Studies on the Effect of Fertilizer Prepared from Rice Husk Ash and Tea Residue

Thazin Nyo

Abstract

In Myanmar, large amounts of rice husk are currently produced every year. These husks are burned as biomass fuel but the problem remains of how to deal with the remaining ash which amount to 20% of the original volume. Tea residue is also the waste material. This work was intended to make effective use of rice husk ashes (RHA) and tea residue (TR) into the fertilizer which were developed by mixing the different ratios of RHA, TR and chemical fertilizers. Before transplanting, physiochemical properties of RHA, TR and soil properties were determined. Elemental composition of RHA, TR and soil were determined by EDXRF method. Then, cultivation of paddy plants in experimental plots was carried out using the prepared fertilizers in the rainy season. Yield and yield related characteristics of rice plant were determined. From plot experiment, mixing the fertilizers, (0.9 TR +2.1 RHA + NPK) kg/ plot gave best yield followed by the combination of (0.9 TR + NPK) kg/ plot. Among all treatments, control treatment (without fertilizer) gave the lowest yield.

Keywords: rice husk ash, tea residue, yield

Introduction

Compost is the aerobically decomposed remnants of organic matter. It serves as a growing medium, or a porous, absorbent material that holds moisture and soluble minerals, providing the support and nutrients in which most plants will flourish (Ishizuka and Tanaka, 1952).

Rice yields can be improved over and above yields obtained with regular use of fertilizer by addition of rice husk ash. Incorporation of rice husk ash was improved the soil physical properties with a reduction of the compactness of the sandy soil, which was eventually beneficial to the growth of crops. Rice husk ash exhibited a large capacity of water absorption with slightly alkaline properties, which functioned as a suitable soil conditioner for the acid sandy soils (Shinohara, and Kohyama, 2004). Tea waste is also used to prepare compost tea. Compost tea that is correctly brewed has a wealth of microorganisms that will benefit plant's growth and health as well as the soil that they live in. Spray the compost tea directly on the plant leaves or apply it to the soil as an organic fertilizer. When compost tea is sprayed on a plant, the plant will often grow more vigorously, resist disease and insect attack, and may produce higher yields of flower and fruit (Hingham and Elaine, 2000),

Materials and Methods

Sample Collection

Rice husk ashes were collected from brewery factory, Shwe Pyi Thar Township. Tea residues were obtained from tea shops. These collected raw materials were air dried, crushed and stored in polythene bags.

Figure 1. Photograph for (a) Rice husk ash (from brewery factory)

(b) Tea residue

Determination of Some Physiochemical Properties and Mineral Content of Rice Husk Ash (from brewery factory),Tea Residue and Soil (before transplanting)

Before the transplanting, the physiochemical properties RHA, TR and soil from experimental plot were determined. The moisture content and the silicic acid contents of the rice husk ash and tea residue samples were determined by oven drying method and Deutschem Einheitsverfahren method. The pH value was determined by pH meter. The organic carbon contents of rice husk ash and tea residue samples were determined by using Ignitation method. The nitrogen, phosphorous and potassium were determined by using Kjeldahal digestion method, Ammonium molybdate method and Flame spectrophotometric technique, respectively. The elemental composition of rice husk ash, tea residue and soil were determined by ED XRF method.

Preparation of Fertilizers for Plot Experiment

The plot experiments were conducted to evaluate the effect of the application of two different kinds of fertilizer: rice husk ash (RHA) and tea residue (TR) on the rice growth. The fertilizers used for plot experiments were prepared according to Table 1.

Experimental Design and Treatment of Soil with Fertilizer

The experimental design was carried out at an experimental field of Myanmar Rice Research Centre, Hmawbi during June to October, 2007. The size of the experimental plot was 200 m^2. The plot was ploughed three weeks before transplanting. Fourtytwo subplots were constructed by building between dikes and valley canals. The area of each plot was ($2m \times 2m$) and spacing plot by plot 45 cm was maintained. The plots were designed as randomized complete block design involving 14 treatments with three replications. The experimental design was described in figure 2.

Two weeks before transplanting, all experimental plots were treated with the different combination of prepared fertilizers. The each combination of those fertilizers was thoroughly mixed with top soil of the field. The basal doze of fertilizer was N 17 g per plot as urea, P_2O_5 25 g per plot as triple superphospate and K_2O 12.5 g per plot as chloride of potash. At top dressing, the rate of N 17 g per plot was applied at panicle initiation stage and 10 days before heading stage.

Plant Cultivation and Data Collection

Rice variety, Shwe – Myanmar, was used for this experiment. The maturity-age of this variety is 120 days. Two seedlings per hill were followed. Young seedlings were transplanted to the paddy field with the spacing of 8″x 6″ on July 18, 2007. Growth observation was done weekly.

Rice plants were harvested at October 17, 2007. At the harvesting, ten hills from in each plot were recorded plant height, panicle length, total tillers, number of panicle bearing tiller, leaf width and length. After measuring the data, those hills were washed in tap water to remove soils and air- dried for three weeks to find the total dry weight matter. The spikelets were separated into filled grains and unfilled grains. The numbers of spikelets per panicle, 1000 grain weight were observed. The grain yields were estimated by particular plot of 1 acre. Statistical analysis of the result was carried out using the IRRISTAT Programming.

Table 1. Various Ratios of the Prepared Fertilizers for Plot Experiment

Different fertilizer	Treatment	Different dosages (Kg /plot)
Tea Residue (TR)	1	0.3 TR
	2	0.9 TR
	3	0.3 TR + NPK
	4	0.9 TR + NPK
Rice Husk Ash (RHA)	5	2.1 RHA
	6	2.7 RHA
	7	2.1 RHA + NPK
	8	2.7 RHA + NPK
Combination of Tea Residue and Rice Husk Ash(TR + RHA)	9	0.3 TR + 2.7 RHA
	10	0.9 TR + 2.1 RHA
	11	0.3 TR + 2.7 RHA +NPK
	12	0.9 TR 2.1 RHA + NPK
Control	13	NPK
	14	No fertilizer

N:P:K = (50:25:12.5) g/plot

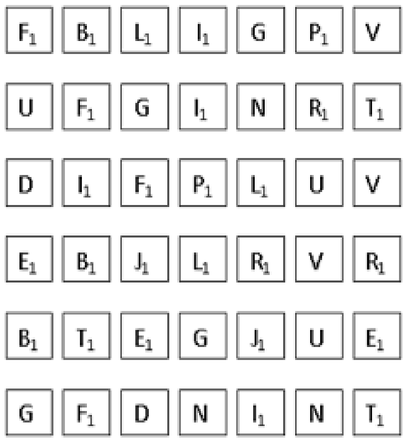


Figure 2. Design of the experimental plots for rice plants cultivation (RCBD)

Results and Discussion

Physiochemical Properties of Rice Husk Ash (from brewery factory) and Tea Residue Samples

The moisture content of the rice husk ash 3.63 ± 0.08 % is less than that of the tea residue 5.23 ± 0.04 %. The pH of the rice husk ash 9.18 is larger than that of the tea residue 5.49. The silicic acid content of the rice husk ash was found to be 0.37 ± 0.01 %.The organic carbon contents were found to be 3.73 ± 0.18 %, and 48.29 ± 0.06 %, respectively. Rice husk ash has 0.13 ± 0.01 N %, 0.63 ± 0.05 P_2O_5 % and 0.58 ± 0.05 K_2O % and tea residue sample has 4.33 ± 0.12 N %, 0.33 ± 0.02 P_2O_5 % and 1.07 ± 0.04 K_2O %.

Table 2 indicated that N and K_2O content of tea residue are higher than rice husk ash but total P_2O_5 are smaller. pH value of rice husk ash showed alkaline properties and the tea residue showed slightly acidic.

Table 2. Physiochemical Properties of Rice Husk Ash (from brewery factory) and Tea Residue Samples

Sample	Moisture (%)	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	Organic Carbon (%)	Silicic Acid (%)	pH
Rice husk Ashes(from brewery factory)	3.63 ± 0.08	0.13 ± 0.01	0.63 ± 0.05	0.58 ± 0.05	3.73 ± 0.18	0.37 ± 0.01	9.18
Air dried tea residue	5.23 ± 0.04	4.33 ± 0.12	0.33 ± 0.02	1.07 ± 0.04	48.29 ± 0.06	ND	5.49

ND = not detected

Soil Texture of the Experimental Plots

Three major groups of soil separate are sand, silt and clay. In this research, the soil contained 31.36 % sand, 31.20 % silt and 34.80 % clay. Therefore, types of soil were observed to be clay loam soil according to USDA texture triangle. Clay loam soil retains nutrients and is very fertile. It holds moisture for long periods of time when wet and dries hard as a brick.

Table 3. Soil Properties of Experimental Plot (before transplanting)

Parameter	Amount
Sand (%)	31.36
Silt (%)	31.20
Clay (%)	34.00
Moisture (%)	0.81
Organic Carbon (%)	0.75
Humus (%)	1.50
Total N (%)	0.11
Available P_2O_5 (ppm)	17.64
Available K_2O (mg/100g)	10.3
Exchangeable K^+ (meq/100gm)	0.22
Exchangeable Ca^{2+} (meq/100gm)	2.92
Exchangeable Mg^{2+} (meq/100gm)	0.08
Silicic Acid (%)	0.17
pH	5.4

Soil type - clay loam

Mineral Content of Rice Husk Ash (from brewery factory),Tea Residue andSoil (before transplanting)

The presence of silicon, potassium, calcium, manganese, iron, sulphur, copper and strontium in rice husk ash, tea residue and soil are shown by EDXRF spectra represented in Figure 3, 4 and 5. The relative abundances (%) of the elements were shown in Table 4. The elemental contents of rice husk ash in decreasing order are Si>K>Ca>Mn>Fe. For tea residue, the elemental content in decreasing order are K>Ca>Mn>Fe>S>Cu. The elemental content in decreasing order of soil are Si > Fe > K > Ca > Mn > Sr.

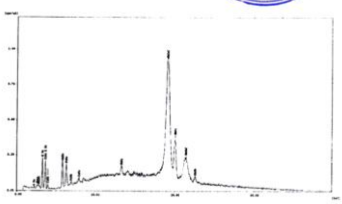


Figure 3. EDXRF spectrum of rice husk ash (from brewery factory)

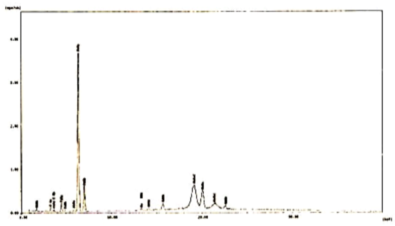
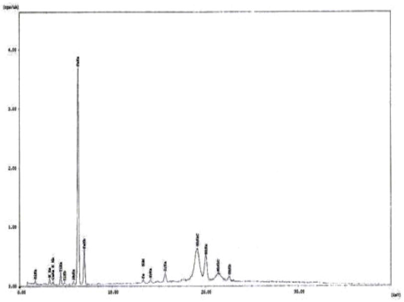


Figure 4. EDXRF spectrum of tea residue



	Content (%)		
Metal	Rice husk ash	Tea residue	Soil
Si	93.42	-	84.03
K	3.81	35.41	3.06
Ca	1.39	34.20	0.70
Mn	0.52	13.06	0.18
Fe	0.85	8.82	10.33
S	-	4.94	-
Cu	-	2.02	-
Sr	-	-	0.05

Table 4.Relative Abundance of Rice Husk Ash,Tea Residue and Soil by EDXRF

Figure 5. EDXRF spectrum of soil from experimental plot (before transplanting)

Yield and Yield Related Parameters of Rice Plants from Experimental Plots

There was an increasing yield in all TR, RHA and the combination of TR and RHA treatments. All treatments applied with NPK showed higher yield than the treatments without NPK (figure 6). Among all treatments, the highest yield 153.59 basket/acre was obtained in (0.9 TR + 2.1 RHA) kg /plot + NPK treatment followed by the 0.9 kg TR /plot + NPK treatment (143.73 basket/ acre). In RHA treatment, the 2.7 kg RHA /plot + NPK treatment gave high yield production (115.87 basket/ acre). All TR treatments had higher yield than all RHA treatments except in rice plants applied with 0.3 kg TR/plot without NPK. Yield was increased with increasing doses of TR and RHA contents. There was an increasing yield in all TR, RHA and the combination of TR and RHA treatments. On reviewing the results of the data represented in Table 5, it can be observed that (0.9 TR + 2.1 RHA) kg/plot + NPK is best treatment doses for yield. In growth related parameters, 0.9 kg TR/plot + NPK treatment had highest number of effective tillers (11.00) among all treatments. Moreover, (0.9 TR + 2.1 RHA) kg/plot+ NPK treatment had highest no: of effective tillers (11.00), panicle weight (21.50 g) and no: of filled grains per panicle (85.00). In RHA treatment, 2.7 kg RHA/plot + NPK treatment gave highest no: of effective tillers (9.50), panicle weight per hill (21.00 g), no: of filled grain per panicle (75.00).

Table 5. Yield and Yield Related Characteristics of Rice Plants from Experimental Plots

Different Fertilizers	Different Dosages (ton / acre)	No: of effective tillers	Panicle weight (g/hill)	No: of filled grains per panicle	Yield (basket / acre)
Tea Residue (TR)	0.3 TR	6.50	12.00	65.00	69.14
	0.9 TR	9.00	17.50	67.50	99.78
	O.3TR + NPK	8.50	16.50	76.50	106.29
	0.9TR + NPK	11.00	21.00	79.50	143.73
Rice Husk Ash (RHA)	2.1RHA	9.00	16.00	59.50	84.56
	2.7 RHA	8.50	17.00	71.50	99.01
	2.1RHA+NPK	8.50	17.00	74.00	103.80
	2.7RHA+NPK	9.50	21.00	75.00	115.87
Combination of Tea Residue and Rice Husk Ash (TR + RHA)	0.3TR+2.7RHA	8.00	15.00	63.50	83.50
	0.9TR+2.1RHA	8.50	17.00	63.00	82.83
	0.3TR+2.7RHA+NPK	9.00	18.50	69.00	101.41
	0.9TR+2.1RHA+NPK	11.00	21.50	85.00	153.59
Control	NPK	7.00	16.00	71.00	78.52
	No Fertilizer	5.50	13.50	59.50	51.71
5 % LSD		2.106	5.453	25.009	40.228
Coefficient of variation (CV %)		16.1	13.5	13.4	19.2
F-probability		0.002	0.000	0.031	0.000
F test		*	**	*	**

cv = coefficient of variation ** = significant at 1% (0.000 – 0.001)

* = significant at 5% (0.002 – 0.05)

N:P:K= (50:25:12.5) g / plot ns= not significant (> 0.05)

Conclusion

This research work was intended to make effective use of rice husk ash and tea residue for plant growth. The plot experiment was carried out by using the various ratios of fertilizers. At the harvesting stage, panicle weight and yield were highly significant difference 1% LSD (Least Significant Difference) and no: of effective tillers and number of filled grains were significantly difference at 5% LSD. From the plots experiment, tea residue 0.9 kg/plot, rice husk ash 2.1 kg/ plot and NPK (50, 25, 12.5) g/plot gave the highest yield 153.59 basket/ acre (0.062 ton/ hector). So, rice husk ash and tea residue can be used in combination with inorganic fertilizer (N, P, K) to increase the yield.

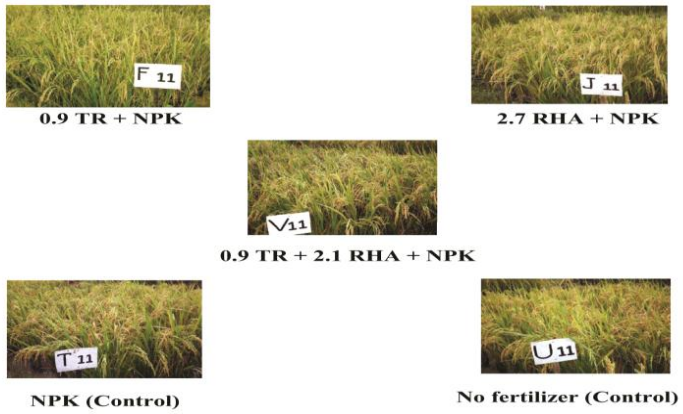


Figure 6 Experimental plots of paddy field (harvesting stage)

Acknowledgements

I wish to express my deepest appreciation to Professor Dr. Cho Cho Win, Head of Chemistry Department, Dagon University, for her kind permission to read this paper. I would like to sincere gratitude to Dr. Kyaw Naing, Associate Professor and Dr. Ye Tint Tun, Manager, Myanmar Rice Research Centre for their close supervision, numerous invaluable suggestions, helpful advice and comments without which this work would not have been completed. I am also indebted to Daw San Kyi, Assistant Manager, Seed Division, Myanmar Agriculture Service, for her kind provision and valuable assistance of the research facilities.

References

Ishizuka, Y and A. Tanaka. (1952). “Biochemical Studies on the Life History of Rice Plant”. *Journal of the Science of Soil and Manure*, **23**, 23 – 28

Hingham, M and R. Elaine. (2000), “Brewing Compost Tea”. *Journal of Kitchen Gardener*, **29**, 1 – 20

Shinohara, Y and N. Kohyama. (2004), “Quantitative Analysis of Tridymite and Cristobalite Crystallized in Rice Husk Ash by Heating”, *Journal of National Institute of Industrial Health*, **42**, 277 - 285