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EFFECT OF DECOMPOSED RICE STRAW AT DIFFERENT TIMES ON RICE YIELD

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ABSTRACT

Inoculant of Trichoderma fungi was used to treat into rice straw at different times for decomposition to study "Effect of decomposed rice straw at different times on rice yields". The decomposed rice straw at 1, 2, 3, 4 weeks gave C/N ratio from 24.12 - 31.71 in dry season and from 16.64 - 31.12 in wet season, these C/ N ratio was lower as compared to rice straw, which was not treated by inoculant of Trichoderma fungi (C/ N: 42.43 and 45.70 in dry and wet seasons, respectively); The decomposed rice straw at different times gave pH value of soil solution from 4.60 - 6.74 in dry season and from 6.38 - 6.83 in wet season and these pH value was not toxic to rice plant growth. The decomposed rice straw at different times in combination with 50% NPK fertilizer increased yield over control from 26.98% - 37.04% in dry season and from 33.45% - 48.08% in wet season and these above treatments were also found to be higher in microbial population; ETS activities and total protein in soil as compared to alone application of NPK fertilizers.

Key words: Decomposed rice straw, ETS activities and total protein in soil, microbial population, pH value

INTRODUCTION

The literatures of organic manure including the livestock manure, human excreta, crop residues and industrial organic wastes, and their efficient utilization or better crop production were previously rewiewed (Grag et al. 1971). The beneficial role of organic manure in increasing soil fertility, improving soil physical conditions as well as crop yield was recognized by many investigators (Son and Ramaswani 1997; Martin et al. 1978; Gaur et al. 1990).

Rice is the most important crop in Mekong Delta. By the introduction of high yielding rice varieties and adoption of intensive rice cultivation, large quantities of rice residues as straw, rice stubbles are available on farms. However, most of rice straw was burnt or removed after harvesting to prepare for the next crop by the habit of the farmers. These rice straw can not be applied or ploughed directly into the soil because their wide C/ N ratio. They are known to produce phyto-toxic substances during their decomposition (Martin et al. 1978; Elliott et al. 1981). To alleviate such problems, the rice straw materials under intensive decomposition in heaps or pits with adequate moisture and suitable microbial inoculants could be used as organic manure (Gaur et al. 1990) in rice field. Inoculant of *Trichoderma* fungi was used to treat into rice straw for decomposition (Man et al. 2003) to study "Effect of decomposed rice straw at different times on rice yields" to aim at understanding their effects on growth of rice plant, rice yield, to microbial communities, ETS activities and total protein in rice soil.

MATERIALS AND METHODS

Rice straw was treated by *Trichoderma* fungi 1, 2, 3 and 4 weeks, after treating the rice straw manure was used to carry out experiment.

Germinated seeds of rice cultivars IR64 (110-day genotype) was seeded in plot 30 m^2 with the seed rate of 150 kg/ ha

The experiment including 7 treatments was conducted in randomized complete block design with 3 replications

T1: Control (0N - $0P_2O_5$ - $0K_2O$)
T2: 50% NPK fertilizer (WS: 40N - $15P_2O_5$ - $15K_2O$: kg/ ha)
DS: 50N- $15P_2O_5$ - $15K_2O$: kg/ ha)
T3. 100%NPK fertilizer (WS: 8 0N -$30P_2O_5$ - $30K_2O$: kg/ ha)
DS: 100N- $30P_2O_5$ - $30K_2O$: kg/ ha)

T4. Rice straw manure (RSM) at 1 week after treating (WAT)+ 50% NPK.
T5: RSM at 2 WAT (6T / ha) + 50% NPK
T6. RSM at 3 WAT (6T / ha) + 50% NPK
T7. RSM at 4 WAT (6T / ha) + 50% NPK

Rice straw manure (6ton / ha) and total phosphorus fertilizer ($P_2O_{5)}$ were basal application. Nitrogen (N) fertilizer was applied in three splits: 1/3 was applied at 10 days after sowing (DAS), the 1/ 3 at 20DAS and 1/ 3 at 30 DAS. Potassium fertilizer (K_2O) was applied in two splits: 1/2 was applied at 10DAS and 1/2 at 30 DAS.

Soil microbial populations were estimated at two times: before sowing and at harvesting. Total protein content (mg/ kg of dried soil) in soil (Herbert et al. 1971) and electron transport system (ETS) activities (n mol INTF per min-g dry weight of soil) were estimated at harvesting time.

Microbial population was estimated by plate counting method, with the media (Subba Rao 1977):

- Nutrient agar medium for bacteria counting.
- PDA for fungi counting.
- Kenknight and Munaier's medium for Actinomycetes counting.
- Bristol's medium for algae counting.

Disease- insect incidence during growth cycle and yield and yield components were recorded. The data under this study was statistically analyzed for a randomized complete block design by IRRISTAT software.

RESULS AND DISSCUSSIONS

1. The C/N ratio of rice straw manure

Table 1: The C/ N ratio of rice straw

Sample	C / N (2005)	
	Dry season	Wet season
Rice straw before treating	42.43	45.7
Decomposition rice straw a t 1 week	31.71	31.12
Decomposition rice straw a t 2 weeks	31.56	24.15
Decomposition rice straw a t 3 weeks	29.81	19.25
Decomposition rice straw a t 4 weeks	24.12	16.64

After rice straw was treated by *Trichoderma*, the C/N ratio was lower than the sample which was not treating. Hitoichi Shiga (1977) reported that the high C/N ratio of rice straw was 60.3, the rate of nitrogen mineralization was slower in moderately mature rice straw compost (C/N: 15.8) and slowest in immature rice straw compost (C/N: 24.6). The result in this experiment (table 1) indicated that C/N ratio of rice straw before treating was 42.43 (dry season) and 45.7 (wet season) and C/N ratio were lowest at 3-4 weeks after treating (C/N: 24.12-29.81 in dry season and 16.64-19.25 in wet season.

2. Effect of decomposed rice straw at different times on soil solution pH

In dry season, there were non-significant differences in pH value at stage 10 DAS, but there were statistically significant different at stage 20, 30 DAS. At stage 20DAS, the treatments (T5, T6, T7) in which rice straw at 2, 3, 4 WAT combined with 50% of chemical fertilizer were significantly higher as compared the treatment T1, but non-significant differences with treatments T2, T3 at 20 DAS was also recorded. While at 30 DAS, treatment T7 gave the highest pH value as compared to other treatments.

In wet season, there were significant differences in pH value at 10 DAS; treatment T7 was significantly highest as compared to other treatments. However, non-significant differences in pH value at 20, 30 DAS was also observed.

The result of pH value of soil solution also shown that the treatments in which rice straw manure at different times by decomposition (1, 2, 3, 4 WAT) combined with 50% of

chemical fertilizer gave value from 6.38 - 6.83 in wet season. The well growth and development of rice plant at 10, 20, 30 days after sowing was recorded in the condition of the above pH value of soil solution, this may be due to rice straw manure at different times of decomposition (1, 2, 3, 4 WAT) was not toxic to rice plant. The result confirm the finding of many earlier workers that pH < 4 was potentially toxic organic acid and if the pH value of the soil solution is increased above 5.5. Nitrogen (in the form of nitrate) is made available to plants. Phosphorus, on the other hand, is available to plants when soil pH is between 6.0 and 7.0 (Izolda Trakhtenberg 2001); and pH value at 6.6 is made available for rice plant development (Ponnamperema 1978).

Table 2: Soil solution pH (2005)

Treatment	Days after sowing (DAS)					
	Dry season			Wet season		
	10	20	30	10	20	30
T1. Control (0NPK)	4.70	5.39	6.02	6.00	6.23	6.35
T2. 50% NPK	4.82	6.04	6.17	6.24	6.47	6.33
T3. 100% NPK	5.37	6.34	6.47	6.38	6.26	6.01
T4.RSM at 1 WAT+50% NPK	4.60	5.96	6.51	6.38	6.31	6.65
T5.RSM at 2 WAT+50% NPK	4.83	6.22	6.53	6.20	6.56	6.62
T6.RSM at 3 WAT+50% NPK	4.94	6.38	6.70	6.42	6.54	6.83
T7.RSM at 4 WAT+50% NPK	4.81	6.43	6.74	6.80	6.57	6.62
CV %	6.89	4.61	1.89	3.20	3.82	6.63
LSD 0.05	ns	0.50	0.22	0.36	ns	ns

3. ***Effect of decomposed rice straw at different times on rice yields***

Table 3: Effect of decomposed rice straw at different times on rice yields (2005)

Treatment	Yield (t/ha)		Percentage of grain yield per control (%)	
	DS	WS	DS	WS
T1. Control (0NPK)	4.87	2.87	-	-
T2. 50% NPK	5.60	3.61	19.91	25.78
T3. 100% NPK	6.53	4.50	39.83	56.79
T4. RSM at 1 WAT + 50% NPK	5.93	3.89	26.98	35.54
T5. RSM at 2 WAT + 50% NPK	6.20	3.83	32.76	33.45
T6. RSM at 3 WAT + 50% NPK	6.27	3.99	34.26	39.02
T7. RSM at 4 WAT + 50% NPK	6.40	4.25	37.04	48.08
CV (%)	5.20	7.13		
LSD (5%)	0.55	0.7		

In dry season, table 3 showed that rice yield range 4.87 - 6.53 t / ha. Treatment T3 gave the highest yield and significantly differed from T1, T2, and T4 but non - significant difference from T5, T6, and T7 at 5% level.

The treatments in which rice straw manure (6 t / ha) combined with 50% recommended rate of chemical fertilizer (NPK) yielded over control from 26.98% - 37.04%. Treatment with 50% application of chemical fertilizer (NPK) yielded over control 19.91%. Treatment with complete application of chemical fertilizer (NPK) yielded over control 56.79%.

In wet season, rice yield ranged 2.87 - 4.50 t / ha. Treatment T3 obtained the highest yield and significantly differed from T1 and T2, but non-significant difference from T4, T5, T6 and T7 at 5% level.

The treatments in which rice straw manure (6 T/ ha) combined with 50% recommended rate of chemical fertilizer (NPK) yielded over

control from 33.45% - 48.08%. Treatment with complete application of chemical fertilizer (NPK) yielded over control 56.79%. Treatment with 50% application of chemical fertilizer (NPK) yielded over control 25.78%.

The result supported the finding in long-term experiment by Man et al (2003) that rice yield in treatment of rice straw after decomposition (6 T/ ha) combined with 50% recommended rate of chemical fertilizer (NPK), was not significantly different from treatment of 100% recommended rate of chemical fertilizer application.

The result also confirmed the study by Naser et al. (2001) that rice straw after harvesting was incorporated into soil within a week by tilling the land with power tiller plus NPK fertilized; grain yield offered higher than treatment of lower fertilizer + no addition of rice straw.

4. Effect of decomposed rice straw at different times on microbial population, ETS, Protein.

Essential factors of sustainable agriculture are maintenance of viable, diverse population and functioning microbial communities in the soils. Soil organisms are one of the most sensitive biological markers, and the most useful agents for classifying disturbed or contaminated systems. The use of microorganisms and their functioning in terms of total numbers of microorganisms, total respiration rates, and enzyme activities (ETS activities, alkaline phosphatase, sulphatase, asparaginase...) for examination of environmental stresses and declining biological diversity, needs to be investigated (OTA 1987; Parkinson and Coleman 1991).

The result (table 4) showed that in dry season, the treatments of decomposed rice straw at different times (1, 2, 3, 4 WAT) was higher in microbial population (C.F.U. / g dry soil) as compared to treatments T1, T2 and T3.

The result on average number of ETS activities (table 4) also indicated that the lowest value of ETS activities (nmol INTF per min-g soil) obtained in control treatment (T1), then treatments T2 and T3. In contrast to this the plot in which application of rice straw manure combined 50% NPK fertilizer were found to be higher in value of ETS activities.

Table 4: Effect of rice straw manure and chemical fertilizer on microbial population, ETS activities, total Protein (2005 DS)

Treatment	Microbial (log_{10} of C.F.U/ g. dry soil)	ETS activities (nmol INTF per min-g dry weight of soil)	Total Protein (mg / kg of dried soil)
T1. Control (0NPK)	6.61	34.17	88.40
T2. 50% NPK	6.39	36.14	109.33
T3. 100% NPK	6.49	40.28	103.33
T4. RSM at 1 WAT + 50% NPK	6.97	58.81	132.58
T5. RSM at 2 WAT + 50% NPK	7.03	42.31	118.44
T6. RSM at 3 WAT + 50% NPK	7.08	49.75	110.08
T7. RSM at 4 WAT + 50% NPK	7.10	58.33	126.37
Average	6.81	45.68	112.61
SD	0.28	10.11	14.8

In case of total soil protein, the result (table 4) showed that treatment T1 was lowest of total soil protein. The plots in which application of rice straw manure combine 50% NPK fertilizer were found to be higher in value of protein than T1, T2 and T3.

In wet season, the treatments of decomposed rice straw application were higher in microbial population (7.42 - 7.53 C.F.U. / g dry soil) when compared with the treatments T2 and T3 in which 50% and 100% recommended rate of chemical fertilizer application.

The result on average number of ETS activities (table 5) also indicated that the lowest value of ETS activities (nmol INTF per min-g soil) obtained in control treatment, then

treatments T2, T3. In contrast to this the plots in which application of rice straw manure combined 50% NPK fertilizer were found to be higher in value of ETS activities than treatments T2 and T3.

In case of total soil protein, the result (table 5) showed that treatment T3 was lowest of total soil protein. The plots in which application of rice straw manure combined 50% NPK fertilizer were found to be higher in value of total soil protein than treatment T3.

Table 5: Effect of rice straw manure and chemical fertilizer on microbial population, ETS activities, and total protein (WS 2005)

Treatment	Microbial (log_{10} of C.F.U/ g. dry soil)	ETS activities (nmol INTF per min-g dry weight of soil)	Total Protein (mg / kg of dried soil)
T1. Control (0NPK)	7.33	58.74	139.64
T2. 50% NPK	7.32	77.93	127.74
T3. 100% NPK	7.28	75.61	103.23
T4. RSM at 1 WAT + 50% NPK	7.48	103.19	145.69
T5. RSM at 2 WAT + 50% NPK	7.42	98.50	140.28
T6. RSM at 3 WAT + 50% NPK	7.46	107.08	188.42
T7. RSM at 4 WAT + 50% NPK	7.53	140.24	172.53
Average	7.4	94.47	145.36
SD	0.09	26.62	28.10

The result on microbial population, ETS activities and total soil protein corroborate the finding of Man et al (2003) that the treatment in which decomposed rice straw (6T/ ha) combined with 50% recommended rate of chemical fertilizer gave higher in microbial population, ETS activities and total soil protein when compared with treatment in which 100% recommended rate of chemical fertilizer application.

5. Insects - diseases

Brown planthopper exhibited at 20 days after sowing (DAS), blast disease, and leaf folder at 28 - 53 DAS and 62 DAS to harvesting. However, the pest and diseases did not affect to rice yield.

CONCLUSIONS

- The decomposed rice straw at different times (1, 2, 3, 4 WAT) was lower in C/N ratio as compared to rice straw, which was not treated by inoculant of *Trichoderma* fungi.
- The decomposed rice straw at different times (1, 2, 3, 4 WAT) gave pH value of soil solution 4.60 - 6.74 and 6.38 - 6.83 in dry and wet seasons, respectively. The pH value, however, was not toxic to rice plant growth.
- Application of decomposed rice straw at different times (1, 2, 3, 4 WAT) and combined with 50% NPK fertilizer increased rice yield over control from 26.98% - 37.04% and 33.45% -48.08% in dry wet seasons, respectively.
- Application of 50% chemical fertilizer yielded over control 19.91% and 25.78% in dry and wet seasons, respectively
- Application of 100% chemical fertilizer yielded over control 39.83% in dry season and 56.79% in wet season.
- Application of decomposed rice straw at different times and combined with 50% chemical fertilizer were found to be higher in microbial population, ETS activities and total soil protein as compared to alone application of chemical fertilizer.

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Chế phẩm nấm Trichoderma được sử dụng để xử lý rơm sau thu hoạch phục vụ cho nội dung nghiên cứu "ảnh hưởng của rơm phân hủy ở những thời điểm khác nhau đến năng suất lúa". Rơm phân hủy ở 1, 2, 3, 4 tuần sau khi xử lý cho tỷ lệ C/N từ 24.12 - 31.71 ở vụ đông xuân và từ 16.64 - 31.12 ở vụ hè thu. Tỷ lệ C/N thấp hơn so với tỷ lệ C/N của rơm không xử lý bằng chế phẩm nấm *Trichoderma* (C/N: 412.43 ở vụ đông xuân và 45.70 ở vụ hè thu). Rơm phân hủy ở những thời điểm khác nhau cho giá trị pH của dung dịch đất từ 4.50 - 6.74 ở vụ Đông xuân và từ 6.34 - 6.83 ở vụ Hè thu. Ở những giá trị pH này không gây độc cho sự tăng trưởng của cây lúa. Rơm phân hủy ở những thời điểm khác nhau bón kết hợp với 50% lượng phân NPK theo khuyến cáo làm gia tăng năng suất lúa hơn đối chứng không bón phân từ 26.98% - 37.04% ở vụ Đông xuân và từ 33.45% - 48.08% ở vụ Hè thu, và những nghiệm thức rơm phân hủy trên cũng cho quần thể vi sinh vật, hoạt động của ETS, tổng hợp protein trong đất cao hơn so với những nghiệm thức chỉ đơn thuần áp dụng phân hóa học (NPK).