ABSTRACT

Use of ^{15}N tracer techniques to evaluate factors affecting interlayer fixation of NH_4^+ and its subsequent release in Trinidadian soils

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A series of laboratory investigations and a green house study were conducted to determine the extent and dynamics of fixation of fertiliser N in a range of agricultural soils using ^{15}N techniques. Existing micro-diffusion procedures as a necessary step in the pre-concentration of exchangeable NH_4^+ and NO_3^--^{15}N were validated, and new procedures for measuring fixed NH_4^+-^{15}N fractions (total, strongly and weakly fixed) were developed. Volume of extract and to a lesser extent quantity of N significantly affected minimal diffusion periods. Recovery of up to 600 μg fixed NH_4^+-N from 5-20 ml and 400 μg exchangeable NH_4^+-N from 10-100 ml soil digests and extracts was quantitative within 96 and 144 hours respectively, when incubated at room temperature (25 ^{0}C). Recovery of approximately 100 μg of NH_4^+-^{15}N was complete between 24 and 72 hours. A new distillation procedure for determining total fixed NH_4^+ was developed, employing 32.5 ml 2M KOH as the distilling agent. This molarity and volume resulted in longer minimal diffusion periods (48-144) for recovery of the recommended 100 μg NH_4^+-^{15}N for CF-IRMS. Soil characterization studies revealed an exceptionally high fixed NH_4^+ content (412 mg kg $^{-1}$) for a micaceous inceptisol (River Estate series). Princes Town, Montserrat, Bejucal and River

Estate soils showed noticeable additional NH_4^+ fixation capacities: 249, 155, 149 and 203 $\mu g\ g^{-1}$ respectively.

Correlations among the soil properties showed that clay content ($r = 0.78$) had the greatest single influence on NH_4^+ fixation. Laboratory incubations investigating the effects of N rate, N carrier, moisture regime, method of fertiliser application and time on NH_4^+ fixation showed fixation to increase linearly with increasing N application rate. Fixation was effected within a few days after fertiliser addition and in all cases N recovery remained < 50 %. All factors significantly affected NH_4^+ fixation. The presence of competing sinks for the NH_4^+ ion such as, nitrification, immobilisation and volatilisation resulted in a decrease in the rate of fixation. Distribution of recently fixed NH_4^+ between strongly and weakly fixed positions favoured the former under experimental conditions with only River Estate experiencing > 5 % ^{15}N in that fraction. The non-acid clay soils (Princess Town and Montserrat series) showed ^{15}N recoveries of > 20 % as NO_3^--N. In green house studies cropping resulted in a slow release of a small portion (13.3 %) of the "recently" fixed NH_4^+ at 42 days after cropping. Potassium (K^+) added after N fertilization resulted in the release of "recently" fixed NH_4^+ being blocked. For agricultural soils with the ability to fix the NH_4^+ ion, the incorporation of this inorganic N pool in the general dynamics of N should be considered where soil fertility management is concerned.