STUDIES ON COPPER IN SOME ALKALI AND ADJOINING SOILS OF UTTAR PRADESH

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Samples of three alkaline soils of Uttar Pradesh and of their adjoining soil profiles were analysed for total and available copper contents. The average total and available contents were 49·2 and 0·47 ppm in alkaline soils and 71·2 and 0·88 ppm in adjoining soils respectively. It was found that the available copper bore a significant positive correlation to the total copper and the organic carbon contents in both the soil types. However, no significant correlation was found between the available copper contents, the *p*H and the clays of the soils in either of the soil types. The available copper contents showed a significant positive correlation in alkaline soils and a significant negative correlation in the adjoining soils to the calcium carbonate contents in them.

INTRODUCTION

According to Brun (1945), copper in a soil exists in three forms, namely in water soluble, in exchangeable and in fixed copper forms. The availability of copper depends on the amount bound by exchange mineral materials and by organic complexes of both exchangeable and insoluble forms. The retention of copper in an alkaline soil is affected both by organic matter and by soluble carbonate. When the amount of organic matter present is relatively small, the retention of copper is mainly due to its precipitation with sodium carbonate (Tobia and Hanna 1958).

The total content of copper in a soil does not indicate the amount of copper available to plants growing on it (Gilbert 1952). Various soil factors, such as *p*H, calcium carbonate, organic matter and finer fractions of the soil, influence the availability of copper to plants as can be seen from the following discussion.

In the present investigation, the copper status of some alkaline soils of the U.P. and of their adjoining soil profiles were evaluated with a view to studying their distribution pattern and the possible effects of different soil factors on copper availability.

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Experimental

Samples from three alkali soil profiles as well as from their adjoining cultivated fields were collected from the following districts of Uttar Pradesh, viz. Ballia, Jaunpur and Varanasi. Genetically, all the soils were Gangetic alluvium affected by salinity and alkalinity.

The total and available amounts of copper were extracted from the soils by digestion with perchloric acid (Holmes 1945) and by treatment with N-ammonium acetate (Iyer and Satyanarayana 1958) respectively. They were determined colorimetrically by carbamate method as described in Jackson (1958).

Results and Discussion

The analytical data pertaining to the total and the available copper contents in the alkaline soils and in their adjoining soil profiles are given in Table I. Texture, $CaCO_3$ and pH were presented in an earlier paper (Singh and Singh 1966). In general, both the forms of copper followed a similar distribution trend irrespective of the nature of the soil types and bore no definite relation to the depth of the profiles.

In alkaline soils, the total copper content ranged from 29·1 to 83·2 ppm with an average of 49·2 ppm and the available copper content varied from 0·26 to 0·75 ppm with an average of 0·47 ppm. The corresponding figures for the adjoining soils are: 51·3 to 93·1 ppm with an average of 71·2 ppm for total content of copper and 0·61 to 1·15 ppm with an average of 0·88 ppm for the amount of available copper. The average values for both the forms of copper reported in the present investigation are nearly similar to those reported by Swaine (1955) and by Neelkantan and Mehta (1961). According to the tentative limit of available copper from 0·5 to 1·0 ppm in copper deficient soil, as suggested by Johnson and Graham (1952), all the soils were copper deficient.

The percentage of available copper to the total copper content (Table I) lay in a short range of (0·76–1·16) in alkaline soils and in a range of (0·91–1·38) in adjoining soils, indicating apparently a positive relationship between the available and the total copper contents. Statistical analysis of the data for the two factors also shows a significant positive correlation ($r = +0{\cdot}86$) in both the types of soil profiles. Donchev (1959) had found a similar result in some mineral and peat soils.

From Table II it can be seen that the content of available copper increases with soil pH to a certain limit and that it decreases with further increases in pH in both the types of soil profiles. This curvilinear relationship between the available copper content and pH can be explained on the basis of the conclusion arrived at by Tobia and Hanna (1958), viz. that in alkaline soils with relatively small quantities of organic matter, copper is retained in

TABLE I

Total and available copper in alkaline soils and in their adjoining soil profiles

Depth (cm)	Copper (ppm) Total	Copper (ppm) Available	% available of total Cu
1. *Abhanpur (Ballia)—Alkali soil*			
0–5	29·2	0·34	1·16
5–25	58·3	0·58	1·00
25–51	53·5	0·36	1·07
51–89	32·6	0·36	1·10
89–127	33·1	0·48	1·45
127–165	61·3	0·58	0·95
165–188	49·8	0·60	1·20
2. *Abhanpur (Ballia)—Adjoining soil*			
0–20	86·2	1·15	1·38
20–51	58·1	0·80	1·38
51–81	68·4	0·93	1·36
81–122	51·3	0·69	1·35
122–165	62·3	0·70	1·12
165–183	67·2	0·61	0·91
3. *Lagdharpur (Jaunpur)—Alkali soil*			
0–5	29·1	0·30	1·13
5–20	70·5	0·54	0·77
20–51	58·6	0·56	0·96
51–81	60·2	0·64	1·06
81–112	83·2	0·75	0·90
112–157	50·1	0·56	1·12
4. *Lagdharpur (Jaunpur)—Adjoining soil*			
0–15	93·1	1·12	1·20
15–48	76·2	0·95	1·25
48–89	74·1	0·90	1·21
89–132	76·7	0·88	1·15
132–165	66·1	0·82	1·24
5. *Korajpur (Varanasi)—Alkali soil*			
0–5	31·2	0·26	0·84
5–30	56·3	0·50	0·89
30–61	50·1	0·46	0·92
61–91	53·2	0·47	0·88
91–127	58·2	0·46	0·79
127–168	46·6	0·38	0·82
168–191	39·5	0·29	0·76
6. *Korajpur (Varanasi)—Adjoining soil*			
0–25	86·4	1·06	1·16
25–61	78·3	0·98	1·25
61–91	75·4	0·94	1·25
91–122	68·2	0·80	1·17
122–152	65·2	0·88	1·33
152–178	56·6	0·72	1·27

the soil due to its precipitation as basic carbonate. Statistical analysis of the data for the two factors did not show any significant correlation in the alkaline ($r = +0{\cdot}14$) and in the adjoining soil profiles ($r = -0{\cdot}27$). However, several investigators (Millar 1955; Reuther 1957) had reported a positive relationship between the two factors.

The ranges of organic carbon and of available copper are given in Table II. It will be seen that available copper shows significant positive correlation to organic carbon in the alkaline ($r = +0{\cdot}86$) and in the adjoining soil profiles ($r = +0{\cdot}56$) respectively. Similar results were reported by Lees (1948).

Bryan (1929) had observed that high calcium carbonate content in soils suppressed the availability of copper. Under the present investigation, it can be seen that available copper (Table II) shows a significant positive correlation ($r = +0{\cdot}51$) to calcium carbonate in alkaline soils, while it shows a significant negative correlation ($r = -0{\cdot}66$) in adjoining soils.

In the present investigation, relationship between available copper and clay contents of the soil was studied. The result did not show any significant correlation between the two factors either in alkaline ($r = -0{\cdot}09$) soils or in their adjoining soil profiles ($r = -0{\cdot}07$). However, Gilbert (1949) had found that copper deficiency occurred most frequently in very sandy and gravelly soils.

TABLE II

Copper affected by various soil factors

(Average in ppm)

*p*H range	Available copper		Organic carbon range %	Available copper	
	Alkali	Adjoining		Alkali	Adjoining
7·2–7·6	—	0·90	0–0·1	—	—
7·7–8·1	0·40	0·92	0·2–0·3	0·34	—
8·2–8·6	0·48	0·78	0·4–0·5	0·56	0·75
8·7–9·1	0·53	—	0·6–0·7	0·58	0·90
> 9·1	0·42	—	> 0·7	0·60	0·99

$CaCO_3$ range %	Available copper		Clay range %	Available copper	
	Alkali	Adjoining		Alkali	Adjoining
0–1	0·43	0·93	0–10	0·36	0·94
1–2	0·37	1·15	10–20	0·57	0·92
2–10	0·85	0·89	20–30	0·46	0·80
10–20	0·58	0·81	30–40	0·46	0·85
> 20	0·60	0·65	> 40	0·47	—

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