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Effect of Nitrogen Enrichment Levels of Municipal Solid Waste Co-compost on Traditional Rice (*Oryza sativa*) Variety *Suwandel*

R.M.J. RATHNAYAKE and B. RANAWEERA

Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka

ABSTRACT

Main constraint of using compost in organic farming is less nutrient content and bulkiness when applying to field. This study was carried out to find out the suitable nitrogen enrichment level of municipal solid waste co-compost for application in the cultivation of traditional rice variety *Suwandel.* Normal municipal solid waste co-compost, municipal solid waste co-compost with 10% nitrogen enrichment, municipal solid waste co-compost with 20% nitrogen enrichment were compared with poultry manure. Co-compost was enriched using urea. Plant height, number of leaves, tillers, seeds, fresh and dry weight of leaves, root, stem and panicle weight, and total yield were recorded. Growth parameters showed significant difference at vegetative stage of plant. Co-compost with 10% nitrogen enrichment and co-compost with 20% nitrogen enrichment showed higher values than normal co-compost and poultry manure. However, there was no significant difference in vegetative and reproductive parameters at later stages and in the yield. Results revealed that nitrogen enrichment in municipal solid waste co-compost was not having any significant effect on the yield and there was no significant difference between municipal solid waste co-compost and poultry manure.

KEYWORDS: Municipal solid waste co-compost, Nitrogen enrichment, *Suwandel*

INTRODUCTION

Traditional rice (*Oryza sativa*) variety *Suwandel* is an indigenous white rice variety with an exquisite aroma. It has many medicinal values like control of diabetic, reduce cardio vascular diseases, antioxidant properties and also known to promote fair skin. It contains high amount of glutamic acid and vitamins than common rice varieties. *Suwandel* is heirloom variety cultivated organically with traditional rain fed methods (Anon, 2014).

Compost is one of the common organic fertilizers used all over the world and it is a product of a controlled aerobic decomposition of organic matter (Rouse *et al.*, 2008). Compost improves soil moisture, nutrient retention, buffering capacity and improves soil overall structure. In compost, nutrient composition generally not constant and the overall percentage is lower than chemical fertilizer.

Chemical fertilizers high in nutrients and available to the plants immediately. Though it gives quick results it has negative effects like chemical fertilizers may have some harmful acids which stunt the growth of microorganisms found in the soil that are helpful for plant growth naturally. Chemical fertilizers tend to leach or filter away easily from soil so it requires additional applications. Heavy application of chemical fertilizers may cause negative effects on environment and accumulation of certain substances that pollute the soil and discourage some minor elements to be not available to the plant (Farah *et al.*, 2014)

Livestock manure, leaf mold, crop residues, and house hold waste are the most commonly used raw materials in compost manufacturing. In addition to those, there is a trend to use municipal solid waste (MSW) and fecal sludge (FS) for compost manufacturing as a solution to nutrient requirement of paddy field as well as a solution to MSW problem.

In Sri Lanka around 3,424 metric tons of MSW is collected daily (Anon, 2012). It is a serious issue within the country. As a solution using MSW co-compost manufacturing is done. Co-composting is the process of composting of two or more materials together. Co-composting of FS and organic MSW allows recycling of nutrients to agriculture. Municipal solid waste consist of 63% organic waste. Composting is an environment friendly and economical treatment for organic solid waste. Municipal solid waste co-compost has its own draw backs such as low nutrient content. Generally it has about 1% of nitrogen (N), 0.5% of phosphorus (P), and 1% of Potassium (K) (Anon, 2009). An effective solution for this is to adjust nutrient content by adding chemical fertilizers.

Nitrogen is an essential plant nutrient being a component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes, and hormones. In paddy plant N promotes rapid plant growth and improves grain yield and grain quality through higher tillering, leaf area development, grain formation, grain filling and protein synthesis. Nitrogen is highly mobile within the plant and soil (Anon, 2012). Excess use of N fertilizer cannot promise a substantial increase in crop productivity. Excess use and runoff cause for eutrophication in water ways which threatens human, animal and plant health (Zafari and Kianmehr, 2012). Rice plant needs 20–30 kg of N per hectare in one season to have a yield response of 1-3 tons per hectare (Anon, 2007).

Normally compost has about 1% of N. Therefore, it is necessary to apply compost in large amounts to have desired effects. Compost is slow nutrient releasing fertilizer. Due to those reasons, the use of compost in paddy cultivation remains low. An effective solution for this is enhancing the N level of compost by adding inorganic fertilizers like urea. This also helps to reduce the use of chemical N fertilizer consumption (Zafari and Kianmehr, 2012).

There is an increasing demand for traditional rice varieties in the market. Farmers are more interested on growing them under organic conditions as demand is increasing for organic products. However, there are problems of using only compost as fertilizer, i.e. difficulty in handling, necessity of application in huge amounts to the fields and low yield due to low nutrient content in compost.

Therefore, this study was carried out with the objective of studying the suitable N enrichment level of MSW co-compost on traditional rice variety *Suwandel* comparing their response to poultry manure, which is the most commonly used organic fertilizer by paddy farmers, because, combining chemical fertilizers with compost reduces the chemical fertilizer consumption and enhances fertilizer use efficiency.

MATERIALS AND METHODS

Location

The experiment was conducted at the Faculty of Agriculture and Plantation Management Wayamba University Sri Lanka, Makandura. Situated in low country intermediate zone (IL_{1a}), at an elevation of 30 m from mean sea level. Experiment was carried out from January to April 2016.

Variety

Suwandel was selected as traditional rice variety.

Fertilizer Treatments for Experiment

Three types of MSW co-compost and poultry manure were used as treatments. Namely poultry manure (1% N) (T_1) as control, MSW co-compost without N enrichment (1% N) (T_2), MSW co-compost with (10% N) (T_3), and MSW co-compost (20% N) (T_4) were the treatments applied in the experiment.

Field Layout

Sixteen sunken beds, each bed with 8 m^2 (4×2 m) were prepared and separated from each other by bunds with 40 cm width. The treatments were arranged in a Completely Randomized Block Design (RCBD) with four replicates.

Compost Preparation

Municipal solid waste with FS co-compost produced by Kurunegala Municipal Council was used in the experiment. Nitrogen enrichment was done by adding urea in to the compost. Amount of the applied compost to plots were calculated according to its percentage of N. Nitrogen requirement of rice plant was considered as 30 kg per hectare (Anon, 2007).

Crop Establishment and Maintenance

Land preparation, crop establishment, fertilizer application and crop maintenance were done according to DOA recommendations. Land was prepared for broadcasting and four types of MSW co compost were applied (Table 1). Dry *Suwandel* seeds were broadcasted on each bed at the rate of 120 g per bed. Irrigation was done daily. Manual weeding and organic control of pests were carried out until harvesting.

Table1. Poultry manure and MSW Co-compost fertilizer application schedule and rates (kg/8 m^2)

Fertilizer application	Poultry manure	MSW CC	MSW CC 10%N	MSW CC 20%N
BD	2.41	2.41	0.24	0.12
TD1 (4WAS)	1.20	1.20	0.12	0.06
TD2 (7WAS)	1.20	1.20	0.12	0.06

WAS- Weeks after sowing, BD- Basal dressing, TD- Top dressing; MSW CC- Municipal solid waste co-compost; N- Nitrogen

Data Recording

Height of plant, Number of tillers and Number of leaves

The number of tillers, leaves and height of plant were measured at 30 days interval until harvesting.

Fresh Weight and Dry Weight

Fresh weight and dry weight of plants were measured at 30 day intervals after germination. Dry weight was measured after oven drying at 80 °C for 72 h.

Number of Panicles and Seeds per Panicle

Number of seeds per panicle was taken after panicle initiation.

Fresh weight and Dry weight of Panicles

Fresh and dry weights of panicles were measured at 30 day intervals after panicle initiation. Dry weight was measured after oven drying at 80 °C for 72 h. Ten plants were randomly selected from each plot for recording of all above parameters.

Yield Parameters

Total yield was measured at the harvesting.

Pest Damages

Paddy bug was the only pest observed with a considerable population during the experimental period. Therefore, count of paddy bug was recorded in weekly intervals.

Statistical Analysis

Data analysis was done by using the Statistical Analytical System (SAS) software version 9.2.

RESULTS AND DISCUSSION

Analysis of Growth Parameters

Statistical analysis of mean values of height, numbers of tillers and fresh and dry weight of root, stem and leaves collected on the 30 days after sowing (DAS) revealed that there was a significant difference among the treatments. The height of the paddy plant was significantly highest in T_3 and T_4 while T_1 and T_2 show lower values (Table 2). Treatments T_3 and T_4 are MSW co-compost fertilizers that were enriched with urea. Urea quickly dissolves in water and release N in easily available form for the plants. It enhances plant vegetative growth. While poultry manure and compost release their nutrients slowly and N will be available for plant in smaller quantities.

As shown in the Figure 1 the number of tillers of all treatments was increasing up to 60 DAS. At that time rice plants reached highest vegetative growth. After that tiller number has being reduced, due to the death of tillers occurred and due to the prevailed drought condition and high temperature. Highest tiller number was observed in T_3 at 60 DAS.

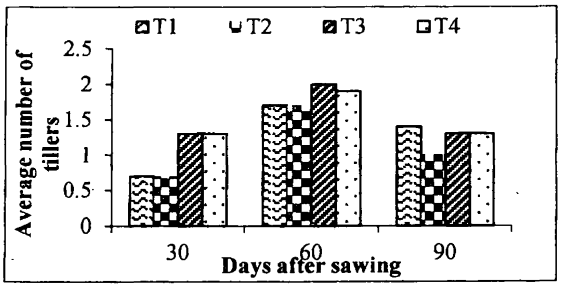

Figure 1. Average number of tillers per plant (From sawing to ripening stage). *T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N.*

At vegetative stage (30 DAS) the fresh weight and dry weight of root, stem, and leaves were significantly different among treatments (Table 3). Root and leaf fresh and dry weights of T_3 and T_4 were significantly higher than T_1 and T_2. While T_3 showed the highest stem fresh weight and lowest by T_2. Stem fresh weight of T_1 and T_4 were significantly different from T_3 and T_2. However, stem dry weight did not show any significant difference among treatments. There was no any significant difference among treatments, at 60 DAS and 90 DAS (Table 4; Table 5).

Table 2. Plant growth parameters

Treatment	Height (cm)			Number of leaves			Number of seeds	
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1	26.62^b	59.94^a	71.21^a	40^a	49^a	47^a	247^a	239^a
T_2	26.45^b	63.55^a	74.29^a	41^a	58^a	51^a	146^a	273^a
T_3	30.07^a	69.41^a	69.55^a	47^a	52^a	87^a	202^a	360^a
T_4	30.05^a	64.55^a	67.40^a	43^a	53^a	50^a	171^a	460^a

Mean followed by same letter in each column are not significantly different at 0.05 level; T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N; DAS-Days after sowing

Table 3. Fresh and dry weight of plant 30 days after sowing

Treatment	Fresh weight (g)			Dry weight (g)		
	Root	Stem	Leaves	Root	Stem	Leaves
T_1	0.425^b	1.477^{ab}	1.190^b	0.182^b	0.420^a	0.452^b
T_2	0.447^b	1.332^b	1.110^b	0.162^b	0.382^a	0.397^b
T_3	0.572^a	1.917^a	1.510^a	0.255^a	0.542^a	0.535^a
T_4	0.537^a	1.860^{ab}	1.505^a	0.217^a	0.462^a	0.590^a

Mean followed by same letter in each column are not significantly different at 0.05 level; T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N

Table 4. Fresh and dry weight of plant 60 days after sowing

Treatment	Fresh weight (g)				Dry weight (g)			
	Root	Stem	Leaves	Panicles	Root	Stem	Leaves	Panicles
T_1	0.797[a]	9.032[a]	2.777[a]	1.047[a]	0.662[a]	3.220[a]	1.857[a]	0.575[a]
T_2	1.240[a]	8.970[a]	3.437[a]	0.450[a]	0.970[a]	2.727[a]	2.007[a]	0.305[a]
T_3	0.887[a]	8.397[a]	2.807[a]	0.967[a]	0.697[a]	2.985[a]	1.827[a]	0.615[a]
T_4	1.335[a]	9.987[a]	3.205[a]	1.122[a]	1.005[a]	3.382[a]	2.242[a]	0.727[a]

Mean followed by same letter in each column are not significantly different at 0.05 level.; T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N

Table 5. Fresh and dry weight of plant 90 days after sowing

Treatment	Fresh weight (g)				Dry weight (g)			
	Root	Stem	Leaves	Panicles	Root	Stem	Leaves	Panicles
T_1	0.665[a]	6.602[a]	2.152[a]	2.522[a]	0.352[a]	2.347[a]	1.727[a]	1.065[a]
T_2	0.462[a]	7.417[a]	2.135[a]	1.807[a]	0.365[a]	2.840[a]	1.537[a]	1.537[a]
T_3	0.792[a]	10.36[a]	3.402[a]	2.832[a]	0.600[a]	3.732[a]	2.672[a]	2.502[a]
T_4	1.160[a]	14.85[a]	4.372[a]	3.340[a]	0.700[a]	4.960[a]	3.262[a]	2.690[a]

Mean followed by same letter in each column are not significantly different at 0.05 level.; T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N

Analysis of Yield

There were no significant differences among the yield of the treatments (Table 6). In all the treatments same N level (30 kg/ha) required by paddy plants were supplied by adjusting the quantity of organic fertilizer applied. Municipal solid waste co-compost was enriched by urea, so only N was concerned.

However, other micro elements that are important for development of yield were supposed to be supplied by compost. Even though the different quantities of compost were applied yield did not show any difference among the treatments. The significant differences shown in growth parameters at 30 DAS have not affected on the yield of plant. Treatments that received lower amounts of micro nutrients have received a rapid vegetative growth due to the quick release of N that may have a nullifying effect on the lower amounts of micronutrients.

Analysis of Paddy Bug Population

High paddy bug populations were observed within the first week and the fourth week after heading (Figure 2). In each week highest paddy bug population was observed in T_4. Due to the sap sucking feeding habit of paddy bug it has a higher potential for survival among other pests during hot weather conditions, due to the availability of relatively higher amounts of water in the food.

Table 6. Analysis of yield

Treatments	Total yield (kg/ha)	Mean values
T_1	1112.5	222.50[a]
T_2	1111.25	222.25[a]
T_3	1082.5	182.50[a]
T_4	1132.5	226.50[a]

Mean followed by same letter in each column are not significantly different at 0.05 level.; T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost 10% N, T_4- MSW co-compost 20% N

As there were no other alternative hosts available in the surrounding fields, whole population of Paddy bugs were attracted to the experimental field. Further with the higher percentage of N provided by urea, T_4 was releasing N at a higher rate than other treatments thus creating plants more attractive to sucking pests resulting development of higher Paddy bug population.

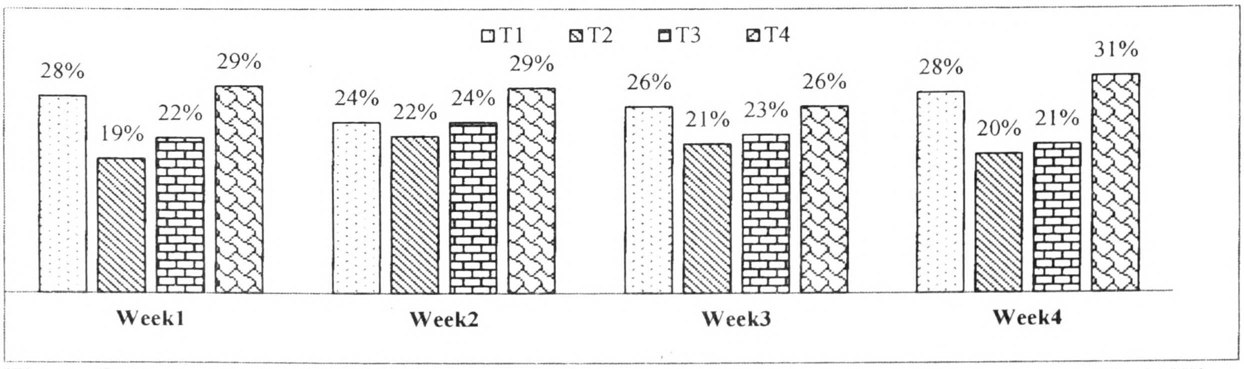

Figure 2. Percentage of Paddy bug population. *T_1- Poultry manure, T_2- MSW co-compost, T_3- MSW co-compost+10% N, T_4- MSW co-compost+20% N*

There were significant differences among the vegetative parameters of *Suwandel* variety at 30 DAS stage. Treatments T_3 and T_4 showed highest value among vegetative parameters. Consequently there was no difference among vegetative and reproductive parameters. There was no significant difference between the treatments for yield.

Uniformity of growth and yield parameters across the treatments could be a result of nutrient rich soil in the experiment site. Hence, it is important to carry out research in conventional paddy field, with the amounts of MSW co-compost that are enough to supply other elements required by plants. Therefore, the farmers who are available with bulk of co-compost and poultry manure can apply in the field without enrichments. When there is a problem with finding and applying higher quantities of compost, by application of suitable N enrichment levels of MSW co-compost can obtain a similar level of yield

Effect of organic fertilizer may also vary according to paddy variety, soil type, method of application, environment condition, rate of application *etc.* Further it takes years to give true effect of organic fertilizer on the field. Therefore, it is necessary to carry out the experiments for further consecutive years under farmer level. Especially in nutrient depleted conventional lands.

CONCLUSIONS

There was no significant difference in vegetative and reproductive parameters at later stages and in the yield. Results revealed that nitrogen enrichment in municipal solid waste co-compost was not having any significant effect on the yield and there was no significant difference between municipal solid waste co-compost and Poultry manure.

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