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EFFECT OF LIMING IN A LATERITIC SOIL AND DELIMING IN A BLACK CALCAREOUS SOIL ON MANGANESE AVAILABILITY

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The supply of micronutrients in optimum doses is one **of** the many factors which contribute to high crop yietds. In the **case** of Mn, it has been shown that the black soils with montmorillonitic clays contain few amounts of water-soluble and exchangeable Mn and high amounts of the active Mn. On the other hand the lateritic soils are relatively low in the active form of Mn and high in the water-soluble and exchangeable form. Daji (1948) has shown that one of the factors contributing to the incidence of *band* disease of areca palms in coastal soils of the Maharashtra state is the toxic accumulation of available Mn in the soil. The condition of the palm is reported to have been improved *by* the application of copper sulphate and lime in conjunction with organic manures to the soil (Joshi and Joshi, 1954).

Studies on the effect of graded doses of lime ($CaCO_3$) on the availability of Mn in lateritic soils and the effect of deliming (removal of $CaCO_3$) of calcareous soils on the availability of this element have not been carried out in India. The present study was, therefore, carried out with a view to assess the effect of liming on Mn availability in a soil {pH 5.6) developed under conditions of intense humid tropical weathering and of deliming the medium black calcareous soil (vertisol) of pH 7,4 developed from basaltic rocks in a semi-arid environment.

The beneficial effect of liming on the availability and uptake of Mn by plants in acid soils has been studied in detail by several workers (Fujimoto and Sherman, 1948; Christensen *et al.* 1950; Reiman, 1962 and Schutte, 1964). The increased mobility of Mn in soil in presence of phosphatic material has been reported by Bingham and Garber (1960) and Page *etal.* (1973). The utility of sulphur in the correction of lime-induced Mn deficiency has been recorded by many workers (Fujimoto and Sherman, 1948; Vavra and Frederick 1952; and Schutte, 1964).

Materials and Methods

The lateritic soil for the experiment was treated with increasing quantities of lime in conjunction with phosphorus, while the calcareous soil was treated with increasing quantities of sulphur. Exchangeable Mn and pH were

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determined on the soils thus treated. Neubauer's tests were also carried out simultaneously using wheat as test plant. The plants grown under different soil treatments were analysed for the Mn content. The lime requirement of the lateritic soil was determined by the Hutchinson and Maclennan method (1914) which was found to be 3410 Kg/ha. Fifty gram lots of the lateritic soil were weighed out in glass containers and treated with $CaCO_3$ corresponding to $\frac{1}{2}$, 1, $1\frac{1}{2}$ and 2. lime requirement of the soil. One of the treatments was $CaCO_3$ equivalent to one lime requirements plus KH_2PO_4 equivalent to phosphate-fixing capacity of soil. They were maintained at field capacity for 10 days on wheat seeds at the rate of 55 were sown in each container. There were four replications and one of these was set aside for the determination of exchangeable Mn at the end of the Neubauer's test.

In the case of medium black calcarecus soil a buffer curve was constructed (Jackson, 1958) by treating 10 g portions of the soil with increasing quantities of normal H_2SO_4 (Figure 1). From this, the quantities of sulphur required to bring down the pH of the soil from 7.4 to about 4.5 in 50 g soil were calculated. These amounts of sulphur were then added to 50 g lots of the soil and the different lots of treated soils were maintaind at field capacity for 10 days and wheat seeds were sown (55 seeds per container). There were 5 repiications and one of these was set aside for determining exchargeable Mn in the soil at the end of the experiment.

In both soils at the end of 21 days' growth, the plants were removed washed free of the adhering soil, dried in filter paper and weighed. These were then oven-dried and the weights were recorded replicate-wise. The plants were analysed for Mn content (Piper, 1950).

Results and Discussion

It is clear that application of increasing quantities of $CaCO_3$ in the lateritic soil led to a progressive decrease in the exchangeable Mn (Fig. 2) as indicated from the slope of the graph 'a' and to an increase in the pH values as will be seen from the graph 'b'. This can be explained as due to the antagonism between calcium and the manganese ions. Similar findings have been recorded by Mann (1930) and Sanchez and Kamprath (1959). Fixation of Mn by adsorption on the surface of the $CaCO_3$ particles is already recorded by Boischot and Durroux (1949). This binding is strong enough and Mn cannot be released with neutral ammonium acetate. Combined application of lime and phosphate resulted in an increase in the exchangeable Mn in lateritic soil. This is in agreement with the observations made by Walsh *et al.* (1950) and Berina (1961) The results of Neubauer's test using wheat as test plant (Table 1) showed a significant reduction in dry-matter production and a decrease in the uptake of Mn by plants as a result of liming of lateritic soil, AH the doses of lime application have significantly depressed the

production of dry matter by wheat plants over the control. Between the different treatments, there was no significant differences in dry matter production. Amongst the individual treatments, the lime applications have significantly decreased the uptake of Mn by the plants over the control. Between different lime doses, there is a significant decrease in the manganese uptake between half lime requirement and the other three doses. Oxidation of soluble Mn to higher oxides is responsible for the observed effect of liming. Hewitt (1945) considered calcium as an elemento that antagonises the uptake of Mn by the plant. Biswas (1963) observed that with increasing pH consequent on liming the soil, Mn^{++} is converted into manganic oxides (Mn^{3+} and above) which are water insoluble and cannot be extracted with neutral N ammonium acetate.

Table 1

Effect of graded dose of iime on the dry matter content and uptake of manganese by wheat crop grown in lateritic soil.

Sl. no.	Treatments	Dry matter in g per 50 plants	Uptake of Mn in mg. per 100 g of oven-dry plant material.
1	Soil alone	1.67	14.43
2	Soil + $\frac{1}{2}$ LR	1.35	13.65
3	Soil + 1 LR	1.38	12.27
4	Soil + 11 LR	1.36	11.75
5	Soil + 2 LR	1.43	10.35
6	Soil + 1 LR + P_2O_5	1.40	14.87

LR—Lime Requirements.

Remarks: Differences between different treatments are statistically significant.

Table 2

Effect of graded doses of sulphur on the dry matter content and uptake of manganese by wheat crop grown in medium black calcareous soil.

Sl. No.	Treatments	Dry matter in g per 50 plants	Uptake of Mn in mg per 1CO g of oven–dry plant material
1	Soil alone	2.01	5.63
2	0.112 g of Sper 50g of soil	2.02	6.00
3	0.223 ,,	1.91	7.00
4	0.334 ,,	2.08	7.48
5	0.446 ,,	2·01	9.08
6	0.541 ,,	2.12	10.08
7	0.636 ,,	2.13	10.76

Remarks: Differences between treatments are statistically significant.

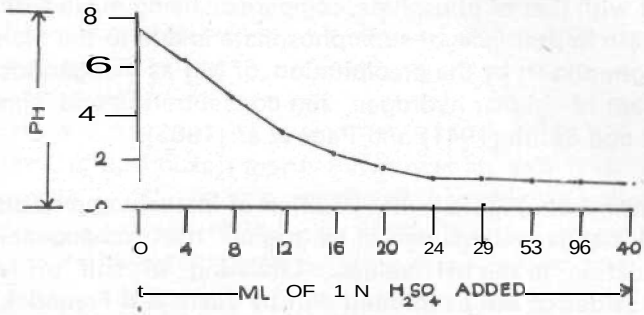

FIG. 1 RELATION BETWEEN PH AND H_2SO_4 ADDITION TO MEDIUM BLACK CALCAREOUS SOIL (BUFFERCURVE)

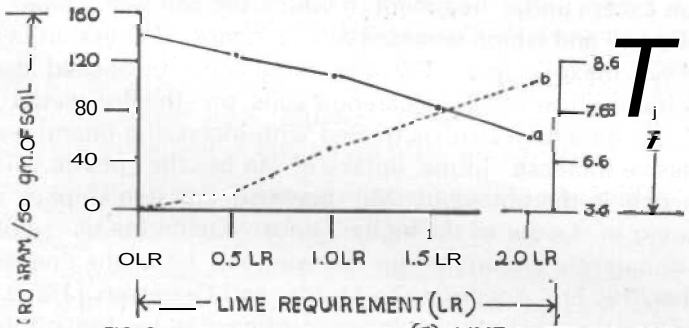

FIG. 2 RELATION BETWEEN (a) LIME ADDITION AND EXCHANGEABLE Mn IN LATERITE SOIL (b) LIME ADDITION AMD PH

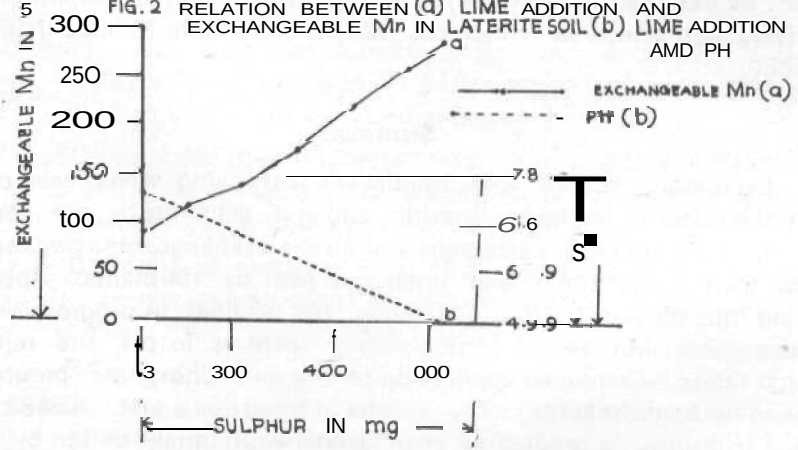

FIG. 3 RELATION BETWEEN (a) SUPHUR APPLICATION AND EXCHANGEABLE Mn IN MEDIUM BLACK SOIL (b) SULPHUR APPLICATION AND PH

There is, however, an increase in the uptake of Mn when the application of lime is combined with that of phosphate, comparison being made with control. The increased uptake of Mn in presence of superphosphate is due to the more favourable chemical state brought about by the precipitation of Mn as manganous phosphate in a local environment of higher hydrogen ion concentration and agrees with the findings of Albrecht and Smith (1941) and Page *et al.* (1963).

It will be seen from Figure 3 that addition of increasing amounts of sulphur in medium black calcareous soil resulted in increasing the exchangeable Mn, with *a* corresponding reduction in the pH values. Lowering of soil pH results in the reduction of higher oxides of Mn as pointed out by Vavra and Frederick (1952) and become available for plants. The results of Neubauer's test using wheat as test plant (Table 2) reveal that deliming of calcareous soil has not affected the dry-matter production exceptunder treatment in which the soil was treated with 0,223g of sulphur per 50g soil and which recorded a significant depression in dry matter production. This is inexplicable. Til! date there is no published data regarding the effect of sulphur application to calcareous soils on the dry matter or yield of crops. When the medium black soil is treated with increasing quantities of sulphur, there is a progressive increase in the uptake of Mn by the plants. There is also significant difference in the uptake of Mn between any two sulphur applications, the difference being in favour of the higher dose. Oxidation of sulphur or acid production was apparently important for releasing Mn from the unavailable forms (Garey and Barber, 1952). According to Mulder and Gerretsen (1952) the beneficial effect of treating the soil with sulphur is often due to formation of pockets of relatively high acidity in which the Mn becomes more soluble than in the bulk of the soil.

Summary

Laboratory studies and Neubauer's tests using wheat were conducted to to study the effect of liming in tsteritic soil and deliming by the application of sulphur in medium black calcareous soil on the exchangeable manganese in the soils, dry matter production and uptake of Mn by the plants. Application to increasing quantities of $CaCO_3$ in lateritic soil resulted in a progressive decreasef in exchangeable Mn with a corresponding increase in pH, the relation being somewhat linear. Combined application of lime and phosphate brought about *an* increase in exchangeable Mn. The results of Neubauer's lest showed a significant reduction in dry-matter production with decrease in uptake of Mn by wheat. The combined application of lime and phosphate has resulted in a significant increase in the uptake of Mn. Treatment with graded doses of sulphur in calcareous soil resulted in increasing the exchangeable Mn with corresponding depression of pH values. In general sulphur application has not effected the dry-matter production by wheat plants. There is a progressive increase in the uptake of Mn by plants grown in sulphur treated soils.

സംഗ്രഹം

വെട്ടുകൽ ഇനം മണ്ണിലും കറുത്ത കാൽക്കേറിയസ് ffisltu. മാൻഗനീസിന്റെ വിനിമയ പ്രക്രിയയെപ്പറ്റി ലബോറട്ടറി പരീക്ഷണങ്ങളും, ഗോതമ്പു ചെടി പരീക്ഷണ വിളയായി ന്യൂബാർ രീതിയിലുള്ള പരീക്ഷണങ്ങളും rosttrnnt . ആദ്യത്തെ ഇനം മണ്ണിൽ ചുണ്ണാമ്പ് കല്ല് ചേർത്തപ്പോഴും ഗന്ധകമാണ് രണ്ടാമത്തെ ഇനം മണ്ണിൽ പ്രയോഗിച്ചത്. ചുണ്ണാമ്പു കല്ല് ക്രമമായി (graded dose) ഇടുമ്പോഴും, വെട്ടുകൽ മണ്ണിൽ വിനിമയ മാഗനീസിന്റെയും അമ്ലാംശത്തിന്റെയും തോതു കുറയുന്നതായി കാണപ്പെട്ടു. ഈ അവസ്ഥയിൽ ഗോതമ്പു ചെടി ആഹരിച്ചെടുത്ത മാൻഗനീസിന്റെ തോതും ക്രമമായി കുറഞ്ഞിരുന്നു. എന്നാൽ കുമ്മായവും ഭാവഹവും കൂട്ടിചേർത്ത് പ്രയോഗിച്ചപ്പോൾ മേൽപറഞ്ഞതിൽ നിന്നും വിപരീത ഫലമാണ് കിട്ടിയത്. കറുത്ത മണ്ണിൽ ഗന്ധകം ക്രമമായി ചേർത്തതിന്റെ ഫലമായി മണ്ണിലെ വിനിമയ മാഗനീസ്, അമ്ലാംശം, ചെടികളം ആഗിരണം ചെയ്ത മാഗനീസ് എന്നിവയുടെ തോതു ക്രമമായി വർദ്ധിച്ചു.

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