS (H1), 50 DAS (H2) and 65 DAS (H3.) Number of tillers, shoots & roots fresh biomass, shoots & roots dry biomass and relative growth rate were recorded in the observation.

2.6 **Analysis**

The data was analysed using IBM SPSS software (version 24) significant differences using one and two way ANOVA.

3. **Results and Discussion**

3.1 **The effect of EM on the growth number of tillers, average weight of plant biomass and absolute growth rate**

Figure 1 shows the pattern for growth number of tillers for all treatment with the EM application (T2 and T3) at three series harvesting on 35, 50 and 63 DAS. From the graph, T3 which was treated with 50% reduced NPK picked up from lowest number of tiller at 50 DAS to the highest at at 65 DAS. At the last series harvesting (63 DAS), the number of tillers for those treated with T2 was similar with T1 (control) with six per plant which was consistent to the increasing number of tillers on growth rice crop. Similar trend was also observed with the average weight of plant biomass (**Figure 2**) where T3 recorded the highest weight followed by T2 and T1. In the beginning, at 35 DAS, T1, T2 and T3 did not show any significant differences but after 50 DAS, the plant biomass treated with T3 started to increase surpassing those treated with T1, which was consistent to the increment in the number of tillers. The effect of EM on average and relative growth rate within a week period are shown in Figure 3 and 4 where no significant differences were observed in all treatment.
Our study shows that application of EM at 30 and 50 DAS did not significantly improve plant growth parameter of aerobic rice cultivation, except for the number of tillers and average biomass weight when compared to the control (without EM). We observed slight increment pattern of average plant growth with T3 where 50% reduction of NPK (0.9 g) shown higher average growth rate at 13.82 g/weeks compared to 10.61 and 10.06 g/weeks for T1 and T2.

From this premise, we encourage to further studies with EM continuously with reduced amount of fertilizer and chemicals to look at the effectiveness of EM at lowering the impacts of chemical pollution as well as reducing the cost of fertilizer application. It was reported that application of EM with fertilizer can reduce the costing about 65 % for 10 ha. This could greatly impact the lives of farmers, and other agriculture stakeholders. Thus, long term studies should be conducted in order to evaluate others benefits due to use of compost with EM; such as possible improvements in soil properties in order to quantify the economic and environmental benefits of this use. The suitable climate condition, sufficient amount of organic fertilizer and chemical fertilizer are the factors that should be considered before applying EM. In general, EM application enhanced plant nitrogen (N),
phosphorus (P), and potassium (K) nutrition in organic amendments while its effect was either negative or insignificant in chemical fertilizer amendments. Effects of EM application on plant nutrient uptake were more pronounced at maturity than at flowering stage [3].

The quality of the fermented organic fertilizer depends on the initial water content; addition of molasses as a carbon and energy source; and the microbial inoculant. The medium pH appears to be reliable fermentation quality criterion for producing this organic fertilizer. Beneficial effects of the fermented organic fertilizer on soil fertility and crop growth will likely depend upon the organic fraction, direct effects of the introduced microorganisms, and indirect effects of microbially-synthesized metabolites (e.g., phytohormones and growth regulators) [4]. It is also important to note that EM is not a substitute for chemical fertilizer management practices but complimentary to conventional agricultural method to reduce the dependency to chemicals, hence lessen the impact to the environment, while reconditioning and improving the natural condition of the ecosystem over time.

References
[1] K Yamada, H L Xu 2001 Properties and Applications of an Organic Fertilizer Inoculated with Effective Microorganisms J. Crop Prod 3 255–268.
[2] A El-Shafei, M Yehia, F El-Naqib 2008 Impact of effective microorganisms compost on soil fertility and rice productivity and quality Misl J. Agric. Eng. 25 1067–1093.
[3] A Javaid, R Bajwa 2011 Effect of Effective Microorganism Application on Crop Growth, Yield, and Nutrition in Vigna radiata (L.) Wilczek in Different Soil Amendment Systems Commun. Soil Sci. Plant Anal. 42 2112–2121.
[4] K Yamada, H L Xu 2001 Properties and Applications of an Organic Fertilizer Inoculated with Effective Microorganisms J. Crop Prod. 3 255–268.
[5] M J Daly, D P C Stewart 1999 Influence of “Effective Microorganisms” (EM) on Vegetable Production and Carbon Mineralization–A Preliminary Investigation J. Sustain. Agric. 14 15–25.