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Utilization of Waste Materials from Monosodium Glutamate Factory as Source of Nitrogen for Paddy in Acid Sulfate Soil

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ABSTRACT

The efficiency of glutamic mother liquour (GML) and humus, the waste materials from a monosodium glutamate factory, as a source of nitrogen for paddy in an acid sulfate soil (Rangsit soil) was studied in the laboratory and pot experiment. The application rate of GML, 'humus', $(NH_4)_2SO_4$ and urea in both the laboratory and pot experiment was 266.7 ppm N. In the laboratory experiment, the effects of GML, 'humus', $(NH_4)_2SO_4$ and urea on NH_4^+ content and the reduction state in submerged acid sulfate soil were investigated during a 6 - week incubation period. GML and 'humus' significantly increased the NH_4^+ content in submerged acid sulfate soil after 6 weeks of incubation to 74 and 70 percent of that in acid sulfate soil amended with $(NH_4)_2SO_4$ respectively. Application of GML and 'humus' enhanced the reduction stage in submerged acid sulfate soil but urea and $(NH_4)_2SO_4$ had no effect. In pot experiment, the effects of GML, 'humus', $(NH_4)_2SO_4$ and urea on growth and yield of rice plant grown in submerged acid sulfate soil were elucidated. GML significantly increased growth, and yield of rice plant, having grain yield of 83 and 82 percent comparing to those of the rice plant grown in the soil amended with $(NH_4)_2SO_4$ and urea respectively. 'Humus' increased growth and yield of rice plant but the effectiveness of 'humus' was very low as compared to that of GML. Grain yield of rice plants grown in the soil amended with 'humus' was 34 and 33 percent compared to those of the rice plant grown in the soil amended with $(NH_4)_2SO_4$ and urea respectively. The low efficiency of 'humus' in increasing growth and yield of rice plant might be due to the effects of some toxic substances released from 'humus' which appeared to have its main effect on reducing the number of grains set per panicle.

INTRODUCTION

In Thailand, the use of organic industrial wastes as a source of nutrients for paddy has been of considerable interest in recent years. During 1983 - 1984, and in 1986, cooperative research programmes between Thailand and Japan were undertaken to study the utilization of organic waste materials in agriculture (Vacharotayan and Yoshida, 1985) and the effect of organic materials on the sustainability of soil fertility in tropical region (Vacharotayan *et al.*, 1988). The results of these cooperative researches indicated that various kinds of organic industrial wastes especially castor meal and activated sludges could be effectively used as source of nitrogen for paddy and upland crop. (Chanchareonsook *et al.*, 1985; Panichsakpatana *et al.*, 1985; Panichsakpatana *et al.*, 1988).

Since, some kinds of waste materials from monosodium glutamate factory are rich in nitrogen. Utilization of these waste materials as nitrogen fertilizer is worth studying. This research was carried out as to study the efficiency of glutamic mother liquor (GML) and 'humus',

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the waste materials from a monosodium glutamate factory, as a source of nitrogen for paddy in an acid sulfate soil.

MATERIALS AND METHODS

A soil sample of Rangsit soil, an acid sulfate soil (Sulfic Tropaquept), was collected from Pathumthani Rice Research Center. The soil was air dried and crushed to pass through a 2 mm sieve. Some properties of the soil are shown in Table 1. Organic industrial wastes, GML and 'humus' were collected from a monosodium glutamate factory. They were air dried and crushed to pass through a 0.5 mm sieve. Some properties of GML and 'humus' are shown in Table 1. A laboratory and pot experiment were carried out.

Table 1 Properties of the soil sample, GML and 'humus'.

Properties of soil sample		Properties of GML and humus		
			GML	'humus'
Texture	clay	pH	3.9	0.9
pH (1:1 soil : H_2O)	3.9	Total N (%)	7.33	3.89
Total N (%)	0.150	Total C (%)	29.3	30.8
Total C (%)	1.466	C/N	4	8
CEC (me/100g soil)	37.5	Total P (%)	0.33	0.13
Free Fe (%)	0.92	Ca (%)	0.17	0.19
Available P (Bray II P, ppm)	14			

Laboratory experiment : Ten grams of air dried soil, amended with GML 'humus' $(NH_4)_2SO_4$ or urea at the rate of 266.7 ppm N, and unamended soil were incubated under submerged conditions at room temperature for 0, 1, 2, 3,4 and 6 weeks. The incubated soils were extracted with 10% KCl solution; NH_4^+ and Fe^{2+} in the extract were determined by distillation and colorimetrically respectively.

Pot experiment : A completely randomized design was used with 5 treatments (Check, GML, 'Humus', $(NH_4)_2SO_4$ and Urea) and 5 replications. Details of the rate of organic or inorganic fertilizer addition in each treatment are shown in Table 2. The amended soil was placed in a plastic pot (height 21 cm, diameter 30 cm) and submerged. After 7 days of submergence, two rice seedlings *(Oryza sativa* L. cv. RD 23) aged

Table 2 Details of the treatments*.

Treatment	Rate of N (ppm)	Rate of waste material or chemical nitrogen fertilizer (g/6 kg soil/pot)	KH_2PO_4 (g/6 kg soil/pot)
Check	0	0	0
GML	266.7	21.8	7.5
Humus	266.7	41.1	7.5
$(NH_4)_2SO_4$	266.7	7.5	7.5
Urea	266.7	3.41	7.5

* waste materials or chemical nitrogen fertilizer and KH_2PO_4 were well mixed with air dry soil before submergence.

21 days were transplanted to each pot. All pots were kept in submerged conditions by watering with distilled water. Height and tiller number of the rice plants were measured at tillering, panicle initiation, flowering and harvesting stage. Rice plants were harvested at 105 days after transplanting. Dry matter (above ground) and grain yield of the rice plants were measured at harvest.

RESULTS AND DISCUSSION

1. Effects of GML and 'humus' on NH^+_4 content and reduction state in a submerged acid sulfate soil

The amount of NH^+_4 in the incubated soil during 0 - 6 weeks of incubation are shown in Figure 1. It was found that the addition of GML and 'humus' significantly increased NH^+_4 content in the submerged acid sulfate soil, but their effectiveness was less than those of $(NH_4)_2SO_4$ and urea. The amount of NH^+_4 released in acid sulfate soil amended with GML and 'humus' after 6 weeks of incubation was 74 and 70 percent respectively of that in the soil amended with $(NH_4)_2SO_4$. According to the amount of NH^+_4 in the soil at 0 week of incubation and the pattern of NH^+_4 release in the soils amended with GML and humus, it could be said that high content of free NH^+_4 was present in GML and humus and the rate of NH^+_4 release from these organic waste materials was slow during 6 weeks of incubation. Application of GML and 'humus' enhanced the reduction state in submerged acid sulfate soil, as indicated by Fe^{2+} content in the soil (Figure 2). The increase in the reduce state occured within the first 3 weeks after organic amendment. Urea and ammonium sulfate had negligible effect on the enhanced reduction state of the soil.

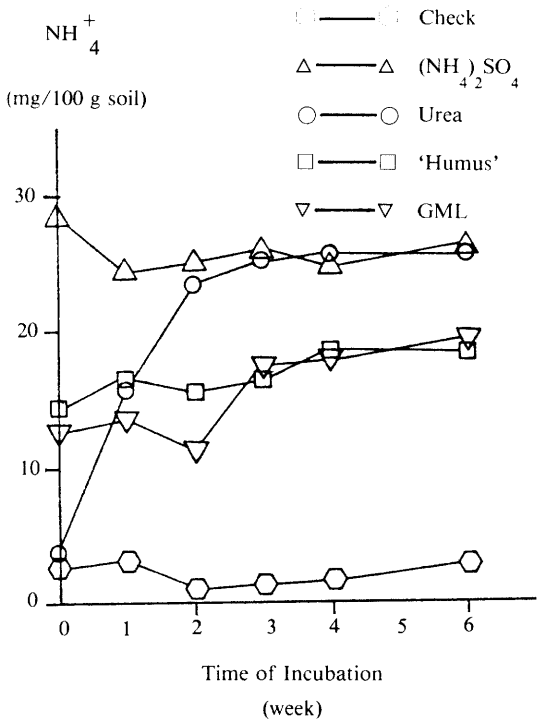

Figure 1 Ammonium (NH^+_4) content in submerged acid sulfate soils amended with GML, 'humus', $(NH_4)_2SO_4$ and Urea.

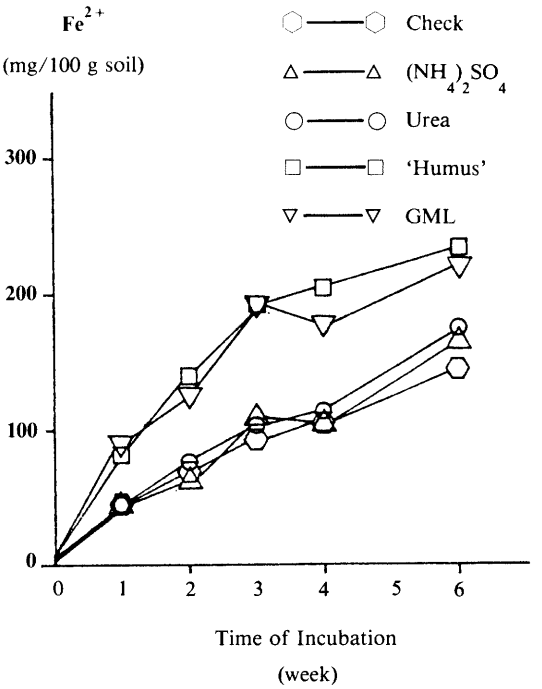

Figure 2 Ferrous (fe^{2+}), content in submerged acid sulfate soil amended with GML, 'humus', $(NH_4)_2SO_4$ and Urea.

2. Effects of GML and 'humus' on growth and yield of the rice plant

Results indicated that GML significantly increased growth (Table 3) and yield (Table 4) of the rice plant grown in the submerged acid sulfate soil. Grain yield of the rice plants grown in the soil amended with GML was 83 and 82 percent of those of the rice plants grown in the soil amended with $(NH_4)_2SO_4$ and urea, respectively. The addition of 'humus' increased growth and yield of the rice plant, but was rather low, compared with that of GML. Grain yield of rice plants grown in the soil amended with 'humus' was only 34 and 33 percent of those of the rice plants grown in the soil amended with $(NH_4)_2SO_4$ and urea respectively. Since the efficiency of 'humus' in increasing NH_4^+ content in submerged acid sulfate soil was rather similar to that of GML. The low efficiency of 'humus' in increasing growth and yield of rice plant grown in submerged acid sulfate soil might be due to the effects of some toxic substance released from 'humus'. The lower efficiency of 'humus' for increasing grain yield compared to the other amendments,

Table 3 Height and tiller number of the rice plant at panicle initiation stage (PI) and flowering stage (F).

Treatment	Height (cm)		Tiller Number/pot	
	PI	F	PI	F
Check	63	74	11	11
GML	81	107	46	45
'Humus'	74	102	26	35
$(NH_4)_2SO_4$	84	107	59	50
Urea	86	119	66	46
F-ratio	**	**	**	**
LSD.05	4	6	7	3
.01	6	8	9	4
%CV	4	5	12	6

Table 4 Rice yield and yield components

Treatment	Grain g/pot	Straw g/pot	Harvest index	Panicle No	1000 seed weight g	Grains/Panicle
Check	8.1	12.2	0.40	7	23.0	50.3
GML	54.4	69.0	0.44	32	21.8	78.0
'Humus'	22.0	49.8	0.31	28	18.6	42.2
$(NH_4)_2SO_4$	65.1	81.1	0.45	35	21.8	85.3
Urea	66.2	81.1	0.45	35	22.2	85.2
F-ratio	**	**	-	**	n.s.	-
LSD.05	3.8	4.6	-	2	-	-
.01	5.1	6.3	-	3	-	-
%CV	6	6	-	6	-	-

was due to a slightly lower number of panicle/plant and 1000 grain weight but a much lower number of grains per panicle and harvest index. Any toxic effect was apparently adversely affecting fertilization, seed set or embryo abortion.

CONCLUSION

GML could be effectively used as source of nitrogen for paddy in submerged acid sulfate soil. 'Humus' significantly increased NH_4^+ content in submerged acid sulfate soil, however, the effectiveness of 'humus' in increasing rice yield was low. Further experiments should be continued to identify the reason for the lower fertilizer efficiency of 'humus' in paddy soils and if possible appropriate method for utilization.

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