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Effect of rice straw on transformations of soil and fertilizer nitrogen in flooded tropical rice soils

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INTRODUCTION. — Rice straw application is followed under tropical lowland rice soils as a fertilizer saving practice as well as for improving the fertility of these soils. Earlier work at the International Rice Research Institute (1974; 1975), has shown that application of rice straw improves the organic matter as well as total nitrogen contents of the soils.

For studying the recycling of nitrogen applied as rice straw it may be useful to know how this amendment affects the mineralization of soil as well as fertilizer NH_4^+. Such information can be useful in better utilization of rice straw as source of plant nutrient as well as a fertilizer saving practice. The present study aimed at studying the effects of straw application on the ammonification of soil as well as fertilizer N in 3 flooded tropical rice soils from the Philippines.

MATERIALS AND METHODS. — The soils used (Table 1) were surface (0-15 cm) samples, which were air dried and ground to pass through a 2-mm sieve before use. For soil analyses, the pH was measured by a glass elestrode, organic matter content, total N and inorganic N forms were determined respectively by the methods of WALKLEY and BLACK (1972) and BREMNER (1965a; 1965b).

Ground rice straw containing 0.50% total N was used in the study and was applied at a rate of 0.15% (or 1500 ppm) of soil weight. Following incubation method was followed during the study:

Twenty gram samples of soils were taken in 125 ml Erlenneyer flasks. Ground straw was then applied and mixed with the soil both with and without 50 parts/10^6 of NH_4^+-N from ammonium sulfate. The treated soil samples in the flasks were then flooded with 50 ml of distilled water; the flasks covered with aluminium foils and incubated at 30°C in 3 replicates for 8 weeks. The incubated soil samples were analyzed for $NH_4 + NO_3^-$ every other week following extraction with 2 M KCl and distillation of the filtered extract with MgO and Devarda's alloy (BREMNER, 1965b).

TABLE 1. — *Analyses of soils used*

Soil	pH (1:1	O.M. (%)	Total N (%)	NH_4^+-N (Parts/10^6)	NO_3^--N (parts/10^6)
Maahas	6.3	2.3	0.120	13.8	29.8
Luisiana	4.4	3.2	0.175	23.4	9.5
Pila clay	7.5	3.8	0.185	17.7	8.1

RESULTS AND DISCUSSION. — The data on the effects of rice straw application on the mineralization of soil and fertilizer N are shown in Tables 2 and 3. The results indicated that Luisiana clay had the highest soil nitrogen mineralization potential followed by Pila and Maahas clay in the descending order. The amounts of NH_4^+ produced after 6 weeks in these soils without any amendment were respectively 64, 61 and 25 ppm (Table 2). In all soils, the contents of NO_3^--N remained very low and whatever it was present in the soil samples initially disappeared within 2 weeks.

It was also observed that the NH_4^+-N production after reaching a peak tended to come down after 8 weeks in all the 3 soils under all the treatments (Tables 2 and 3).

The results reported in Tables 2 and 3 further show that straw application did not significantly affect the mineralization of soil nitrogen in Maahas and Pila soils but its application showed positive effect on the mineralization of soil N in the Luisiana clay after 8 weeks of incubation. Similarly ammonification of fertilizer N was also not adversely affected by straw application in all the 3 soils. The usual immobilization effect due to straw application of soil or fertilizer N was not observed during the 8 weeks of study in any of the soils studied (Table 3).

TABLE 2. — *Effect of straw application on ammonification of soil nitrogen in flooded soils.*

Soil	Straw rate (%)	NH_4^+ (ppm) after weeks of incubation				
		0	2	4	6	8
Maahas clay	0.0	9.0 h	14.2 g	20.8	25.4 i	17.4 g
Maahas clay	0.15	8.7 h	13.0 g	20.6 e	25.6 i	20.2 g
Luisiana clay	0.0	20.3 e	46.6 de	55.7 c	64.2 ef	48.1 e
Luisiana clay	0.15	19.9 e	43 2 def	52.8 c	63.0 e	49.8 d
Pila clay	0.0	11 8 f	36.2 f	53.9 c	61.0 fg	49.4 e
Pila clay	0.15	11.6 fg	39.3 ef	55.0 c	62.9 ef	48.2 e

In a week means followed by a common letter are not significantly different at the 5% level.

TABLE 3. — *Effect of straw application on ammonification of fertilizer nitrogen in flooded soils.*

Soil	Straw rate (%)	NH_4^+ (ppm) after weeks of incubation				
		0	2	4	6	8
Maahas clay	0.0	35.5 d	47.2 de	48.6 d	49.4 h	38.3 f
Maahas clay	0.15	38.7 c	43.4 def	45.5 d	49.8 h	38.3 f
Luisiana clay	0.0	47.8 a	88.5 b	95.6 b	98.7 c	87.8 b
Luisiana clay	0.15	47.5 a	80.8 c	96.7 b	101.3 b	91.0 b
Pila clay	0.0	45.8 b	95.1 ab	96.7 b	86.3 d	73.5 c
Pila clay	0.15	45.4 b	92.1 ab	93.3 b	87.8 d	78.4 c

In a week means followed by a common letter are not significantly different at the 5% level

There are reports in literature on the effects of straw application on the mineralization and immobilization of soil and fertilizer N (BROADBENT, 1970; WILLIAMS et al., 1968), which bring out that the immobilization effects due to straw on the quantity of straw applied, N content of straw and total N content of the soil. It has been generally observed that the immobilization of soil or fertilizer N is always lower under flooded conditions compared to aerobic soils because under flooded situations bacteria are the main microorganisms, which operate at lower energy level and synthesize much less cell materials resulting in less immobilization of N (ACHARYA, 1935 a, 1935 b; BROADBENT, NAKASHIMA, 1970; PONNAMPERUMA, 1972).

BROADBENT and NAKASHIMA (1970) reported that though the N factor or additional N immobilized per unit weight of straw varied with the quantity of straw applied, N content of the straw and nature of the soluble N supplied but in no case it was negligible.

Another important factor which significantly influences the immobilization of soil or fertilizer N is the nitrogen content of soils. The immobilization of N due to straw application in nitrogen deficient soils have been significant and this effect being far less in soils with high organic matter or total N contents. The organic matter content of the soils used varied from 2.0 to 3.8% and total N contents from 0.120 to 0.185%. It seems that enough soil N was mineralized from these soils to counteract the immobilizing effect of straw application.

The results of the present study suggested that the application of rice straw (containing 0.5% N), at a rate of 0.15% or 1500

ppm of soil may not have any adverse effect due to immobilization of soil or fertilizer N under flooded rice soils with organic matter levels similar to the soils studied This seems to be an important and favorable point for the use of rice straw as source of N for tropical flooded rice soils in the wake of fertilizer N shortage and its high costs.

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SUMMARY — Effects of rice straw (containing 0 50% N) application on ammonification of soil and fertilizer NH_4^+ were studied in 3 flooded soils in the laboratory Rice straw at a rate of 0 15% of soil (wt basis) did not have any significant effect on the ammonification of soil as well as fertilizer N The results suggested that the rice straw applied at the rate may not adversely immobilize soil or fertilizer N in the soils studied under flooded conditions

RÉSUMÉ — Les effets de la paille de riz (teneur en azote 0,50%) sur la minéralisation du sol et sur l'engrais ammoniacal ont été étudiés au laboratoire pour trois types de sol inondés La paille de riz mise à un taux de 0 15 pour cent du poids du sol n'a pas d'effet significatif ni sur la minéralisation du sol ni sur l'engrais ammoniacal. Les résultats indiquent qu'à ce taux la pealle de riz n'aurait pas l'effet nuisible de bloquer l'azote du sol ou de l'engrais pour les sols étudiés en conditions d'inondation.

ZUSAMMENFASSUNG. — Es wurde die Wirkung von Reisstroh (0.5% N-Gehalt) auf Stickstoffbindung im Boden und auf Künstlichen Stickstoffgehalt in drei überfluteten Bodenarten im Labor untersucht. Eine Beimischung von 0.15% Reisstroh zum Boden (auf Gewichtsbasis) hatte Keinen signifikanten Effekt, weder auf Stickstoffbindung noch auf Künstlichen Stickstoffgehalt. Die Ergebrisse zeigen an, dass Reisstroh in dieser Beimischung den Boden- oder Künstlichen Stickstoff in den untersuchten Böden bei Überflutung wahrcheinlich nicht nachteilig festlegt.

RESUMEN. — Efectos de paja de arroz (conteniendo 0.50% N) applicacion sobre amonificacion de la nitrogeno en el suelo y fertilizante en tres suelos inundados dentro el laboratorio. Paja de arroz equivalente a 0.15% del suelo (base de peso) no efectado significativamente amonificacion del nitrogeno del suelo o del fertilizante. El resultados sujere que applicaciones como esta en los sueos investigados bajo inundacion no van immobilizar el nitrogeno.

RIASSUNTO. — E' stato studiato l'effetto delle foglie di riso (contenente 0,50% di N) sull'ammonizazione dell'azoto del terreno e del fertilizzante, su tre terreni sommersi, in laboratorio. L'aggiunta di foglie in quantità pari allo 0,15% del terreni non ha alcun effetto. I risultati indicano che le foglie a questi livelli non immobilizzano l'azoto del terreno e dal concime in condizioni di sommersione idrica.

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