

EFFECT OF pH ON AMMONIUM FIXATION IN SOILS

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Many research reports have pointed out that the pH of the soil considerably influence the fixation of NH_4^+ by clay minerals present in the soils. A significant tendency for NH_4^+ fixation to increase with an increase in PH was reported by Nommik (1957) in more than 200 surface soils of Sweden. Kaila (1962) also observed significant positive relationship between soil pH and NH_4^+ fixing capacity. On the other hand, Page and Ganje (1964) reported that since the exchange sites associated with interlayer spaces of soil clays are primarily due to lattice composition, no distinct effect of pH is expected on NH_4^+ fixation. So the present work is taken up to find out the relationship of soil pH and native fixed NH_4^+ as well as fixed NH_4^+ under 200 ppm of applied N in 21 representative soils of west Bengal.

Materials and Methods

Soils used in the present investigation were collected from surface layers (0-6") from 21 representative regions of West Bengal and were sieved through 2 mm sieve before use. pH was determined by glass electrode pH meter (1:2.5) (Jackson 1958). Native fixed NH_4^+ was determined according to the method of Silva and Bremner (1966), using $\text{K}_2\text{Cr}_2\text{O}_7$ to destruct organic compounds, centrifuging twice with 0.5 M KCl to remove exchangeable NH_4^+ and NO_3^- - N and treating with 5N HF : 1N HCl and shaking 24 hours to destruct the clay minerals and liberate the fixed NH_4^+ . The liberated NH_4^+ is then estimated by distillation.

For fixed NH_4^+ under 200 ppm of applied N, 10 g samples were first treated with 200 ppm of N in the form of $(\text{NH}_4)_2\text{SO}_4$, moistened to field capacity and incubated for 10 days. After incubation, the soils were dried on water bath at 60°C. Alternate wetting with distilled water to field capacity and drying on water bath was carried out three times to induce fixation of applied NH_4^+ . Finally the samples were ground in an agate mortar and fixed NH_4^+ was determined by the method of Silva and Bremner (1956). The results were presented in Table 1. Simple correlations and linear regression equations were done and the results were presented along with Table I.

Results and Discussion

The results presented in Table 1 and statistical analysis clearly reveal that the pH of the soil significantly influenced the native fixed NH_4^+ ($r=0.6616^{**}$) as well as fixed NH_4^+ under 200 ppm of applied NH_4^+ ($r=0.5795^{**}$). These observed results were in conformity of the findings of Nommik (1957) and Kaila (1972).

Under low pH, ions like H^+ , Al^{3+} and Fe^{3+} will dominate the system. H^+ ions, because of their high replacing power, replace other cations in the crystal lattice and occupy the inter lattice positions. According Rich (1960), H^+ ions even in concentrations as low as 1×10^{-5} moles per liter, actively participate in K^+ (or NH_4^+) exchange (in wedge shaped regions around the wedges) and the exchange of K^+ is enhanced by a high H^+ concentration (low pH). The occupation of inter lattice positions by H^+ ions will leave the crystal in some what expanded suite (d (001) spacing of 11.6 Å according to Barashad (1954) so that the subsequently added NH_4^+ neither could effectively replace the strongly bound H^+ ions in the crystal lattice nor contract the crystal lattice. Moreover, in such an expanded state, adsorbed NH_4^+ is accessible, atleast in the vicinity of the adsorbed H^+ , to a replacing cation (Barashad, 1954).

This highly acidic condition may also lead to the partial filling of inter lattice spaces (where NH_4^+ is likely to get fixed) with $\text{Fe}(\text{OH})_3$, $\text{Al}(\text{OH})_3$ or difficultly exchangeable Fe^{3+} or Al^{3+} . This will result in blocking of fixation of NH_4^+ . This occupation by Al^{3+} or Fe^{3+} may also result in reduction of the collapsibility of the lattice. So these factors will result in decreased fixation of NH_4^+ under acidic (low pH) conditions. Similar observations were reported by Joffe and Levine (1947), Rich (1960), Rich and Thomas (1960), Sawhney (1960) and Vander Marel (1954).

When the pH of the soil is high, H^+ , Al^{3+} and Fe^{3+} are neutralised from the adsorbed positions by cations like Ca^{++} , Mg^{++} , Na^+ etc. and so will naturally increase the fixing ability of the soils. This hypothesis was also supported by Stanford (1948), Nommik (1957) and Karlsson (1952).

The effect of pH also varies with the nature of the associated cation. For example, Mg^{++} ions will "prey open" the lattices and thus assist the entry of protons. The principle of exchange by MgCl_2 was ascribed by Rich (1964) to the H^+ ions released by Hydrolysis of exchangeable Fe^{3+} and Al^{3+} , rather than direct exchange of K^+ (or NH_4^+) by Mg^{++} . NH_4^+ fixation especially at edges, would therefore be favoured at a high pH and they would be released at a low pH because of proton exchange (Rich,

Table I

Effect of pH on the native fixed NH_4^+ and fixed NH_4 under 200 ppm applied N

X	Y_1 Native fixed NH_4^+ m. c./100 g	Y_2 Fixed NH_4 under 200 ppm applied N m. e/100g
5.7	0.63	0.85
6.3	0.61	0.69
6.6	1.16	1.57
5.9	0.77	0.96
7.0	0.77	1.41
5.4	0.73	1.15
6.0	0.78	1.15
6.7	0.91	1.33
5.1	0.66	1.03
5.6	1.58	2.45
7.1	0.70	0.78
7.4	1.86	2.08
8.3	1.63	2.05
6.8	1.67	2.11
7.4	2.28	2.87
7.0	1.78	2.37
6.9	1.93	2.11
7.6	2.20	2.86
7.5	1.27	2.20
7.4	7.06	2.26
8.3	1.96	2.10

1. pH and native fixed NH_4 $r = 0.6616^{**}$ $Y_1 = (-1.6299 + 0.4378)x$

2. pH and fixed NH_4^+ under 200 ppm N. $r = 0.5795^{**}$ $Y_2 = (-1.2699 + 0.4440)x$
 $n = 21$

The regression equation of pH and native fixed NH_4^+ was found to be $Y = (-1.6299 + 0.4378)x$, and for fixed NH_4^+ under 200 ppm applied N was $Y = (-1.2699 + 0.4440)x$. These regression coefficients suggest that for the arable soils of west Bengal it is possible to calculate the native fixed NH_4^+ based on pH values $[(-1.6299 + 0.4378)\text{pH}]$ and also possible fixation under usual maximum dose of applied N i. e. 200 ppm $[(-1.2699 + 0.4440)\text{pH}]$.

Summary

The effect of pH on native fixed NH_4^+ as well as fixed NH_4^+ under 200 ppm applied N was studied in 21 representative soils of West Bengal. A significant positive correlation was observed between pH and native fixed NH_4^+ ($r=0.6616^{**}$) and also with fixed NH_4^+ under 200 ppm applied N ($r=0.5795^{**}$). Regression equation for native fixed NH_4^+ was found to be $y=(-1.6299+0.4378)\text{pH}$ and for fixed NH_4^+ under 200 ppm applied N, $y_2=(-1.2699+0.4440)\text{pH}$.

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സംഗ്രഹം

മണ്ണിൽ സ്വതന്ത്ര ബന്ധിക്കപ്പെട്ടിട്ടുള്ള അമോണിയത്തിന്റേയും ദശലക്ഷത്തിൽ 200 ഭാഗം നൈട്രജൻ മണ്ണിൽ പ്രയോഗിച്ചപ്പോൾ ബന്ധിക്കപ്പെട്ട അമോണിയത്തിന്റേയും മണ്ണിലെ അമ്ളക്ഷാരമാനമനുസരിച്ചുള്ള പ്രതികരണം മനസ്സിലാക്കാനായി പശ്ചിമബംഗാളിലെ വിവിധഭാഗങ്ങളെ പ്രതിനിധാനം ചെയ്യുന്ന 21 മണ്ണിനങ്ങൾ പഠനവിധേയമാക്കപ്പെട്ടു. ഈ പഠനത്തിൽനിന്നും അമ്ളക്ഷാരമാനം (pH) മണ്ണിൽ സ്വതന്ത്ര ബന്ധിക്കപ്പെട്ടിട്ടുള്ള അമോണിയത്തിന്റേയും മണ്ണിൽ നൈട്രജൻ പ്രയോഗിക്കുമ്പോൾ ബന്ധിക്കപ്പെടുന്ന അമോണിയത്തിന്റേയും വ്യക്തമായും സ്വാധീനിക്കുന്നതായി കണ്ടു.

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