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2003) is that tobacco plants deficient in iron (Fe) exhibit classic deficiency symptoms, mainly highly chlorotic young leaves and reduced growth. However, if zinc (Zn) and manganese (Mn) are deficient as well as Fe, leaf chlorosis is much less evident and growth is near normal. This masking of deficiency symptoms occurs with no increase in tissue Fe concentrations. Clearly the nutrient imbalance of Fe being deficient while Zn and Mn are not is what triggers the expression of deficiency symptoms.

Later research from Iran (Ghasemi-Fasaei & Ronaghi 2008) explored the frequent failure of Fe applications to deficient wheat plants to restore normal growth and sometimes even to exacerbate Fe deficiency. Here wheat was grown in calcareous soils that tend to reduce the availability of cationic micronutrients and promote deficiency symptoms. They grew wheat on such a soil and applied an Fe-chelate to the soil or $FeSO_4$ to the foliage. Neither Fe application increased growth. While tissue levels of Fe increased in response to treatment, tissue levels of Zn, Mn and Cu decreased increasing the ratio of Fe to other cationic micronutrients individually and combined. This imbalance was attributed to an antagonistic effect of Fe on the absorption of other nutrients and the practice of applying Fe to correct its deficiency in grasses growing on calcareous soils was questioned.

While the relevance these studies to turfgrass nutrient management on non-calcareous soils or sand is not immediately obvious, it is evident that a proper balance of nutrients is critical for optimum grass performance. This balance can be disturbed by imbalanced nutrient supply or by nutrient antagonisms during absorption by roots or partitioning within the plant.

A more obvious lesson can be drawn from a very recent report from Italy (Astolfi et al. 2010) that described an interaction of sulfur (S) availability with Fe nutrition in barley. They noted that improvements in air quality and the use of fertilizers of greater purity seemed to be related to increased incidences of Fe deficiency in grain crops. When S was withheld from barley plants, Fe deficiency symptoms increased sharply. This was shown to be related to a failure by plant roots to release a chelate into the soil when confronted with an Fe shortage. These chelates called phytosederophores (PS), bind Fe^{3+} very efficiently and allow it to be captured and absorbed by roots. PS synthesis is induced by low Fe availability and depends upon a ready supply of S since they are made from the S-containing amino acid methionine. In this case, a micronutrient (Fe) becomes seriously deficient because a macronutrient (S) was insufficient to permit a normal plant response to the deficiency stress.

Only a few of the many nutrient interactions known to be critical for normal turf growth and performance have been discussed in these two articles. There are undoubtedly many other such interactions that are not recognized and may be responsible for some most perplexing management problems, such as interactions with pesticides and surfactants in the soil or on the turf leaf surface. It is evident that maintaining basic nutrient balances and beneficial interactions can be added to the long list of grass requirements with which the turf manager must be familiar. However, such knowledge must be based on sound research of nutrient interactions conducted on turfgrass species. Those funding turf research should be encouraged to devote greater attention to this critical aspect of turfgrass nutrition.

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