

Studies on iron compounds in plant and their relation to plant nutrition

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The aim of this investigation was to study experimentally the relative proportions of Fe and Fe in plant and their relation to some natural chelating iron compounds, such as amino acids, in plant supplied with different rates of iron. Moreover, the uptake of some nutrient elements, namely N, P, K, Ca, Mg, Fe, Zn, Mn, and Cu were determined to learn more about the behaviour of iron in plant. To satisfy these objectives, two greenhouse experiments, namely sand culture and calcareous soil pots experiments were carried out. Spinach plant was used as indicator plant. 0, 50 and 100 ppm Fe were applied as ferrous-EDTA form. Six rates of iron, namely control, 5, 15, 50, and 100 ppm Fe, the following results and conclusions were recorded:

1. Total iron uptake increased with the increasing of Fe-EDTA application up to the biggest rate used (100 ppm Fe). Similar trends were also obtained for ferrous content in plant. In the mean time, Fe content was significantly increased only up to 15 ppm Fe application. But at higher rates, 50, and 100 ppm Fe, there were no significant differences noticed.
2. Although nitrogen and phosphorus concentrations in spinach plant were significantly increased with each increment of iron application up to 50 ppm. yet iron addition at low rates. up to 15 ppm Fe, enhanced nitrogen concentration in plant but higher levels did not affect these elements materially over that resulted from the 15 ppm Fe.
3. The P/F ratio tended to decrease significantly by increasing the rate of iron application. but there was no significant differences between P/Fe ratio at all rates of iron application. Such trend means that this ratio tended to remain constant regardless of the rate of iron application and that any increase of ferric iron is intimately correlated with an increase of phosphorus concentration and vice-versa. Such data suggest that the capacity of the plant to absorb and hold iron in a soluble and mobile form becomes less as the phosphorus concentration in the plant rises.
4. Iron additions particularly at low rates enhanced the potassium uptake. but differences tended to diminish as the rate of iron application was increased.
5. No clear trend was noticed in the uptake of calcium and magnesium under these conditions of experiments.
6. Concerning manganese, zinc and copper, iron application up to 5 ppm Fe increased the manganese and zinc concentration in plant. however, beyond this rate, both elements were significantly decreased. Copper significantly decreased with increasing the rate of iron application.
7. In sand culture experiment, Fe-EDTA applications affected the concentration of individual free amino acids differently. Compared to the control, iron application decreased the concentration of free alanine, leucine, isoleucine, serine, and phenylalanine. However no clear trends was noticed with respect to glycine, valine, proline, arginine and histidine. On the other hand, there was an obvious accumulation of free aspartic, glutamic, threonine and cysteine amino acids with iron application. The most important free amino acids chelated with ferrous iron were as follows: Cysteine > histidine > aspartic acid > serine > glutamic acid.
8. In calcareous soil experiment, there were decreasing in phenylalanine, leucine, valine, arginine, alanine, and proline than the control, whereas, no clear trends were noticed in the concentration of free serine, histidine, glycine, and threonine. On the other hand, there was a tendency for accumulation of free cysteine, aspartic acid, and glutamic with increasing the rate of iron application. The most dominant and important free amino acids chelated with Fe⁺⁺ were as follows: Cysteine > histidine > aspartic acid > serine > glutamic acid.

10. Results indicated that the amount of Fe⁺⁺ chelated with amino acids are very small if compared with the

concentration or the content of Fe^{++} in plant. Under physiological pH, it may be concluded that although the free amino acids can bind or chelate with ferrous iron, yet the free amino acids are not the dominant compound chelated with iron in cell or through iron translocation, consequently ferrous and ferric iron, or the active form of iron, must be bound or chelated with other organic compounds, most probably organic acids and phytoferritin which seem to play an important role in protecting the active iron from precipitation or changing to the inactive form.