

Nitrogen mineralization in soil amended with mesocarp fiber of oil palm and other wastes : A greenhouse study

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Abstract

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Mesocarp fiber of oil palm, sludge cake from frozen seafood factory, rick husk and organic fertilizer were mixed with a soil and incubated for 0, 15, 30, 45, 60, 75 and 90 days in plastic pots. At the end of each incubation period, NH_4^+ -N and NO_3^- -N contents were determined by MgO-Devada alloy steam distillation method. N-mineralization differed depending upon incubation period and types of organic amendment. At 60 days of incubation, N-mineralization of the amended soil had increased slightly. NO_3^- -N content was higher than NH_4^+ -N content at all incubation periods especially in the soil amended with of the mesocarp fiber of oil palm. The soil inoculated with *Sclerotium rolfsii* had higher rates of N-mineralization than the soil without *S. rolfsii* with the exception of the soil amended with mesocarp fiber of oil palm at 5 g/kg. soil and rick husk during 60-90 days of incubation period. NO_3^- -N, was the dominant product of N-mineralization in soil both added with *S. rolfsii* and without *S. rolfsii*.

Key words : agricultural waste, mesocarp fiber of oil palm, N-mineralization, *Sclerotium rolfsii*

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wastes i.e. mesocarp fiber of oil palm, sludge cake from frozen seafood factory, rice husk and organic fertilizer, (2) to compare nitrogen mineralization in the amended soil in the presence and absence of *S. rolfsii*.

Materials and Methods

Agricultural and industrial wastes preparation and analysis

Agricultural and industrial wastes used in this experiment are listed in Table 1.

These wastes were ground and sieved through a 2 mm. sieve and analyzed at the Central Laboratory Center, the Faculty of Natural Resources, (FNR), Prince of Songkla University (PSU). Some of their chemical characteristics as shown in Table 1. The ground mesocarp fiber of oil palm after oil extraction will be referred to as oil palm throughout the text.

Soil analysis and *Sclerotium rolfsii* preparation

Soil was collected from a vegetable growing area at Bang Klam District, Songkhla Province. This soil sample was air-dried and sieved through 2 mm. Some chemical and physical properties of the soil were analyzed. This soil had a sandy loam

texture (66% sand, 18.6 % silt and 14.8 % clay), with pH 6.8, 2.3% organic matter, total N 0.1%, available P 1,089 mg/kg soil, exchangeable K 0.5 cmol(+)/kg, exchangeable Ca 8.4 cmol(+)/kg and exchangeable Mg 0.8 cmol(+)/kg .

S. rolfsii was originally isolated from pumpkin fruit from the field of the Department of Pest Management, FNR, PSU. Inoculum of *S. rolfsii* was prepared by transferring mycelia of *S. rolfsii* onto sterile sorghum seeds (1 kg) in a plastic bag. This bag was incubated at room temperature (26-32 °C) until mycelia of *S. rolfsii* completely colonised the sorghum seeds. These sterile the sorghum seeds (7.5 g) colonised with *S. rolfsii* were later mixed with soil and used in the experiment.

Treatments and experimental design

Experiment 1

In the first experiment, two rates of oil palm and sludge cake were used ; 5 g and 10 g for oil palm and 2.5 g and 5 g for sludge cake. The other wastes were used at 5 g and unamended soil was a control treatment. One kilogram of soil was thoroughly mixed with each waste and sterilized water was added to maintain a moisture equivalent at 60% of water holding capacity. This mixture was placed in a plastic pot (15 cm diameter)

Table 1. Nutrient status of some agricultural and industrial wastes.

Type of wastes	C/N Ratio	Moisture (%)	Total N (%)	Organic carbon (%)	pH (1:5H ₂ O)	EC (mS-cm ⁻¹) (1:5H ₂ O)
Oil palm ^(A)	53.1	7.6	0.96	51.27	5.2	1.9
Organic 1 ^(B)	12.7	36.7	0.89	11.33	7.9	2.2
Organic 2 ^(C)	23.8	44.3	0.37	8.80	8.8	3.3
Rice husk ^(D)	77.0	49.5	0.30	23.08	4.7	6.0
Sludge cake ^(E)	5.0	8.6	8.86	44.18	5.8	6.6

(A) Oil palm which had been processed, extracted for oil in palm oil processing factory and the air dried mesocarp fiber was ground.

(B) Organic fertilizer product from garbage processing factory and had been commercialised at a garden shop in Hat Yai.

(C) Organic fertilizer from a whiskey brewing factory.

(D) Rice husk mixed with fermented molasses.

(E) Sludge cake from frozen seafood factory. The solid portion was compressed and dried at 65 -70 °c.

lined with a plastic bag and incubated for 0, 15, 30, 45, 60, 75 and 90 days in a glasshouse of the Faculty of Natural Resources, PSU. Each treatment consisted of 4 replications.

Experiment 2

The second experiment was similar to the first experiment except that 7.5 g of *S. rolf sii* colonized sorghum seeds was added to each replication 15 days after amending soil with the oil palm and the other agricultural wastes.

At the end of each incubation period, 10 g of the soil mixture was sampled from each replication and extracted with 100 ml of 2 M KCl; the extractants from individual treatments and replications were analysed for the amount of NH_4^+ and NO_3^- as described by Keeney and Nelson (1982)

Data analysis

Data were analyzed using the SPSS (+PC) computer package. One way ANOVA was carried out on N-mineralization, NH_4^+ -N and NO_3^- -N. Means were then compared with Least Significant Difference (LSD).

Results and Discussion

N-mineralization in soil without *S. rolf sii*

The amounts of N-mineralization of the soil amended with oil palm and the other agricultural wastes were higher than in the control (Figure 1)

During 60 days of incubation, N-mineralization of amended soil had increased slightly. Sludge cake which had lowest C/N ratio had highest N-mineralization, while the soil amended with oil palm had N-mineralization lower than rice husk, the substrate which had highest C/N ratio. This result may suggest that apart from C/N ratio, other parameters may also play an important role in the N-mineralization process. These parameters include the chemical composition of wastes (Chescheir *et al.*, 1986), lignin and polyphenol content (Fox *et al.*, 1990), crude protein content (Hattori and Mukai, 1986; Oglesby and Fownes, 1992) and microbial biomass (Bloem *et al.*, 1997). Soil amended with oil palm and other agricultural wastes except organic 2 had significantly increased ammonium form of nitrogen at 60 days after incubation compared with control (Table 2). However, NH_4^+ -N content was lower than NO_3^- -N content at all incubation periods (Table 3). This result indicated that under aerobic incubation of nitrogenous materials NO_3^- -N content was higher than NH_4^+ -N content (N' Dayegamiye *et al.*, 1997). Apart from nitrification, NO_3^- -N may occur from the oxidation of other nitrogen compound in soil such as protein and ribonucleic acid (Bloem *et al.*, 1997). NO_3^- -N content of amending soil greatly increased between 75-90 days, particularly in soil amended with oil palm at 5 g/kg soil (Table 3).

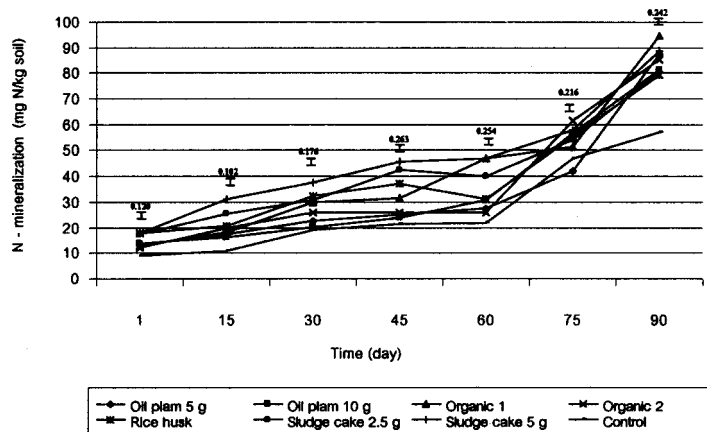


Figure 1. Effect of organic amendment on N-mineralization in soil without *S. rolf sii* during 90 days of incubation in the greenhouse.

Table 2. Effect of organic amendments on NH_4^+ - N (mg/kg as N) in soil without *S. rolfsii* during 90 days of incubation in a greenhouse.

Treatment	Incubation time (days)							LSD at P < 0.05
	1	15	30	45	60	75	90	
Oil palm 5 g	3.89	4.34	5.66	6.74	7.61	12.56	19.04	0.096
Oil palm 10 g	3.36	3.82	3.85	5.21	8.16	14.44	19.63	0.108
Organic 1	4.07	4.49	4.09	5.75	8.16	9.56	20.14	0.025
Organic 2	3.71	3.95	4.06	4.26	6.10	14.42	21.97	0.125
Rice husk	5.37	6.33	7.04	7.61	9.13	10.16	13.79	0.082
Sludge cake 2.5 g	4.13	4.26	5.07	7.22	15.52	16.00	19.77	0.128
Sludge cake 5 g	6.28	6.87	8.22	12.81	12.56	15.82	20.13	0.105
Control	2.86	4.01	5.35	6.41	6.58	8.86	14.24	0.106
LSD at P < 0.05	0.035	0.021	0.024	0.089	0.075	0.197	0.134	

Table 3. Effect of organic amendments on NO_3^- - N (mg/kg as N) in soil without *S. rolfsii* during 90 days of incubation in a greenhouse.

Treatment	Incubation time (days)							LSD at P < 0.05
	1	15	30	45	60	75	90	
Oil palm 5 g	9.67	13.18	16.88	18.21	19.92	29.55	68.51	0.130
Oil palm 10 g	10.29	12.27	16.23	18.53	22.78	42.11	61.76	0.186
Organic 1	9.08	15.27	33.97	25.85	38.74	42.05	74.72	1.155
Organic 2	8.26	15.79	21.78	21.78	19.71	47.03	63.44	0.065
Rice husk	12.52	14.42	25.16	27.10	22.13	45.21	65.43	0.312
Sludge cake 2.5 g	13.31	21.44	25.69	35.42	24.51	38.30	60.76	1.198
Sludge cake 5 g	11.36	24.36	29.56	33.08	34.91	49.23	68.44	0.108
LSD at P < 0.05	0.112	0.183	0.176	0.263	0.236	0.125	0.155	

N- mineralization in soil with *S. rolfsii*

After amending soil with oil palm and other agricultural wastes, N-mineralization had increased significantly, particularly between 15 to 45 days, in soil with the pathogen present (Figure 2). At 60 days of incubation, N-mineralization of amended soil decreased significantly except amending soil with organic 1. The strong reduction of N-mineralization was probably due to *S. rolfsii* growth

(Bloem *et al.*, 1997). N-mineralization of soil amended with organic 1 slightly increased during the incubation period. This results indicated that organic 1 had high degree of maturity and N-mineralization rate was maintained at constant value (Castellanos and Pratt, 1981; Aoyama and Nozawa, 1993; Mckenney *et al.*, 1995). During 45-90 days, immobilization of nitrogen occurred in soil mixture amended with oil palm and rice

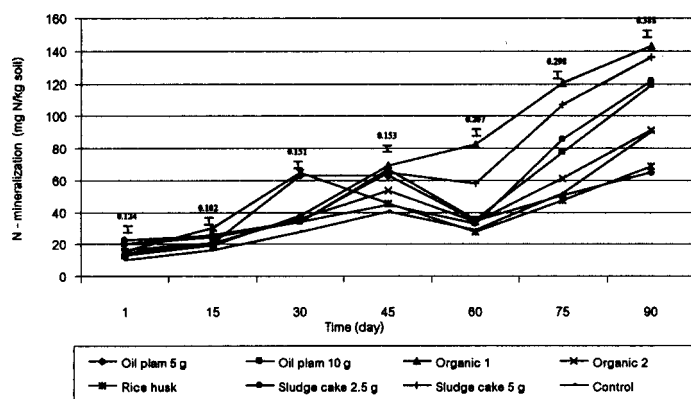


Figure 2. Effect of organic amendment on N-mineralization in soil with *S.rolfsii* during 90 days of incubation in the greenhouse.

Table 4. Effect of organic amendments on NH_4^+ - N(mg/kg as N) in soil with *S.rolfsii* during 90 days of incubation in a greenhouse.

Treatment	Incubation time (days)							LSD at P < 0.05
	1	15	30	45	60	75	90	
Oil palm 5 g	6.10	18.85	43.39	36.40	4.64	10.84	17.37	0.088
Oil palm 10 g	8.45	10.49	18.29	45.68	5.96	7.15	9.41	0.118
Organic 1	2.76	7.31	13.48	27.34	10.10	19.51	23.60	0.034
Organic 2	5.07	9.11	19.40	28.98	11.14	12.58	20.45	0.128
Rice husk	6.18	11.73	35.57	18.27	2.97	9.29	14.24	0.140
Sludge cake 2.5 g	9.52	13.96	18.98	25.93	7.16	18.83	22.00	0.071
Sludge cake 5 g	7.27	9.84	14.89	34.49	10.62	21.14	30.52	0.095
Control	2.56	6.83	10.89	19.10	5.07	9.93	16.29	0.105
LSD at P < 0.05	0.080	0.058	0.122	0.156	0.091	0.086	0.093	

husk, the substrates which had C/N ratio at 53.1 and 77.0 respectively.

NH_4^+ -N content was very low when compared with the mineralized N (NH_4^+ + NO_3^- - N) in each incubation period (Table 4). However during 15-45 days, NH_4^+ -N content in soil amended with *S. rolfsii* was higher than in soil without *S. rolfsii*. At 60 days, NH_4^+ -N content in inoculated soil amended with oil palm and other agricultural wastes was reduced significantly. The strong reduction of NH_4^+ -N was possibly due to the uti-

lization of nitrogen by microbes from inorganic rather than from organic source. However, at the end of incubation period, NH_4^+ -N content of amended soil was significantly higher than control treatment except for soil amended with rice husk, Although NH_4^+ -N content had reduced in some incubation period, NO_3^- - N content greatly increased in all incubation periods and this content was higher than in soil without *S. rolfsii* (Table 5).

Table 5. Effect of organic amendments on NO_3^- - N (mg/kg as N) in soil with *S. rolfsii* during 90 days of incubation in a greenhouse.

Treatment	Incubation time (days)							LSD at P < 0.05
	1	15	30	45	60	75	90	
Oil palm 5 g	10.36	12.13	19.16	26.69	29.73	39.86	47.38	0.103
Oil palm 10 g	11.52	13.87	15.64	21.30	29.18	70.45	109.65	0.167
Organic 1	10.61	12.04	24.31	41.75	72.17	100.65	119.70	0.181
Organic 2	9.39	11.73	16.31	24.48	22.73	48.55	71.10	0.100
Rice husk	9.51	18.46	29.05	27.15	24.54	38.23	54.45	0.089
Sludge cake 2.5 g	13.32	11.30	15.34	18.73	25.70	67.05	99.85	0.118
Sludge cake 5 g	12.62	16.15	19.49	30.15	47.05	86.17	105.33	0.434
Control	7.16	9.82	16.63	20.95	23.69	41.92	73.17	0.134
LSD at P < 0.05	0.094	0.080	0.092	0.074	0.165	0.259	0.383	

Conclusion

N-mineralization differed depending upon incubation period and type of organic amendments. During 60-90 days, the soil inoculated with *S. rolfsii* had higher N-mineralization than that of the soil without *S. rolfsii*, except the soil amended with oil palm at 5 g/kg soil and with rice husk. Thus, amending the soil with some agricultural wastes such as organic fertilizer and sludge cake may aggravate plant disease problem because the pathogen has the capacity to utilize N-content in these substrates. On the other hand, oil palm has a potential to be utilized for soil fertility improvement with least effect on the possibility of increasing plant disease problem. This finding supported the results obtained from Kanjanameesathian *et al.*, (1999) who demonstrated that oil palm 5 g/kg soil reduced percent post emergent damping-off of Chinese kale seedling caused by *S. rolfsii*. NO_3^- -N was the dominant product of N-mineralization in soil both with added *S. rolfsii* and without *S. rolfsii*.

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