335/38

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Research Abstract

Background

The soils of Bangladesh are generally considered to be high in potassium because of the prevalence of micas and other potassium-rich minerals. Yet there is some concern that potassium fertility will become an increasing problem in Bangladesh because of (1) the very strong potassium fixation characteristics of the Bangladesh soils, and (2) the depletion of readily available potassium attributable to the generally low potassium fertilization rates and the removal of potassium during intense cropping. These experiments are designed to evaluate of overall potassium status of Bangladesh soils and the likelihood of short-term and long-term problems due to potassium depletion. The experiments are performed under both oxidized and reduced (flooded) conditions due to the important role of soil redox potential on the reactions of soil potassium.

The following experiments were done under the above title:

Potassium solubility experiments:
The **first experiment** was carried out with two soils from Faridpur and Brahmanbaria of Bangladesh to see the effect of reaction time (5 to 40 days) on soil redox potential and solubility of native K upon incubation of aqueous soil suspensions under reduced conditions. The redox potential decreased to -236mV in Faridpur soil and -223mV in Brahmanbaria soil. The soluble Fe content increased after 10 days in Faridpur soil while it did after 5 days in Brahmanbaria soil and later remained static at least till 20 days. The level of soluble Fe was higher in Faridpur soil than in Brahmanbaria soil. Soluble K slightly decreased after 5th day in Faridpur soil and increased over time in Brahmanbaria soil. The same trend was also found for ammonium extractable K for both the soils, respectively.

The **second experiment** consisted of 25 soils, five each from five upazilas of Bangladesh viz. Paba, Brahmanbaria, Tala, Faridpur and Senbag to see the native K solubility under both oxidized and reduced conditions. The amounts of soils released on water extract or extracted by ammonium acetate extract were variable both among the upazilas and within the upazilas. In general, Tala and Faridpur soils had higher values than the others. The Reduced soils released more K than oxidized ones in 80% cases of Paba and Brahmanbaria, 60% of Faridpur and Senbag and 40% in Tala soils. For ammonium acetate extractable K, 80%, 60% and 40% soils of Paba, Brahmanbaria and Tala respectively, extracted more K in reduced soils while rest soils of these upazilas and all

soils of Faridpur and Senbag upazilas extracted more K in oxidized samples over reduced samples.

Potassium adsorption isotherm experiments:

The **third experiment** was carried out with two soils from Faridpur and Brahmanbaria of Bangladesh to see the effect of different potassium concentration on solubility/adsorption of K upon incubation of aqueous soil suspensions under reduced and oxidized conditions. There were twelve levels of K viz.: 0, 0.4, 1, 2, 3, 4, 6, 8, 10, 12, 16 and 20 $cmol_c\ kg^{-1}$.

With increase in concentration of added K, the amounts K adsorbed by both soils increased progressively. For each soil, reduced condition adsorbed more than oxidized ones while Faridpur soil adsorbed more K than Brahmanbaria soil did. ie the order of K adsorption amount is Faridpur reduced > Faridpur oxidized > Brahmanbaria reduced > Brahmanbaria oxidized. Rate of adsorption remained constant over increasing K addition within 76 to 88% in Faridpur reduced samples but decreased to 53% on higher K addition. For Brahmanbaria soils, the reduced ones had 72% to 40% while in oxidized samples it was from 76 to 26% with increasing K addition.

Some of the added K was even fixed in clay lattice (not extracted by ammonium acetate extraction). The amount of K fixation was high in Faridpur reduced samples followed by Brahmanbaria reduced samples. Both soils fixed low amounts of K in oxidized condition. Rate of K fixation remained constant at a scale of 30% only in case of Faridpur reduced samples. In other cases it was decreased with increasing K addition. Initially, K was released instead of fixation up to 1 $cmol_c\ kg^{-1}$ addition for Faridpur soil and up to 0.4$cmol_c\ kg^{-1}$ addition for Brahmanbaria soil.

Observing the result of the third experiment, the **fourth experiment** was set up with lower levels of potassium concentrations (0, 0.4, 0.8, 1.2, and 1.6 $cmol_c\ kg^{-1}$), five soils each from five upazilas of Bangladesh. With increase in concentration of added K, the amounts K adsorbed by all soils increased progressively. However, marked difference between oxidized and reduced soils was not observed. Rate of adsorption remained constant over increasing K addition over 80% in both oxidized and reduced samples of Paba upazila and reduced samples of Faridpur upazila and over 70% in oxidized samples of Faridpur upazila, around 50-60% in reduced samples of Brahmanbaria upazila. The rate decreased with increasing K addition was observed in both oxidized and reduced samples of Senbag upazila and oxidized samples of Brahmanbaria upazila while it was increased with increasing K addition in both oxidized and reduced samples of Tala upazila.

Some soils showed K fixation behavior while others showed K release while considering the total extracted K by water and ammonium acetate extractions in relation to the added K. Except K addition at 0.4cmol kg^{-1}, the soils of Paba, Brahmanbaria and Senbag showed K fixation on small scale with increasing K addition in both oxidized and reduced condition with exception of Senbag soil which also fixed in 0.4 4cmol kg^{-1} K addition. On the contrary, both Tala and Faridpur soils released K in a decreasing trend

with increasing K addition in both oxidized and reduced condition. The magnitude of K release was much higher in Tala soil than Faridpur soil.

Zinc experiment

The **fifth experiment** was done with a micronutrient Zn. The objective was to evaluate the fate of added Zn in reduced environment. A soil from Faridpur upazila of Bangladesh having 228.5mmol kg^{-1} soil of total Fe oxide and 44mmol kg^{-1} soil of poorly crystalline Fe was selected for this study. Eight levels of S (0, 25, 50, 75, 100, 150, 200 and 250 mmol kg^{-1}) and two levels of Zn (0 and 0.3 mmol kg^{-1}) were added to soils as solution of K_2SO_4 and $ZnCl_2$, respectively. More than 95% added Zn was adsorbed in all S levels.

Mineralogical composition:

The **sixth experiment** consisted of particle size distribution and mineralogical composition of 25 soils collected from different regions of Bangladesh comprising variable agroecological conditions. Fine textures (silty clay loam, silty clay and clay) were observed in High Ganges River Floodplain, Ganges Tidal Floodplain, Level Barind Tract and North-Eastern Piedmont Plain soils while others were of medium textured (loam and silt loam).

Mica was the predominant clay minerals along with smectite in High Ganges River Floodplain, Ganges Tidal Floodplain and Lower Meghna River Floodplain soils; with kaolinite and interstratified kaolinite-smectite in Level Brand Tract and Madhupur Tract soils, chlorite in Old Himalayan Piedmont Plain and Tista Meander Floodplain soils and with kaolinite in Eastern Surma Kushiyara Floodplain and North-Eastern Piedmont Plain soils.

Salinity experiment:

The **seventh experiment** was done with surface and sub-surface samples of five soils collected from the coastal areas of Bangladesh. Electrical conductivity (EC) and anion concentration of the soils were determined using a soil:ratio of 1:5 while the EC and cation contents were determined from the saturation paste. The EC values of 1:5 soil : water ratio were ranged from 0.7 to 7.2 dS m^{-1}, while the same of saturated paste were 4.9 to 44 dS m^{-1}. Variable amounts of chloride, fluoride, nitrate and phosphate were found in all soils, while sulphate ions were found in most of the soils. The chloride contents were well correlated with the EC values of the soils. Variable amounts of Ca, Mg, Na and K were observed in saturation paste extract.

Concluding remarks:

Scientific information generated through seven experiments on Bangladesh soils has both theoretical and practical utilities towards development of Bangladesh agriculture, improvement of my professional skills and development of science as a whole. A conference paper has been submitted and three journal papers are under preparation. I am grateful to IDB for providing the fellowship for doing post doctoral research in USA.