22 Manganese Nutrition In North Dakota Crops

22.1 Manganese and crop nutrition

Soil Manganese (Mn) originates from the weathering of ferromagnesium rock, small particles of which are very common across all North Dakota soils. Manganese has three possible valence states: 2+, 3+ and 4+, all of which may be present in the soil simultaneously depending on the oxidation state of their nano-environment. The solubility and availability of Mn for plant uptake is heavily dependent on soil pH. Soils with a pH less than 5 can have excess levels of plant-available Mn resulting in Mn toxicity. Manganese toxicity has been reported in canola in North Dakota, grown in soils with a pH of around 4.5. There have been no reports of Mn deficiencies confirmed on any North Dakota crop, although toxicity has been documented.

Manganese as Mn^{2+} is an exchangeable cation and reversibly binds to the negative cation exchanges of clay particles along with Ca^{2+} and Mg^{2+}. The role Mn plays in plant physiology is centered around a select few, but important enzymes, as well as the 'Hill' part of the photosynthesis reaction where water is split into H^{+} and O_2. Manganese is considered largely immobile within the plant, and any symptoms or signs of a Mn deficiencies can appear very similar to those of IDC. Iron and Mn compete in soils for plant uptake, and for utilization within the plant by the different plant tissues and organelles. A greenhouse study provided evidence for this competition. Soybeans experiencing Mn were treated with Fe in the form of an Fe-EDDHA chelate, reducing the amount of Mn uptake, and subsequently alleviating the toxicity symptoms (Moraghan et al., 1986). Other studies have also shown the inverse of this relationship where an application of additional Mn, can result in an increase in IDC symptomology in soybeans. The Mn reduces the amount of Fe taken up by the plants exacerbating the disorder (Roomizadeh & Karimian, 1996).

22.2 References for manganese nutrition in crops

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- Roomizadeh, S., & Karimian, N. (1996). Manganese–iron relationship in soybean grown in calcareous soil. *Journal of Plant Nutrition*, **19**(3–4), 397–406. https://doi.org/10.1080/01904169609365134