

## EFFECT OF INTEGRATED APPLICATION OF ORGANIC AND CHEMICAL FERTILIZER ON DRY SEEDED RICE (*Oryza sativa* L.).

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### ABSTRACT

In many parts of Makandura (NWP) region, most paddy tracts are abandoned during *yala* season because of poor yield due to scarcity of water and low natural soil fertility. Locally available organic materials may have potential to alleviate this situation. Therefore, effect of poultry manure, paddy straw and coir dust on yield of dry seeded rice (Kekulan rice) was tested in a Red Yellow Podzolic soil at Makandura (NWP) during 1992 *yala* season. Different combinations of these organic materials mixed with half dose of recommended chemical fertilizers were compared with full dose of recommended chemical fertilizer and with combination of these organic materials alone. Vegetative and yield parameters of rice and considered main limiting factors for dry seeded rice culture such as weed growth, soil temperature and soil moisture retention, were measured. Plant height and tiller number increased with half dose of chemical fertilizer integrated with poultry manure alone and also with combination of other organic materials. Flower initiation was about seven days earlier in poultry manure treated plots than that of recommended chemical fertilizer treated plots. Straw mulched plots significantly reduced weed growth and soil moisture retention was enhanced by combined application of coir dust, straw and poultry manure. The integrated use of these materials together with half dose of recommended chemical fertilizer significantly ( $p < 0.05$ ) increased rice yield over the recommended chemical fertilizer due to increase in number of panicles per square meter, number of seeds per panicle and reduce in percentage of empties. However, grain: straw ratio was reduced by addition of these organic materials. Application of poultry manure at 5t/ha, coir dust at 5t/ha and straw mulch at 4t/ha integrated with half the quantity of recommended chemical fertilizer proved to be the best combination to obtain significantly highest (36%) rice yield about seven days earlier than usual nutrient management practice.

**KEYWORDS:** Coir-dust, Dry seeded rice, Poultry litter, Soil moisture, Straw

### INTRODUCTION

Rice farmers have used organic manure for centuries until chemical fertilizers were introduced. They confer many benefits to the soil-plant system, which cannot be provided by inorganic fertilizers. However, this practice has been gradually neglected during the last two decades. As a result, physical, chemical and biological properties of rice soils have gradually degraded with continuous cropping. This may be a reason for national rice yields stagnating around 3 to 3.5 t/ha during the last decade.

Only few rice farmers are currently using green manure, rice straw and stubble of the previous crop though beneficial effects of these manure have been

emphasized by researchers (Nagarajah and Amarasiri, 1977). On the other hand, several animal manure available in Sri Lanka have shown tremendous potential to increase upland crop yields (Jayasundara, 1984; Wijewardena, 1993). These manure have been shown to contain high percentage of necessary plant nutrients with compared to plant residues (Marikkar and Amarasiri, 1988). The annual production of animal manure in Sri Lanka has a potential to replace approximately 50% of plant nutrient content in imported chemical fertilizer (FAO, 1985). The use of animal wastes for rice cultivation is very scarce in Sri Lanka and is limited mostly to upland crops. There was hardly any research information available on the use of animal wastes for rice cultivation.

In many part of Makandura region, most of paddy tracts are abandoned during *yala* season because of poor yields due to scarcity of soil moisture and low natural soil fertility. However, this area has potential to produce appreciable amount of rice. If there is a way to improve water retention in the soil and improve soil fertility status by application of using locally available organics, reasonable high rice yields could be obtained.

Since there are large-scale poultry farms available around Makandura region, deep litter could be utilized for rice cultivation. On the other hand, as Makandura region belongs to coconut triangle, numerous heaps of coir dust is available for many uses in agriculture (Jayasundara, 1991). Since coir dust has a tremendous capacity to absorb moisture, it could increase the water holding capacity of the soil. On the other hand, straw from the previous rice crop could be utilized for the following dry seeded rice crop as a mulch and thereby improving the fertility of the soil and reducing the evaporation and weed growth which are considered to be the limiting factors for better rice yield under dry seeded rice culture.

The main objective of this experiment was to study the effect of integrated use of poultry litter, coir dust and straw mulch with chemical fertilizer to increase the fertility and water holding capacity of the soil and suppress weed growth and thereby increase rice grain yields.

## MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Centre, Makandura to investigate the combined effects of animal manure and crop residues together with reduced dose of chemical fertilizer on growth and yield of dry seeded rice. The major soil group found in Makandura region is classified as Red Yellow Podsollic soil with hard and soft laterite (Panabokke, 1967) which has sandy clay loam texture and low natural soil fertility. The following treatments were tested in a

Randomized Complete Block design with four replicates. The following treatments were tested using a randomized complete block design with four replicates.

Treatment	Description
T-1	Department of Agriculture Recommended chemical Fertilizer (DOA) - Control
T-2	1/2 DOA + Poultry litter (PM) (5t/ha)
T-3	1/2 DOA + PM (5t/ha) + Straw (ST)(4t/ha)
T-4	1/2 DOA+ PM (5t/ha) + CoirDust(CD)5t/ha
T-5	1/2 DOA + PM (5t/ha) + CD (5t/ha) + ST (4t/ha)
T-6	PM (5t/ha) + CD (5t/ha) + ST (4t/ha)

The experiment was conducted during 1992 *yala* season with the on set of rains. The plot size was 5m x 3m. Poultry manure (deep litter) and coir dust were applied one week before sowing seeds and incorporated with soil at the second plowing. Basal inorganic fertilizer was applied according to recommended rate (P<sub>2</sub>O<sub>5</sub> 10 kg/ha) and a half of it for relevant treatments two days prior to sowing. Dry seeds of short aged (03 months) rice variety Bg -300 were direct broadcast at a seed rate of 150 kg/ha. Straw was applied as mulch at the rate of 4t/ha for relevant treatments. The first top dressing application of chemical fertilizer was at three weeks after sowing (15N, 10 K<sub>2</sub>O kg/ha) and the second was done at seven weeks after sowing (30 N kg/ha) for relevant treatments. Experiment was entirely carried out under rain fed conditions. Four composite soil samples at the depth of 10 cm were collected from each replicate before the experiment for general chemical and physico chemical characteristic of the soil. Soil core samples were collected seven times from differently treated plots at 10 cm depth during study period and percentage soil moisture retention of these samples was measured using gravimetric method. At the same time, soil temperature of differently treated plots at 10 cm depth was measured using a soil thermometer.

The percentage of flowering was taken from randomly selected 5m<sup>2</sup> area at eight weeks after sowing, as significant visual variations were evident among the treatments. Plant height and number of tillers/m<sup>2</sup> were also recorded at this stage. Harvesting was done in random 5m<sup>2</sup> area per plot, using a 1m x 1m quadrat. Weed count was taken in the same area after harvesting.

## RESULTS AND DISCUSSION

**(a) General characteristics of the soil**

The soil of the experimental site was classified as Red yellow podzolic soil with soft and hard laterite and chemical analysis of the soil showed that it was slightly acidic with low nutrient and organic matter content (table 1).

**Table 1. Some important soil chemical characteristics of the soil at experimental site.**

<i>Soil property</i>	<i>Content</i>
pH (1:1) water	5.2
Total N (%)	0.09
Olsen P (mg Kg <sup>-1</sup> )	1.4
Exch. K (mg Kg <sup>-1</sup> )	42.9
Organic matter (%)	1.02

**(b) Vegetative parameters**

The treatment effects on vegetative parameters of rice plant are presented in table 2.

**Table 2. Effect of treatment combinations on some vegetative parameters of rice plant eight weeks after sowing.**

<i>Treatment</i>	<i>Plant height (cm)</i>	<i>No: of tillers / m<sup>2</sup></i>	<i>% flowering</i>
DOA	43.5 b	410 b	12.7 d
1/2 DOA + PM	65.6 a	563 a	22.2 c
1/2 DOA + PM + ST	65.0 a	599 a	30.3 b
1/2 DOA + PM + CD	64.1 a	576 a	26.1 bc
1/2 DOA + PM + CD + ST	66.3 a	582 a	38.3 a
PM + CD + ST	68.6 a	481 b	37.9 a
CV%	4.1	8.7	5.2

Values followed by the same letter in each column are not significantly different at  $p=0.05$  in LSD test.

The above data revealed that plant height, number of tillers/m<sup>2</sup> and the percentage of flowering of the rice plant at eight weeks period were drastically increased by combined application of chemical fertilizer with other organic materials tested. On the other hand, tallest plants were observed when poultry manure was combined with either chemical fertilizer or other organic materials

tested, over recommended chemical fertilizer. This may be due to presence of comparatively higher N % in poultry litter.

Combined application of chemical fertilizer and poultry litter ( $T_2$ ) showed higher percentage of flowering over recommendation ( $T_1$ ). The highest percentage flowering was recorded when all three organic materials integrated together ( $T_6$ ), at this stage. Further, it was clearly shown that combined application of all three organic materials advanced flowering over the other combinations. This suggested that early flowering of the rice plant was promoted by application of poultry manure or combined with coir dust or straw or both. This is very important because duration of the *yala* rains is very short in this region and maximum utilization of soil moisture is the key factor for better yield.

Therefore, early flowering of the rice plant, which is promoted by application of poultry manure with other organic materials, enhanced better rice yield may be due to maximum utilization of soil moisture during a comparatively short period of time. Effect of organic materials on soil moisture retention temperature and soil moisture retention during the growing period of the rice plant is present in figure 1 and 2 respectively.

#### **Soil moisture and soil temperature**

The soil moisture retention data indicated that the highest moisture retention during three months of growing period was reported from the treatments contain the combination of all three organic materials (figure 1). It was clearly indicated that at eight week stage of the crop, when flowering starts, the highest soil moisture retention (figure 1) and soil temperature (figure 2) were achieved by treatments with combined application of these organic materials. This may be led to advance flowering. This is further evident by existing strong relationship between percentage of flowering and the soil moisture retention of different treatments at flowering stage ( $R^2 = 0.83$ ) (figure 3). As far as soil temperature was considered, this relationship was not so marked even though there was a trend ( $R^2 = 0.66$ ) (figure 4).

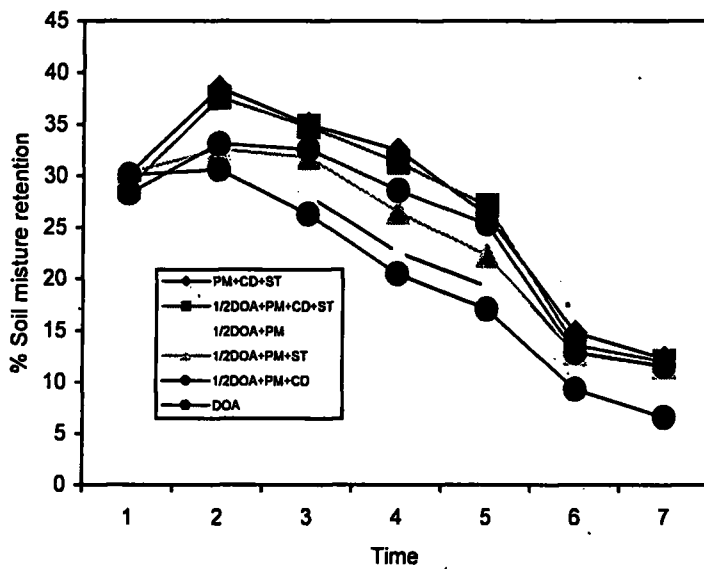
#### **(d) Yield parameters**

The yield parameters of rice also indicated similar type of response to added organic materials. The results are shown in Table 3 and 4.

**Table 3. Effect of treatment combinations on number of panicles /m<sup>2</sup>, number of seeds /panicle, 1000 seed weight and grain: straw ratio of rice.**

<i>Treatment</i>	<i>No. of panicles/m<sup>2</sup></i>	<i>No. of seeds/panicle</i>	<i>1000 seed weight (g)</i>	<i>Grain:straw</i>
DOA	391c	26.5 b	33.80	0.92a
1/2 DOA + PM	456ab	30.9 ab	31.33	0.73b
1/2 DOA + PM + ST	478a	36.5a	33.55	0.74b
1/2 DOA+ PM + CD	448b	35.2a	33.58	0.77b
1/2 DOA + PM + CD + ST	486a	34.8a	32.80	0.76b
PM + CD + ST	406c	32.3a	32.33	0.69
CV%	6.5	5.8	4.3	7.7

Values followed by the same letter in each column are not significantly different at  $p = 0.05$  in LSD test.



**Figure 1. Percentage Soil moisture retention of different treatments during 3 months growing period.**

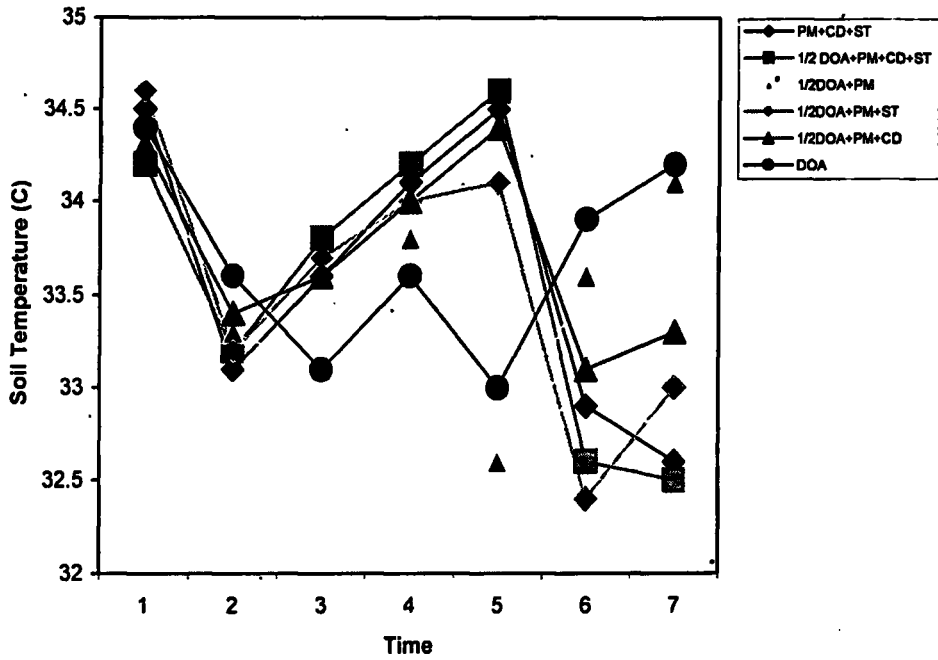


Figure 2. Soil temperature with respect to treatments during 3 months of growing period.

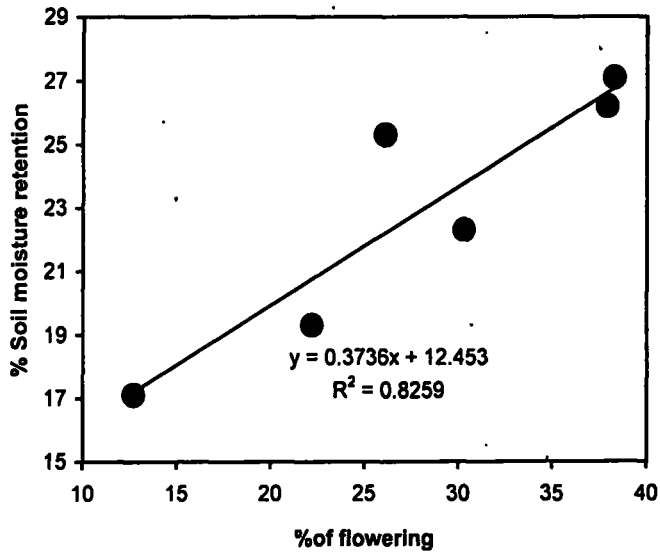


Figure 3. Relationship between % soil moisture retention and % flowering of different treatments at 8<sup>th</sup> week.

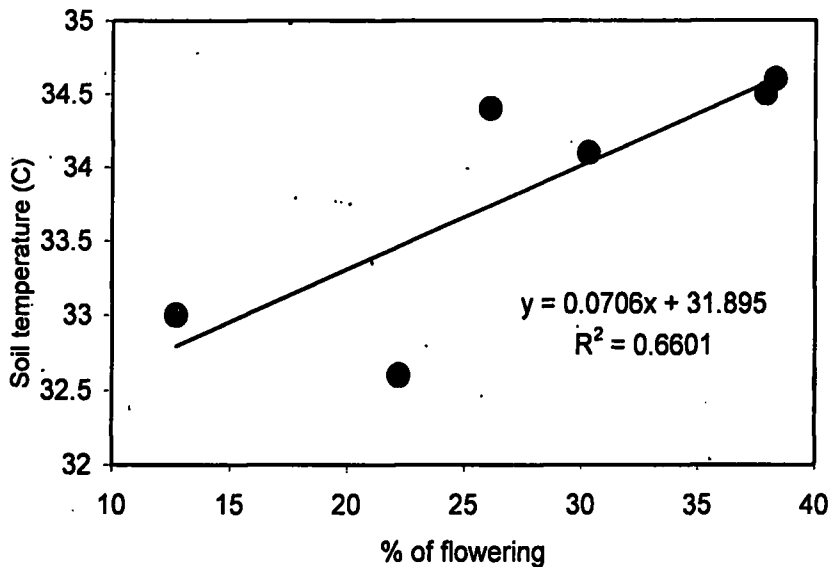


Figure 4. Relationship between soil temperature and percentage of flowering of different treatments at 8th week.

#### (d) Yield parameters

The yield parameters of rice also indicated similar type of response to added organic materials. The results are shown in tables 3 and 4.

Table 3. Effect of treatment combinations on number of panicles /m<sup>2</sup>, number of seeds /panicle, 1000 seed weight and grain: straw ratio of rice.

Treatment	No. of panicles/m <sup>2</sup>	No. of seeds/panicle	1000 seed weight (g)	Grain: straw
DOA	39.1c	26.5 b	33.80	0.92a
1/2 DOA + PM	45.6ab	30.9 ab	31.33	0.73b
1/2 DOA + PM + ST	47.8a	36.5a	33.55	0.74b
1/2 DOA + PM + CD	44.8b	35.2a	33.58	0.77b
1/2 DOA + PM + CD + ST	48.6a	34.8a	32.80	0.76b
PM + CD + ST	40.6c	32.3a	32.33	0.69
CV%	6.5	5.8	4.3	7.7

Values followed by the same letter in each column are not significantly different at  $p=0.05$  in LSD test.

**Table 4. Effect of treatment combinations on percentage of Empties, Rice grain yield and weed dry matter.**

<i>Treatment</i>	<i>% Empties</i>	<i>Rice grain yield (t/ha)</i>	<i>Weed dry matter (g/5m<sup>2</sup>)</i>
DOA	12.5a	2.36c	130.9a
1/2 DOA + PM	10.3b	3.14b	142.0a
1/2 DOA + PM + ST	9.8b	3.21ab	72.4b
1/2 DOA+ PM + CD	10.1b	3.18ab	150.1a
1/2 DOA + PM + CD + ST	10.8b	3.36a	81.3b
PM + CD + ST	11.6b	2.26c	75.0b
CV%	5.9	4.5	14.5

Values followed by the same letter in each column are not significantly different at  $p=0.05$  in LSD test.

It was found that grain yields of treatments, which comprised of combined application of 50% recommended chemical fertilizer and organic materials were superior over the other treatments tested. The highest grain yield was observed when all three organic materials were substituted for 50% chemical fertilizer. However, incorporation of poultry litter with coir dust or straw integrated with 50% recommended chemical fertilizer also gave comparable yields. On the other hand, incorporation of only three organic materials with soil gave similar yield as recommended chemical fertilizer.

It was indicated by yield parameters that increase in grain yields mainly due to increase in number of panicles/m<sup>2</sup> and number of seeds/ panicle and also due to reduction in percentage of empties. These characters were found to be superior in the treatments, which contain 50% chemical fertilizer, combined with other organic materials tested (table 4).

However, it was observed that all the treatments which contain poultry litter, showed comparatively low grain: straw ratio. This is mainly due to high vegetative growth promoted by poultry manure during early stage of the crop. However, this drawback was compensated by increase in number of panicles/ m<sup>2</sup> and number of seeds / panicle which mainly contributed to increased grain yield. The effect of poultry manure on growth and yield of rice may be due to presence of high percentage of easily available plant nutrients and also due to presence of other micro nutrients (Marikkar and Amarasiri, 1988).

It was found that the yield increase in most of upcountry vegetables by application of poultry manure was mainly due to increase in number of fruits/plant but not due to increase in fruit weight (Jayasundara, 1984; Wijewardena, 1993). This is found to be applied for rice too where number of rice grains/

panicle was significantly increased by poultry litter application over no poultry litter treatment (T<sub>1</sub>).

The beneficial effects offered by straw mulch may be due to suppress weed growth, which is found to be the most significant drawback for dry seeded rice culture, and also providing easily available potassium. Evaporation can also be minimized by straw mulch. The treatments, which contain poultry litter, showed comparatively higher weed growth except combined with straw mulch.

### CONCLUSIONS

Poultry litter could supply easily available plant nutrients to the rice plant while coir-dust and straw mulch are capable of retaining moisture in the soil. Straw mulch on the other hand, suppresses the weed growth. All these factors ultimately, contribute to higher rice grain yield. Combined application of 50% reduced recommended chemical fertilizer with poultry litter at 5 t/ha increased the dry seeded rice yield significantly over the recommended chemical fertilizer. This yield could be further increased by incorporation of coir dust at 4 t/ha with soil before seeding and application of straw at 4 t/ha as mulch after sowing seeds. However, further investigation should be carried out to study long-term effect of incorporation of coir dust with rice soil, which has high C/N ratio.

### REFERENCES

- FAO 1985. Food and Agriculture Organization Soil bulletin: no: 40: 12-16.
- Jayasundara, J.M.P.B. 1984. Half yearly report, Regional Agriculture Research Centre, Bandarawela.
- Jayasundara, J.M.P.B. 1997. Use of coir-dust for agriculture, AGTC in brief (May, 1997). 2: 7-3.
- Marikkar, S. and S.L. Amarasiri .1988. Plant nutrient content in animal wastes, Tropical Agriculturist. 144: 79-87.
- Nagarajah, S and S.L. Amarasiri. 1977. Use of organic materials as fertilizers for lowland rice in Sri Lanka. Soil organic matter studies. IAEA. 1: 97-104.
- Panabokke, C.R. 1967. The soils of Ceylon and Use of fertilizer. Metro Printers Ltd. Colombo, Sri Lanka. 151p.
- Wijewardena, J.D.H. 1995. Effect of animal manure and chemical fertilizers on growth and yield of tomato. Krushi. 15: 7-10.