

SUMMARY

The aim of this investigation was to study (a) the effect of phosphorus fertilizers on availability of ferrous and ferric, (b) the role of CaCO_3 and other soil constituents factors in iron nutrition, and (c) identify the predominant Fe-containing compounds formed under high pH and phosphorous concitions. Three studies were conducted to satisfy these objectives.

To accomplish the first objective, greenhouse and laboratory pot experiments were conducted.

The greenhouse experiment:

Ferrous-or ferric-sulfate was banded alone or with Phosphate fertilizers [urea phosphate (10-30-0), urea phosphate sulfate (10-30-0-7S), diammonium phosphate (DAP), and mono calcium phosphate (MCP] in an Fe-deficient soil collected from Texas, USA. The Fe rates were 0, 25, and 50 mg kg^{-1} and P rates were 0, and 50 mg kg^{-1} . Dry matter yield and nutrient uptake by sorghum plants were measured and the residual effects were determined on a second succeeding sorghum crop. The results obtained from the experiment can be briefly summarized as follows.

- (1) The Fe application alone had little effect, but when banded together with P fertilizers it more effectively increased dry matter yield, and Fe, Mn and Zn uptake.
- (2) Addition of P fertilizers with FeSO_4 increased the DTPA-extractable soil Fe in the following order: DAF > 10-30-0 > 10-30-0-7S > MCP.

- (3) The addition of P fertilizers also increased NaHCO_3 -extractable soil P, but decreased the DTPA-extractable soil Mn and Zn.
- (4) The ferrous Fe source was generally more effective than was the ferric Fe source.
- Ferrous and Ferric sulfate availability was enhanced by banding with P fertilizers.

The laboratory experiment:

The effect of P fertilizers (10-30-0, 10-30-0-7S, DAP, and MCP) on movement and availability of Fe from a fertilizer band was determined. Also, effect on soil pH and availability of native soil Mn and Zn was determined. The fertilizers were banded at a rate of 50 mg P kg^{-1} with 25 mg Fe kg^{-1} as FeSO_4 and incubated at field capacity (F.C.) moisture and 25°C in a closed system for 35 days. An Fe deficient calcareous soil (Clareville fsl Pachic Argiusto I) was used in this study.

The following is the summary of the results:

- (1) The soil pH in the fertilizer band was decreased from 0.2 to 0.4 pH unit by P fertilizers after 7 days incubation and decreased slightly further at 35 days. This influence of P fertilizers on soil pH extended as far as 2.0 cm from the band.
- (2) The quantity of extracted Fe tended to increase somewhat with time to 35 days. The DAP source tended to be the most effective on extractable-Fe.
- (3) Extractable Mn and Zn tended to decline with time of incubation. Extractable-Fe decreased with increasing distance from the band and movement was restricted to about 1.5 cm.

To achieve the second objective a separate study was conducted to relate the specific soil factors to Fe availability to soybean on calcareous soils. Soybean [glycine max (L.) Merr.] was grown in a growth room in sand-soil mixture using 27 soils, collected from Egypt and USA (Texas), that were selected to give a wide range of Fe oxide and CaCO_3

content. The Fe-deficiency stress was measured by using visual chlorosis evaluations in addition to chlorophyll, Fe concentration and Fe uptake.

Results of this experiment showed the following:

- (1) Degree of iron chlorosis was negatively correlated with DTPA-extractable Fe and amorphous iron oxide content, but it was positively correlated with CaCO_3 content and its size fraction, clay-size fraction, and fine-clay size fraction of CaCO_3 .
- (2) The iron uptake and dry matter yield were negatively affected by CaCO_3 content.
- (3) The DTPA-extractable Fe positively correlated with amorphous Fe-oxide content ($r = 0.869$). The DTPA-extractable Fe is thus a relatively good quantitative indicator of the Fe-oxide phase.

To satisfy the third objective, ferric perchlorate and sodium dihydrogen phosphate at different P:Fe molar ratios were mixed as aqueous solutions, and the pH was increased to approximately 8.0 by either titration with NaOH or reaction with solid-phase CaCO_3 . The resulting Fe phosphate and Fe hydroxide products were analyzed by powder x-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), and selective extraction with DTPA.

Results of this study showed the following:

- (1) The ferric phosphate and ferric hydroxide products were amorphous as indicated by powder XRD. At high P:Fe ratios, e.g., > 2 , ferric phosphate predominated; at P:Fe ratios, e.g., < 1 , ferric hydroxide was the dominant product.
- (2) At low phosphate levels, the ferric hydroxide was destabilized by the presence of ligand-bound P during the precipitation process, and Fe was more readily extracted by DTPA.