Omonrice 11: 74-82 (2003)

IMPROVEMENT OF SOIL FERTILITY BY RICE STRAW MANURE

Luu Hong Man[1], Vu Tien Khang[1], Takeshi Watanabe[2]

ABSTRACT

Rice straw manure (RSM) was studied by treating with fungal inoculant (*Trichoderma sp*) through a long-term experiment on "Improvement of soil fertility by rice straw manure". The results on average of six continuous seasons showed that a complete application of RSM increased yield over control 5.91 % and 7.92% in wet and dry season, respectively. While, complete application of chemical fertilizer (NPK) increased yield over control 29.31% and 25.73% in wet and dry season, respectively. Treatments in which RSM combined with different doses of chemical fertilizer yielded over control 14.67 – 28.71 % and 26.27 -32.41% in wet and dry season, respectively. The microbial population and their function in soil indicated that a complete application of chemical fertilizer and control treatment had lower microbial population in soil as compared to complete application of RSM or in combination with different doses of chemical fertilizer. A positive correlation between soil microorganisms and ETS activities and between soil microorganisms and total protein content in soil were also recorded.

Key words: NPK fertilizer, soil improverment, soil microorganisms, RSM

INTRODUCTION

Rice is the most important crop in Mekong Delta. With the introduction of high yielding rice varieties and adoption of intensive rice cultivation, large quantities of rice residues as straw, rice stubles are available on farms. However, most of rice straw was burnt or removed after harvesting. These rice straw cannot be applied or incorporated directly into the soil because of their wide C:N ratio. They are known to reduce the availability of important mineral nutrients to growing plants through immobilization into organic forms and also 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 in rice field (Gaur et al. 1990).

The Cuu Long Delta Rice Research Institute (CLRRI) has collaborated to Japan International Research Center for Agricultural Sciences (JIRCAS) to carry out a long-term experiment in which rice straw was decomposed by suitable fungal inoculant to produce manure. Studies on " improvement of soil fertility by rice straw manure" aim at (1) determining the effect of continuous application of rice straw manure and inorganic fertilizer alone or in combination on rice yield and (2) identifying their effects to microbial communities in rice soil condition.

MATERIALS AND METHODS

Fungal inoculant (*Trichoderma* sp.) in powder formula produced by CLRRI's Microbiology Department was applied to treat into rice straw heap with adequte moisture suppling for decomposition. It took 30-45 days after inoculation, decomposed rice straw was used as organic manure.

The experiment stated in 2000's wet season. Germinated seeds of rice varietie "IR64" (110-day growth duration) was broadcasted in the plot (30 m^2) with 200kg / ha seed rate. The experiment including seven treatments was conducted in randomized complete block design with three replications:

[1] Cuu Long Delta Rice Research Institute, Omon, Vietnam
[2] Japan International Research Center for Agricultural Sciences, JIRCAS, Japan

T1: Control (0 N - 0 P_2O_5 - 0 K_2O)

T2: 100% rice straw manure (6 t/ha)

T3: 100% rice straw manure (6 t/ha) + 20% NPK (16N- 6P_2O_5 -6K_2O kg / ha)

T4: 100% rice straw manure (6 t/ha) + 40% NPK (32N- 12P_2O_5 -12 K_2O kg / ha)

T5: 100% rice straw manure (6 t/ha) + 60% NPK (48N- 18P_2O_5 -18 K_2O kg / ha)

T6: 100% rice straw manure (6 t/ha) + 80% NPK (64N- 24P_2O_5 -24 K_2O kg / ha)

T7: 100% inorganic fertilizer (wet season: 80N- 30P_2O_5 -30 K_2O kg / ha and dry season: 100N- 30P_2O_5 -30 K_2O kg / ha)

Rice straw manure (6t / ha) was basal application. Total phosphorous fertilizer (P-$_2O_5$) was basal application. Nitrogen (N) was applied in three splits: 1/3 was applied at 10 days after sowing (DAS), then 1/3 at 20 DAS and 1/3 at 30 DAS. Potassium fertilizer (K_2O) was applied in two slipts: 1/2 was applied at 10DAS and 1/2 at 30 DAS. The standard grower's practice at recommended rate in dry season will be applied as (100N- 40P_2O_5 -30 K_2O kg / ha)

Soils microbial populations were estimated at the time of before sowing and at harvesting time. 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) or dehydrogenase (Chendrayan et al. 1980) were estimated at harvesting time. Soils were sampled at 10 days before harvesting to analyze the nutrient in soil.

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.

SPAD value was recorded by Chlorophyll meter (SPAD -502) at 50 DAS, disease- insect incidence during growth cycle, yield and yield components were recorded. The data under this study was statistically analysed for a randomized complete block design by IRRISTAT progame.

RESULTS AND DISCUSSION

1. Effect of rice srtaw manure and inorganic fertilizer in combination or alone application on rice yield:

IR 64 is one of the most popular varieties in the Mekong Delta actually due to its high yielding, short duration, moderate resistance to brown plant hopper, and some major diseases, good eating quality.

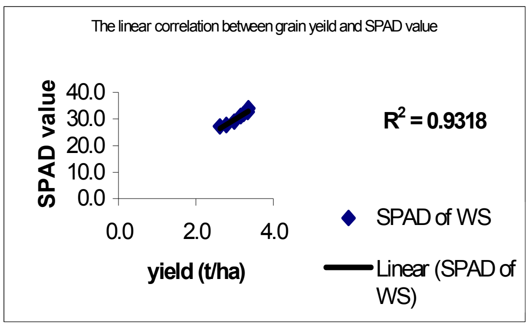
The SPAD meter (SPAD-502) test can be used as an useful tool of nitrogen management in rice. The optimum SPAD value for high yielding varieties ranges 32-36 and 29-32 for direct seeding practice in dry season (DS) and wet season (WS), respectively (Huan et al. 1998; 2000).

SPAD values in treatments T4, T5, T6 and T7 ranged from 30.9 to 35.2 in 2000 WS, from 30.2 to 33.1 in 2001 WS, and from 32.0 to 33.8 in 2002 WS (table 1); the other treatments T1, T2 and T3 obtained SPAD values from 27.0 to 30.0. Otherwise, in dry season, SPAD values in treatments T4, T5, T6 and T7 ranged 35.1-38.3, 31.2-34.4, and 31.7-36.1 in 2001 DS, 2002 DS and 2003 DS, respectively. Treatments T1, T2 and T3 obtained SPAD values of 27.8-31.2, 25.9-29.8, and 26.7-31.4 2001 DS, 2002 DS and 2003 DS, respectively. The treatment T7 gained the highest SPAD value as compared to the other treatments in first season (2000 WS). However, non-significant diferrence in term of SPAD value among treatments T4, T5 T6 and T7 was observed in continuous seasons.

The result on average of SPAD value in WS and DS also indicated that the treatment T7 gave the highest SPAD value as compared to the other treatments and non–significant difference in term of SPAD value between treatment T5 and T6 was also observed.

Table 1. Effect of rice straw manure and chemical fertilizer on SPAD value at 50 days after sowing

Treatment	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Av. WS	Av. DS
T1. Control	27.0	27.8	27.2	25.9	27.7	26.7	27.3 a	26.8 a
T2. RSM (6t/ha)	27.4	28.2	27.5	26.5	27.9	29.6	27.6 a	28.1 b
T3. RSM + 20 %NPK	28.6	31.2	28.5	29.8	30.0	31.4	29.0 b	30.7 c
T4. RSM + 40% NPK	30.9	35.1	30.2	31.2	32.0	31.7	31.0 c	31.7 d
T5. RSM+ 60%NPK	30.8	36.4	32.2	33.4	32.6	34.7	31.8cd	34.3 e
T6. RSM+80% NPK	31.7	36.4	32.9	33.6	33.1	35.2	32.6 d	35.0 e
T7. NPK (DS:100:30:30) (WS: 80:30:30)	35.2	38.3	33.1	34.4	33.8	36.1	34.0 e	36.2 f
CV (%)	4.71	3.30	2.8	3.0	2.8	2.5	3.60	3.07
LSD (5%)	2.53	1.94	1.51	1.63	1.55	1.45	-	-



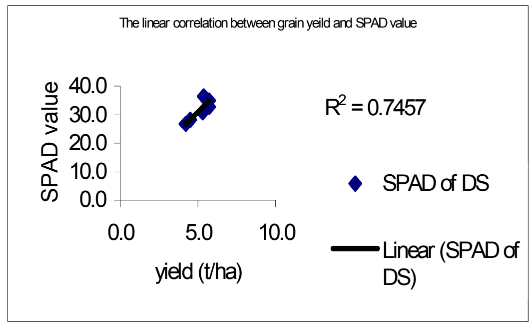


Fig 1. The correlation between SPAD index and grain yield.

Possitive correlation between SPAD value and grain yield was noticed as R^2 = 0.931 and R^2 = 0.7457 in wet season and dry season, respectively.

The result on yield (table 2) indicated that in 2000‘ s wet season (WS), non-significant differences in terms of grain yield among treatments T1, T2, T3; among treatments T3, T4, T5 and among treatments T5, T6, T7 were recognized. However, T7 statistically gained much higher yield than treatments T1, T2, T3, T4.

In 2000’s dry season (DS), non-significant differences in grain yield among treatments T3, T4, T5, T6 and T7 were observed. However, these treatments performed higher yield than treatments T1 and T2.

In 2001 WS, treatment T6 obtained the highest yield and significantly differed from T1, T2 and T3. However, T6 grain yield was not different from T4, T5 and T7. Non-significant differences in grain yield between treatment T1 and T2 were recognized, but these treatments significantly obtained lower grain yield as compare to treatment T3.

In 2002 DS, maxium grain yield was obtained in treatment T5 and significantly differed from T1, T2 and T3. However, T5 grain yield was not different from T4, T6 and T7. There were non-significant differences in grain yield between treatment T1 and T2, but these treatments significantly obtained lower grain yield as compared to T3.

In 2002 WS, treatment T6 obtained the highest yield and significantly differed from T1, T2 and T3. However, T6 grain yield was not different from T4, T5 and T7. There were non-significant differences in grain yield between treatment T2 and T3, but these treatments was significant higher in grain yield as compared to T1.

In 2003 DS, treatment T4 obtained the highest yield and significantly differed from T1, T2 and T7. However, T4 grain yield was not different from T3, T5 and T6.

Table 2. Effect of rice straw manure and chemical fertilizer on rice yield of IR64.

Treatment	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Av. WS	Av. DS
T1. Control	2.19	4.32	2.67	4.78	2.98	3.49	2.61a	4.20a
T2. RSM (6t/ha)	2.23	4.60	2.91	5.13	3.20	3.84	2.78a	4.52b
T3. RSM + 20 %NPK	2.51	5.50	3.24	6.05	3.22	4.36	2.99b	5.30c
T4. RSM + 40% NPK	2.66	5.84	3.53	6.46	3.26	4.89	3.19c	5.73d
T5. RSM+ 60%NPK	2.71	5.94	3.63	6.76	3.33	4.49	3.22c	5.73d
T6. RSM+80% NPK	2.90	5.92	3.71	6.55	3.42	4.30	3.34c	5.59cd
T7.NPK (DS:100:30:30) (WS: 80:30:30)	3.07	5.89	3.60	6.65	3.37	3.55	3.30c	5.36c
CV (%)	8.20	5.50	4.00	5.10	3.3	9.0	6.01	5.85
LSD (5%)	0.37	0.52	0.24	0.55	0.19	0.65	-	-

The results also indicated that the 2003 DS obtained lower grain yield as compared to the others (2001 DS and 2002 DS). Especially, the treatment T7 in which complete application of chemical fertilizer (NPK) obtained the lowest yield that was caused by rice leaf blast disease at 35 days after sowing and neck blast disease at 85 days after sowing (table 3)

The above results also indicated that grain yield of IR64 was increased by the continuous application of rice straw manure. Especially, from second season to the continuous seasons, the grain yield of treatment T4 in which rice straw manure was incorporated with 40% NPK was not significantly differed from treatment T7 (complete application of chemical fertilizer). Continuous application of organic manure alone overyielded 9,9 % than control (Padalia 1975). Otherwise, application of organic manure in combination with inorganic fertilizer overyielded 11-12% than control (Tan 1992). In this experiment (table 4), the treatment which was completely applied by rice straw manure overyielded 5.91% and 7.92 % than control in WS and DS, respectively.

The treatment in which complete application of chemical fertilizer (NPK) overyielded 29.31% and 25.73 % than control in WS and DS, respectively.

The treatment in which rice straw manure combined with different doses of chemical fertilizer (NPK) overyielded 14.67 - 28.71% and 26.27 – 32.41 % than control in WS and DS, respectively.

Table 3. Rice Blast disease of dry season 2003

Treatment	Leaf blast disease (%) *	Neck blast disease (%)**
T1. Control	1.48	1.38
T2. RSM (6t/ha)	2.94	0.90
T3. RSM + 20 %NPK	12.54	1.42
T4. RSM + 40% NPK	14.87	1.54
T5. RSM+ 60%NPK	30.70	2.66
T6. RSM+80% NPK	38.27	3.60
T7. NPK (DS:100:30:30) (WS: 80:30:30)	72.00	4.52
CV (%)	26.50	22.50
LSD (5%)	11.62	0.91

* Number disease leaves/total leaves observation; using arcsine transformation; 35 days after sowing.

** Number disease panicles /total panicles observation; using square-root transformation $(X + 0.5)^{1/2}$; 85 days after sowing.

Table 4. Effect of rice straw manure and chemical fertilizer on rice yield over control (%)

Treatment	Percentage of grain yield over control							
	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Average of three WSs	Average of three DSs
T1. Control	-	-	-	-	-	-	-	-
T2. RSM (6t/ha)	1.82	6.40	8.61	7.32	7.30	10.03	5.91	7.92
T3. RSM + 20 %NPK	14.61	27.31	21.34	26.56	8.05	24.93	14.67	26.27
T4. RSM + 40% NPK	23.46	35.18	32.20	35.14	9.39	40.11	21.68	36.81
T5. RSM+ 60%NPK	23.74	37.50	35.95	41.42	11.74	28.65	23.81	35.86
T6. RSM+80% NPK	32.42	37.01	38.95	37.02	14.76	23.21	28.71	32.41
T7. NPK (DS:100:30:30) (WS: 80:30:30)	40.02	36.34	34.83	39.12	13.08	1.72	29.31	25.73

2. Microbial communities under rice soil conditions:

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 micro-organisms, 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 continuous application of organics will energise the living soil micro-organisms, involved in biochemical activity of importance to soil fertility and plant nutrition (Gaur et al. 1990). In this long-term experiment, we have only estimated the microbial population, total protein content and electron transport system (ETS) activities or dehydrogenase in soil. The result (table 5) showed treatments in wet season obtained higher in microbial population than treaments in dry season. In general, the result on average of three wet and dry seasons also indicated that plots in which rice straw manure was incorporated, obtained higher in microbial population as compared to plots in which rice straw manure was not applied (T1 and T7). This observation was similarly recorded in terms of ETS activities and total soil protein (mg/ kg of dried soil).

Table 5. Effect of rice straw manure and chemical fertilizer on microbial population of soil in $\log_{10}$ of C.F.U/ g. dry soil.

Treatment	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Average of three WSs	Average of three DSs
T1. Control	7.84	6.48	7.73	7.20	7.04	6.43	7.54	6.70
T2. RSM (6t/ha)	8.71	6.90	8.14	7.32	7.08	6.82	7.98	7.01
T3. RSM + 20 %NPK	8.77	6.78	7.92	7.76	7.04	6.78	7.91	7.06
T4. RSM + 40% NPK	8.73	6.70	8.22	7.51	7.28	7.14	8.08	7.11
T5. RSM+ 60%NPK	8.74	6.95	8.30	7.08	7.23	6.78	8.09	6.93
T6. RSM+80% NPK	8.57	7.04	7.98	7.66	7.23	7.11	7.93	7.26
T7. NPK (DS:100:30:30) (WS: 80:30:30)	7.93	6.78	7.70	7.04	7.00	6.76	7.54	6.86
* Before sowing	8.71							
Average	8.47	6.80	8.00	7.38	7.13	6.83	7.86	7.00
Sd	0.34	0.18	0.22	0.28	0.11	0.24	0.23	0.18

Note:* sd of microbial population in wet season was not calculate to treatment of before sowing.
C.F.U/ g. dry soil.: cell forming unit / gram of dry soil

The result on average number of ETS activities (table 6) also indicated that the lowest value of ETS activities (u mol INTF per min-g soil) obtained in complete application of chemical fertilizer treatment (T7), in contrast to this the plot in which complete application of rice straw manure was found to be higher in value of ETS activities than treatment T7. While among treatments in which rice straw manure in combination with different doses of chemical fertilizer, only treatment T6 and T4 exhibited the highest value of ETS activities in WS and DS, respectively.

In case of total soil protein, the result (table 7) showed that among treatments in which rice straw manure in combination with different doses of chemical fertilizer, treatment T5 and T6 exhibited the highest value of total soil protein in WS and DS, respectively.

Table 6. Effect of rice straw manure and chemical fertilizer on ETS activities* of soil

Treatment	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Average of three WSs	Average of three DSs
T1. Control	33.3	67.0	59.4	75.6	47.8	52.5	46.8	65.0
T2. RSM (6t/ha)	53.2	79.0	60.4	94.7	51.9	67.6	55.1	80.5
T3. RSM + 20 %NPK	33.2	75.0	87.1	105.4	53.8	75.9	58.0	85.4
T4. RSM + 40% NPK	33.1	80.6	61.5	126.9	60.9	97.7	51.8	101.7
T5. RSM+ 60%NPK	46.8	87.8	98.2	87.2	48.9	73.0	64.6	82.7
T6. RSM+80% NPK	33.4	70.4	86.9	104.6	74.6	79.7	64.9	84.9
T7. NPK (WS:80-30-30) (DS: 100-30-30)	33.1	61.5	58.4	73.4	46.6	62.7	46.0	65.8
Average	38.01	74.47	73.12	95.43	54.95	72.78	55.2	80.9
Sd	8.81	8.91	16.93	18.80	9.89	14.25	7.72	12.60

Note: * ETS activities = n mol INTF per min-g dry weight of soil INTF: Iodonitrophenyl Formazan

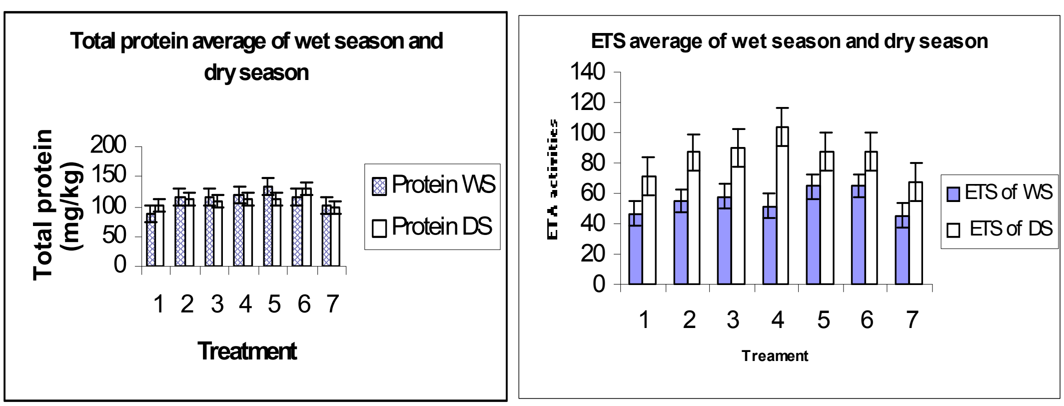


Fig 2. Average value of ETS activities and total protein content in soil.

Table 7. Effect of rice straw manure and chemical fertilizer on total protein* of soil

Treatment	2000 WS	2001 DS	2001 WS	2002 DS	2002 WS	2003 DS	Av. of three WSs	Av. of three DSs
T1. Control	76.6	118.6	100.6	104.5	88.7	77.3	88.7	100.2
T2. RSM (6t/ha)	93.3	130.5	132.2	114.2	119.3	87.3	114.9	110.6
T3. RSM + 20 %NPK	78.7	115.1	141.5	111.9	122.5	94.1	114.2	107.2
T4. RSM + 40% NPK	90.5	129.9	149.1	121.6	115.0	90.1	118.2	113.5
T5. RSM+ 60%NPK	86.0	137.6	195.1	113.3	116.3	89.6	132.4	113.5
T6. RSM+80% NPK	79.7	129.8	139.3	146.1	132.7	112.1	117.2	129.5
T7. NPK (WS:80-30-30) (DS: 100-30-30)	73.2	95.5	124.9	108.7	104.1	86.5	100.7	96.9
Average	82.63	122.45	140.39	117.19	114.09	91.06	112.35	110.23
Sd	7.50	14.03	28.77	13.78	14.11	10.63	13.97	10.59

Total protein content = mg / kg of dried soil

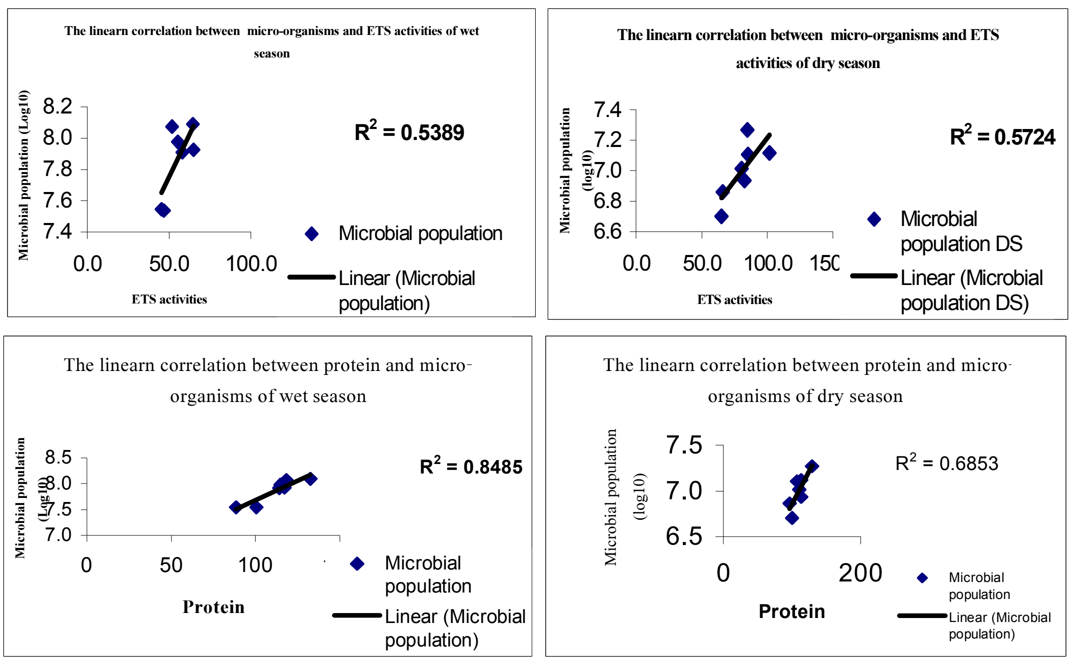


Fig 3. The linear correlation between soil micro-organisms and ETS activities; the linear correlation between soil micro-organisms and total soil protein.

The results in this long-term experiment (Fig.3) showed that there were positive correlation between soil micro-organisms and ETS activities, R^2 = 0.5389 and R^2 = 0.5724 in WS and DS, respectively; positive correlation between soil micro-organisms and total protein content in soil, R^2 = 0.8485 and R^2 = 0.6853 in WS and DS, respectively.

CONCLUSIONS

1. Application of rice straw manure increased yield over control 5.91% and 7.92 % in wet season and dry season, respectively.
2. Application of chemical fertilizer yielded over control 29.31 % and 25.73 % in wet season and dry season, respectively.
3. Rice straw manure combined with different doses of organic fertilizer yielded over control 14.67 – 28.71 % and 26.27 - 32.41 % in wet season and dry season, respectively.
4. There were significantly possitive correlation between SPAD value and grain yield.
5. Complete application of chemical fertilizer treatment and control were lower microbial population in soil as compared to complete application of rice straw manure and treatments in which rice straw manure combined with different doses of chemical fertilizer.
6. There were a positive correlation between soil micro-organisms and ETS activities and between soil micro organisms and total protein content in soil.

REFERENCES

Boy SA and MM Mortland. 1990. Enzyme interaction with clays and clay organic matter complexes. In: J. M. Bollag & G. Stotzky (eds.) Soil Biochem. 6, 1-28.

Burn RG. 1982. Enzyme activity in soil: Location and possible role in microbial activities. Soil Biocheme. 14, 423-427.

Chendrayan K, TK Adhyya and N Sethunathan. 1980. Dehydrogenase and invertase activities of flooded soils. Soil Biol. Biochem. 12: 271-273.

Elliot L, VL Cochran, and RI Papendick. 1981. Wheat residues and nitrogen placement effects on wheat growth in green house. Soil. Sci.. 131: 48-52.

Gaur AC, S Neelakantan and KS Dargan. 1990. Organic manures. I.C.A.R. Newdlhi. India.

Herbert D, PJ Phipps. and RE Strange. 1971. III. Chemical analysis of microbial cells.In Norris/Ribbon (eds.). Methods. Microbiol.5B: 249-252.

Huan TTN, TQ Khuong, Tadao Kon and PS Tan. 1998. OMON RICE. (6): 53-58.

Huan TTN, PS Tan and Hiroyuki Hiraoka. 2000. Optimun fertilizer nitrogen rate for high yielding rice based on growth diagonics in wet seeded culture of rice. Proceedings of the 2000 annual workshop of JIRCAS Mekong Delta project; Nov 14-17, 2000. 60-67.

International Rice Research Institute (IRRI). 1991. IRRISTAT User's manual. Version 91.1. IRRI,1991.367 p.

Martin JP, RL Branson and WM Jarrell. 1978. Decomposition of organic material used in planting mixes and some effects on soil properties and plant growth. Agrochimica. 22: 248-261.

Office of Technology Assessment of U.S. Congress (**OTA**).1987. Technologies to maintain biological diversity. OTA-F330. Washington DC, US Government printing office:331p.

Padalia CR. 1975. Effect of N. P & K fertilizer with and without farmyard manure on high yielding variety of rice. Oryza 12(10): 53-58.

Parkinson D and DC Coleman. 1991. Microbial communities. activity nad biomass. Agric. Ecosyst. Environ. 34: 3-33.

Subba Rao NS. 1977. Soil microorganisms and plant growth. Oxford & IBH publishing Co.PVT.LTD. pp. 192 - 207.

Tan PS. 1992. Organic manure for high yielding rice. OMONRICE. (2): 64-68.

SUMMARY IN VIETNAMESE

Cải thiện độ phì đất bằng rơm rạ

Rơm rạ sau thu hoạch được xử lý bằng chế phẩm sinh học (*Trichoderma sp*) đã tạo thành nguồn phân hữu cơ làm vật liệu nghiên cứu. Thông qua thí nghiệm dài hạn "cải thiện độ phì của đất từ nguồn phân hữu cơ rơm rạ", với 6 vụ lúa liên tục, kết qủa ghi nhận được như sau:

Bón hoàn toàn phân hữu cơ rơm rạ cho năng suất cao hơn đối chứng 5.91% trong vụ Hè -Thu (HT) và 7.92% trong vụ Đông -Xuân (ĐX).

Bón hoàn toàn phân hóa học (NPK) cho năng suất cao hơn đối chứng 29.31% trong vụ HT và 25.73% trong vụ ĐX.

Những nghiệm thức kết hợp phân hữu cơ rơm rạ với các mức phân hoá học (NPK) cho năng suất cao hơn đối chứng từ 14.67% đến 28.71% trong vụ HT và từ 26.27% đến 32.41% trong vụ ĐX.

Kết quả cũng cho thấy ở nghiệm thức đối chứng và nghiệm thức bón hoàn toàn phân hóa học có mật số vi sinh vật, tổng số protein, và chỉ số ETS hoạt động trong đất thấp hơn so với nghiệm thức bón hoàn toàn phân hữu cơ rơm rạ hay so với những nghiệm thức sử dụng phân hữu cơ rơm rạ được bón kết hợp với các mức phân hóa học khác nhau.

Kết qủa này cũng ghi nhận được sự tương quan giữa mật số vi sinh vật với chỉ số ETS hoạt động và sự tương quan giữa mật số vi sinh vật với tổng số protein trong đất.