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EVALUATION OF SOME CHEMICAL EXTRACTANTS FOR DETERMINATION OF EXCHANGEABLE AMMONIUM IN TROPICAL RICE SOILS[1]

KEY WORDS: Normality, pH, extracting solutions, KCl, Nacl, Morgan's reagent, MgO, rice soils

K. L. Sahrawat[2]

The International Rice Research Institute, Los Banos, Laguna, Philippines

ABSTRACT

Seven rice soils varying in texture, pH, organic matter and total nitrogen content were extracted with 1N and 2N KCl, 1N and 2N Nacl, 10% Nacl at pH 2.5, N CH_3 CooNa at pH 3.0, and Morgan's reagent using a soil: solution ratio of 1:10. The ammonium in the extracts was determined by steam distillation with MgO.

The normality of KCl or Nacl had no significant effect on the amount of NH_4^+ -N extracted but KCl proved a better extractant than Nacl. However, Nacl at pH 2.5 generally extracted significantly higher amounts of NH_4^+ -N as compared to the neutral salt solution. N CH_3 CooNa at pH 3.0 did not extract more NH_4^+ than Morgan's reagent. Overall, KCl

appeared to be better than Nacl; Nacl at pH 2.5 N CH_3 CooNa and Morgan's reagent were either equally effective or better for some of the soils as compared to KCl. However, when recovery of the known amount of NH_4^+-N applied to soils was used as a criterion, the efficiency of these chemicals were in the following descending order:
KCl > NaCl, pH 2.5 > NaCl > CH_3CooNa, pH 3.0 > Morgan's reagent.

INTRODUCTION

The high cost of fertilizer nitrogen in South and Southeast Asian countries coupled with the need for increased yields of rice has stimulated research on methods of using soil and fertilizer nitrogen more efficiently. The measurement of exchangeable NH_4^+ - N in rice soils is an important component of such research.

Various chemical salt solutions like KCl, Nacl, and Morgan's reagent varying both in normality and pH have been used for extracting NH_4^+ - N from souls.[3,4]. Jackson[4] recommended the use of 10% Nacl solution acidified to pH 2.5 for extracting NH_4^+ - N in soils. Recently, Sahrawat and Prasad[5] proposed the use of Morgan's reagent (pH 4.8) for simultaneous extraction of NH_4^+, NO_2^- and NO_3^- - N from soils. However, there are few reports on the comparative value of these solutions for extracting NH_4^+ - N from soils. The work reported in this communication was carried out to compare the commonly used extracting solutions varying in normality and pH for extracting NH_4^+ - N from some rice soils.

MATERIALS AND METHODS

The soils used (Table 1) were selected to obtain a wide range in texture, pH, organic matter and total nitrogen content. The soils used were surface samples (0-15 cm) and they were air dried and ground to pass through a 2 mm sieve before use.

The following solutions were used for extracting NH_4^+ - N from the soils:

1. 2 N Kcl (pH 7.0)
2. 1 N Kcl (pH 7.0)
3. 2 N Nacl (pH 7.0)
4. 1 N Nacl (pH 7.0)
5. 10% Nacl (pH 2.5)
6. CH_3 CooNa - CH_3CooH (pH 4.8) (Morgan's reagent)
7. 1 N CH_3CooNa (pH 3.0)

Morgan's reagent (pH 4.8) was prepared by dissolving 100 g of sodium acetate in about 800 ml of water and adding 30 ml of glacial acetic acid to make to one litre. The pH was then adjusted to 4.8 using dilute NaOH solution or acetic acid (Sahrawat and Prasad[5]). The pH of Nacl (pH 2.5) and CH_3CooNa (pH 3.0) solutions were adjusted using 6 N Hcl.

The following procedure was used for extraction and determination of NH_4^+ - N from the soil samples.

Ten g soil was shaken with 100 ml of the extracting solution

TABLE 1

Analyses of soils used

Soil	pH	Clay %	Sand %	Organic matter %	Total N %
Maahas clay	6.5	46	30	1.6	0.120
Luisiana clay	4.8	44	31	2.6	0.175
Pila clay loam	7.5	39	39	3.9	0.185
Aggaie sandy loam	7.4	17	55	1.0	0.070
Buenavista clay loam	6.3	33	44	1.1	0.070
Calalahan sandy loam	3.4	5	77	2.7	0.110
Paete clay loam	5.3	12	65	10.4	0.350

in a Burrell Wrist action shaker for one h. The soil suspension was then filtered through Whatman NO. 40 filter paper and NH_4^+ - N in the filtrate determined by steam distillation. Twenty ml aliquot of the extract was distilled with 0.2 g of Mg 0 and ammonia absorbed in 2% boric acid with mixed indicator. The absorbed ammonia was titrated with 0.02 N H_2SO_4 to determine the amount of NH_4^+ - N in the samples (Bremner[3]). Blanks were run for all extractants and reagents used. All determinations were made in duplicate.

In case of extracting solutions with low pH, the extracts were first neutralized with dilute NaoH solution by adding the alkali

dropwise using phenolphthalein indicator and then distilled with MgO following the procedure described earlier.

The efficiency of the extracting solutions in recovering NH_4^+ - N added to soils was also compared in an another experiment. In this experiment, 10 g soil samples were treated with 100 ppm of NH_4^+ as $(NH_4)_2\ SO_4$. The samples were flooded with 25 ml of water and equilibrated for 2 h by shaking them on a wrist action shaker after which NH_4^+ - N was extracted using the different extractants. NH_4^+ - N was determined in the filtered extract by steam distillation with MgO as described earlier.

RESULTS AND DISCUSSION

The amounts of NH_4^+ - N extracted by different extracting solutions are given in Table 2. The results indicate that the amounts of NH_4^+ - N extracted by KCl on Nacl were not significantly affected by the strength (2 N or 1 N) of these reagents. KCl was either at par or better than Nacl in extracting NH_4^+ - N from the soils used. However, the pH of the extracting solutions significantly affected the amounts of NH_4^+ - N extracted from different soils used. Thus Nacl solution with pH 2.5 extracted significantly higher amounts of NH_4^+ - N as compared to the neutral salt solution.

In case of Morgan's reagent, the amount of NH_4^+ - N extracted from soils was unaffected by the pH of the reagent (4.8 or 3.0) except in Maahas clay, where the pH 3.0 solution extracted significantly higher amounts of NH_4^+ - N than the pH 4.8 one (Table 2).

TABLE 2

Exchangeable NH_4^+ - N extracted by six solutions from seven soils.

Extractant	NH_4^+ - N (ppm of dry soil)*						
	Maahas clay	Luisiana clay	Pila clay loam	Aggaip sandy loam	Buenavista clay loam	Calalahan sandy loam	Paete clay loam
2 N KCl	12.2ab	24.8a	18.6ab	19.8c	53.5ab	53.9bc	194.2ab
1 N KCl	12.2ab	24.9a	18.6ab	19.8c	53.4abc	53.7c	194.0b
2 N Nacl	12.1ab	23.9bc	17.8c	19.9bc	53.1bc	54.1b	193.6c
1 N Nacl	12.0b	23.6c	17.8c	19.9bc	53.1bc	54.1b	193.3c
10% Nacl (ph 2.5)	12.3ab	24.0b	18.4b	20.3a	53.7a	54.6a	194.4a
Morgan's reagent	12.0b	24.8a	18.6ab	20.2ab	53.2bc	54.5a	194.1ab
1 N CH_3CooNa (ph 3.0)	12.4a	24.8a	18.8a	20.4a	53.5ab	54.6a	194.3ab

*In each column, means followed by a common letter are not significantly different at 5% level based on Duncan's New Multiple Range Test.

In an overall evaluation of these extracting solutions, KCl appeared to be better than Nacl for extracting NH_4^+ - N from the soils used. Nacl at pH 2.5 or Morgan's reagent was either equally effective or better for some of the soils used as compared to KCl. However, KCl (pH 7.0) was the most effective extractant in recovering the NH_4^+ = N added to soils, followed by Nacl (pH 2.5), Nacl (pH 7.0), CH_3CooNa (pH 3.0), and Morgan's reagent (pH 4.8) in the descending order of NH_4^+ - N recovery (Table 3).

It was also observed that as long as the concentration of the cations like Na^+ or K^+ remained between 10 and 20 me/g of soil in the extracting solutions, there was no differential effect of the extraction of NH_4^+ - N from the soils used in this study.

TABLE 3

Recovery of NH_4^+ - N added to soils by five extracting solutions.

Extractant	Recovery (%) of NH_4^+ - N added to soils*				
	Maahas clay	Pila clay loam	Calalahan sandy loam	Luisiana clay	Average
2 N KCl	86.4a	87.7a	90.3a	82.5a	86.7a
2 N Nacl	80.6b	82.6b	80.4cd	80.0a	80.9c
10% Nacl (pH 2.5)	81.3b	84.6b	85.6b	82.0a	83.4b
Morgan's reagent	70.0c	75.3c	76.3d	70.0b	72.9e
CH_3CooNa (pH 3.0)	73.4c	75.2c	82.5 bc	72.1b	75.8d

*In each column, means followed by a common letter are not significantly different at the 5% level.

The results further indicated that the recovery of NH_4^+ - N added to these soils were never quantitative, being from 82.5 to 90.3% when 2 N KCl was used as the extractant. The recovery values were still lower with the other extractant solutions (Table 3). Preliminary studies in this laboratory have shown that these soils fix NH_4^+ - N in a way that a part of the added NH_4^+ - N is rendered unextractable even during equilibration periods of 1 to 2 h.

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2. Present address: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), 1.11.256, Begumpet, Hyderabad 500 016, AP., India

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