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Evaluation of Effectiveness of Some Liquid Organic Fertilizers for Rice (*Oryza sativa)* under Organic Farming Condition

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ABSTRACT

Beneficial microbial population in soil and plant surface plays a significant role in plant growth, development and disease suppression. Different sources of organic matter can be added to agricultural fields in order to enhance the beneficial microbial population and ameliorate their activities in soil. Liquid organic fertilizer can be used for sustainable farming by increasing the number of beneficial organisms in soil and plant surfaces as an organic approach to plant/soil care. The study was carried out to evaluate different liquid organic fertilizer types such as Compost tea, Compost tea with leaves, Panchagavya, Jeevamurtha and their microbial count to enhance paddy growth under local conditions. Liquid organic fertilizer made from different types of sources was used in this study. Effects of sources were evaluated by application and culturing microorganisms. The highest yield, chlorophyll content, plant height, number of tillers, thousand grain weight, percentage of thousand grain weight were recorded for Jeevamurtha solution with compared to other tested solutions. The highest microbial count was obtained for Compost tea with leaves solution. Jeevamurtha can be recommended for farmers to get high yield with low cost. Further investigations for paddyon other varieties,soil,environmental conditionsand seasons must be carried out before recommending the liquid fertilizer types.

KEY WORDS: Compost tea, Compost tea with leaves, Panchagavya, Jeevamurtha, Total bacterial count

INTRODUCTION

The liquid organic bio fertilizers are suspensions having agriculturally useful microorganisms, which fix atmospheric nitrogen and solubilize insoluble phosphates and make it available for the plants. The use of this fertilizer is environment friendly and gives uniform results for most of the agricultural crops and directly reduces the use of chemical fertilizer by 15 to 40% (Anon, 2010). Use of liquid organic fertilizers is one of the important components of integrated nutrient management, as they are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. Several microorganisms and their association with crop plants are being exploited in the production of liquid fertilizers. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants (Anon, 2005).

Liquid organic fertilizer can be used for sustainable farming by increasing the number of beneficial organisms in soil and plant surfaces as an organic approach to plant/soil care. It contains living microorganisms and their activities will influence the soil ecosystem and produce supplementary substances for the plants (Higa and Parr, 1994). However, the species and quantity will vary depending on the nutrient obtained from the raw materials and they are used to improve soil health and nutrition.

There are different types of liquid organic fertilizer and their differences are mainly in the raw materials used, forms of utilization and the sources of microorganisms (DOAE 2003;Higa and Parr, 1994). Compost tea is an aerobic water solution that has extracted the beneficial microbial population from stable, mature compost with the nutrients. Compost tea highly enriched with compost extracted nutrients and microorganisms compared to compost and also reduce the burden of handling large quantity of compost (Anon, 2005). Also compost teas are viewed as potential alternatives to the use of synthetic chemical fungicides as they provide a means of controlling plant pathogens that are deemed safer for health and the environment. Also compost teas may provide a general microbial population that serves to compete with some plant pathogens for nutrients and specifically inhibit the growth of pathogens (Inghem, 2003). Compost tea with leaf extract also has the same characteristics of compost tea,but various types of leaves provide more nutrients to the compost tea solution.

Panchagavya another valuable organic liquid fertilizer and it is a combination of five products obtained from the cow, such as cow dung, cow urine, cow's milk, curd and ghee.

It is a traditional liquid fertilizer in India whichused to safeguard plants and soil microorganisms and to increase plant production. Application of it is found to be more profitable than recommended fertilizer application and chemical spray. It has a significant role in providing resistance to pest and diseases and increasing the overall yield (Vijayakumari *et al.*, 2012).

Jeevamrutha also considered being a panacea for the prosperity of agriculture which preparedby mixing dung and urine from local cattle with other materials. It is important to provide a congenial environment to microorganisms that help in making available the essential nutrients for plant growth *viz.*, nitrogen, phosphorus and potassium while improving the soil considerably. It is supposed to encourage microbial activity in the soil (Anon, 2013). Therefore liquid bio fertilizer is relatively valuable concept to Sri Lankan Agriculture and research is necessary to adopt the procedure with locally available materials and local condition.

MATERIALS AND METHODS

Location

The experiment was carried out in the Rice Research and Development Institute, Batalegoda and microbiology laboratory of the Department of Plantation Management, Wayamba University of Sri Lanka from January to April, 2013.

Liquid Bio Fertilizer for Experiment

Four types of liquid bio fertilizer with control (T5) were tested as treatments. They were Panchagavya (T3), Jeevamrutha (T4), Compost tea (T2) and Compost tea with leaves (T1).

Field Layout

Fifteen sunken beds (6×3 m^2) were prepared providing drains with 0.3 m width between beds. The treatments were arranged in randomly complete block design (RCBD) and replicated three fold.

Liquid Bio Fertilizer Sample Preparation

Preparation of Panchagavya Solution

A 8 l plastic container was used and 1.25 kg fresh cow dung and 75 g cow ghee were put in to the plastic can and it was mixed twice daily (10 min) for three days. On the fourth day, the rest of the ingredients (750 ml cow urine, 500 ml cow milk, 500 ml cow curd, 75 g jaggery, 750 ml tender coconut water, 500 ml toddy, 3-4 ripped banana) were added and it was mixed twice daily (10 min) for 15 days.

Preparation of Jeevamrutha Solution

A 8 l plastic can was used and 250 g fresh cow dung and 5 l water solution were put in to plastic can and it was mixed gently in clockwise. After that the rest of the ingredients (50 g Dried Glericidea leaves, 50 g sugar and 50 g Natural top soil) was added and stir thoroughly. Solution was kept under shade and it was covered by gunny bag. It was mixed twice daily (10 min) for 5 days.

Preparation of Compost Tea Solution

A 8 l plastic can was used and 500 g compost bag was soaked in ¾ of container which include 7 l of chlorine free water. Solution was continuously aerated by using aerators.

Preparation of Compost Tea with Leaves Solution

A 8 l plastic can was used and 500 g compost with leaves, 83 g Glirecedia (*Glirecedia sapium*) leaves, 83 g kappetiya (*Crotalaria retusa)* leaves, 83 g Wild sunflower leaves *(Tithonia diversifolia))* were soaked in ¾ of container which include 7 l of chlorine free water. Solution was continuously aerated by using aerators.

Culture Procedure

Liquid bio fertilizer solution samples were taken at 24, 48 and 72 hr time intervals. One milliliter of well stirred brewed sample was taken, dilution series prepared and microorganisms were cultured using pour plate technique with three replicates. Plate count Agar was used as the culture media. Then cultured sample were kept in an incubator at 37 ^{0}C for 48 hr.

Crop Establishment and Maintenance

As a basal dressing compost (350 kg) were applied to all plot. BG 250 variety seeds (2 1/2 month) were sawed and coconuts cadjans were used to protect from bird damage. The four types of liquid bio fertilizer were applied through the cropping period as given in Table 1. Irrigation was done and irrigation intervals were adjusted according to prevailing weather conditions. Manual weeding and other cultural practices were done as recommended.

Data Recording

Vegetative, reproductive and yield parameters were taken from selected plants. Five randomly selected plants were used from each treatments of each replicate for data recording.

Table 1. Liquid bio fertilizer application schedule

No of DAP	Liquid bio fertilizer types and dosage (50 m^2)			
	Panchagavya (ml/l water)	Jeevamurtha (ml/l water)	Compost tea (ml/l water)	Compost tea with leaves (ml/l water)
20-30	30	30	200	200
30-40	60	60	250	250
50-60	80	90	300	300

Note:DAP= Days after planting

Vegetative Parameters

Number of tillers and Height of the plant

The numbers of tillers and height were counted at 21 days after seed sawing. Counting was continuously done according to 10 days interval until panicle initiation.

Reproductive Parameters

Number of Panicles

Numbers of panicles were counted after the panicle initiation stage.

Chlorophyll content

Chlorophyll content of leaves was calculated by using sprad meter.

Yield Parameters

Total yield and thousand grain weight were calculated after the harvesting.

Total Bacterial Count

All microbial colonies were counted separately and total bacterial count (TBC) was calculated.

$$TBC = \text{Dilution factor} \times \frac{\text{No of microbial count}}{\text{Volume}}$$

Statistical Analysis

The data were statistically analyzed using SAS 9.1.3, (1999) program.

RESULTS AND DISCUSSION

Twenty four hours after preparing the solutions the highest microbial count is observed in compost tea with leaf extract (T1-3.9) and the lowest value in Panchagavya (T3-0.22) (Table 2). Those two values were significantly different from microbial count of jeevamurtha and compost tea. After 48 hr of preparing liquid fertilizer solution the total microbial count has decreased in all treatments (Figure 1). That's may be due to the declining of nutrients available in the liquid bio fertilizer solution. Compost tea with leaf extract (T1) showed the highest (1.89) microbial count. But it was not significantly different from the compost tea (T2). Panchagavya (T3) showed the lowest significant value in this stage as well.The microbial counts in all treatments were increased once again when it comes to 72 hr after preparing the liquid bio fertilizer solution (Figure 1) most probably due to multiplication of remaining microorganisms in existing nutrients and the continuous aeration.

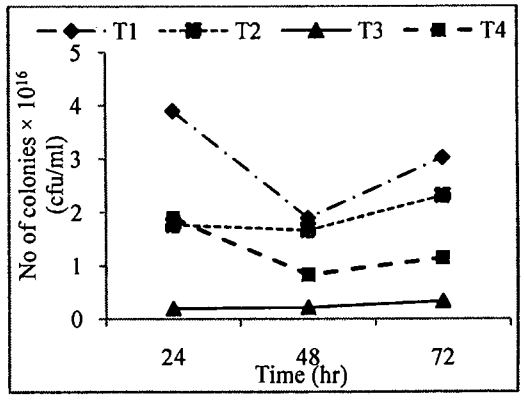

Figure 1. Changing microbial count with the time

Note:T1=Compost tea with leaves, T2= Compost tea, T3=Panchagavya, T4=Jeevamurtha

Similarly at this stage the highest value (3.02) was observed in T1 and it was not significantly different from T2. A significant lower value (0.34) was observed in T3 at this stage as well.As shown in the Figure 2, the height of bushes in all treatments was increased with time. But it was not significantly different at any stage of growth. Even though it is not statistically significant a slightly high value (44.69) for height was also observed in Jeevamurtha (T4) (Table 3).

Table 2. Microbial count mean

Trteament	Microbial count (mean)		
	24 hr	48 hr	72 hr
T1	3.9 [a]	1.89 [a]	3.02 [a]
T2	1.77 [b]	1.67 [a]	2.31 [a]
T3	0.2 [c]	0.22 [c]	0.34 [c]
T4	1.89 [b]	0.84 [b]	1.15 [b]

Means followed by same letter in each column are not significantly different at 0.05 level

Table 3. Vegetative, Reproductive and Yield parameters of *oryza sativa* after the application of liquid fertilizer

Treatment	Vegetative parameters		Reproductive parameters		Yield parameters		
	No of tillers	Plant height (cm)	Panicle initiation %	Chlorophyll content	1000 grain weight (g)	1000 grain weight % compared to control	Total yield (g/m^2)
T1	4.06 [a]	43.42 [a]	33.07 [a]	43.99 [a]	24.63[a]	5.12	527.57 [ab]
T2	3.80 [a]	43.82 [a]	35.93 [a]	44.29 [a]	25.78 [a]	10.02	421.17 [c]
T3	3.66 [a]	42.98[a]	34.50 [a]	44.16 [a]	25.29 [a]	7.9	578.9 [ab]
T4	4.60 [a]	44.69[a]	33.53 [a]	44.72 [a]	25.83 [a]	10.24	706.3 [a]
T5	3.60 [a]	40.42[a]	39.53 [a]	43.17 [a]	23.43 [a]	0	325.97 [c]

Means followed by same letter in each column are not significantly different at 0.05 level

As shown in the Figure 3 number of tillers of all treatments were increased up to 48th day, at the time the bushes usually show the highest vegetative growth. After that, tillers may have died reasoning the decrease in number of tillers. Eventhough statistically not significant, thehighest numbers of tillers were observed in Jeevamurtha (T4). Highest values for both height and number of tillers were observed in Jeevamurtha (T4), suggesting that Jeevamurtha contain more nutrients responsible for the vegetative growth of the bush.

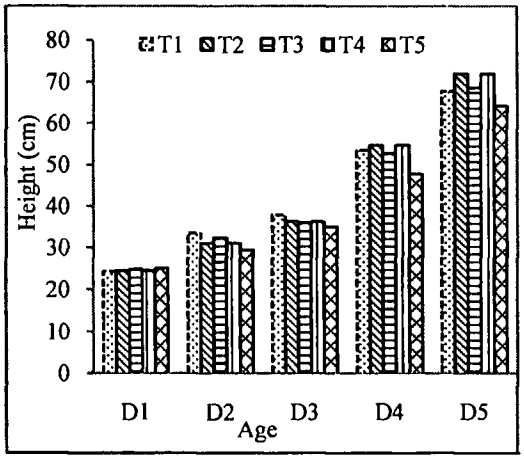

Figure 2. Average height of the paddy plants
T1=Compost tea with leaves, T2=Compost tea T3= Panchagavya, T4=Jeevamrutha, T5= Control DAS=Days after sawing D1=18DAS, D2=28DAS, D3= 38DAS, D4=48DAS, D5=58DAS

When reproductive parameters are considered, percentage of panicle initiation was not significantly different among treatments. The slightly high value (39.53) (Table 3) observed in the control, was probably due to the less number of tillers present in the control test. Chlorophyll content was measured by means of sprad value. The highest chlorophyll content (44.72) was recorded from Jeevamurtha. (Table 3).

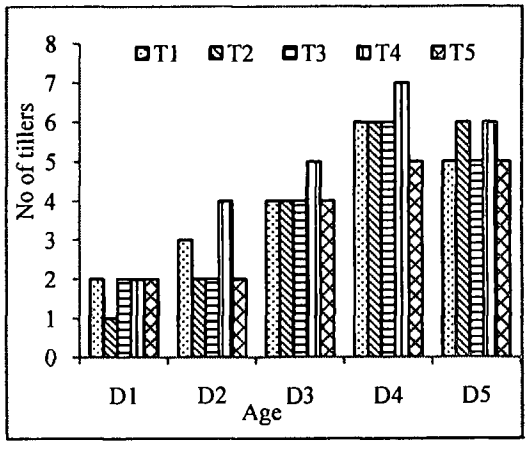

Figure 3. Average tillers of the paddy plants
T1=Compost tea with leaves, T2=Compost tea T3= Panchagavya, T4=Jeevamrutha, T5=Control DAS=Days after sawing D1=18DAS, D2=28DAS, D3= 38DAS, D4=48DAS, D5=58DAS

Jeevamurtha (T4) which contains cow dung and Gliricedia leaves may have high amount of Nitrogen, which can influence the chlorophyll content as mentioned by Hokmalipour and Darbandi (2011). The highest 1000 grain weight was observed in Jeevamurtha (T4) (25.83). When 1000 grain weight is considered the percentage Jeevamurtha had higher percentage (10.24%) with compared to the control (0%). It may be due to high chlorophyll content in Jeevamurtha treated plants. Since high chlorophyll content enhances the photosynthetic rate, grain filling should have been increased (Table 3). The yield was varied in the order of Jeevamurtha (T1) > panchagavya (T2) > compost tea with leaves (T3) > compost tea (T4) > control (T5). The significantly highest yield was observed in Jeevamurtha (T4) as shown in Figure 4.This

may be due to the higher number of tillers and chlorophyll content observed in Jeevamurtha. With increased No of tillers in a unit area the number of panicles also increases and higher number of chlorophyll result in more photosynthesis and fills more grains resulting more yields.

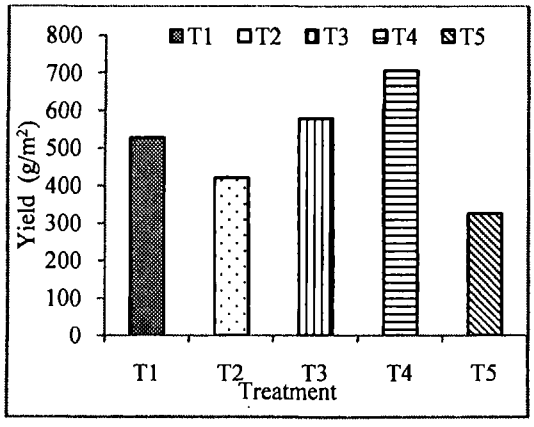

Figure 4. Average yield of paddy (g/m^2)
Note:T1=Compost tea with leaves, T2=Compost tea T3= Panchagavya, T4=Jeevamrutha, T5= Control

Economic Assessment

An economic assessment was performed to find the feasibility of using different liquid bio fertilizers. The lowest cost (Rs. 20/10 l of solution) was spent for Jeevamurtha (T4). Compost tea with leaves (T1) and Compost tea (T2) had similar costs (Rs. 25/10 l of solution) and it was the second lowest cost. But, if the compost could be found for free of charge from the home garden for both T1 and T2 would cost nothing. The cost for Panchagavya (T3) was very high (Rs. 300/10 l) since it includes costly ingredients. In addition to this finding, material for panchagavya is difficult and not freely available.

CONCLUSIONS

In this study, Jeevamurtha showed higher values for some parameters, such as highest yield, chlorophyll content, plant height, number of tillers, thousand grain weight, and percentage of thousand grain weights.During this study visual observations showed a clear difference among treatments but time did not permit to repeat the investigation for re-confirmation. Though significant differences were not found among different organic treatments, it is clear that different organic fertilizer treatments can be used in paddy cultivation successfully which helps soil restoration and promotesmore healthy food for the nation.However, effectiveness of organic fertilizer may change with the paddy variety, soil type, methods of application, environment conditions, rate of application etc. Therefore, further studies are necessary to understand the most effective and successful means of organic fertilizer application to paddy.

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