Balancing cereal crop micronutrient supply

Manganese deficiency can reduce cereal yields by one-third or more

Mark Plunkett
Soil & Plant Nutrition Specialist,
Teagasc Crops, Environment and Land Use Programme

Nitrogen (N), phosphorus, potassium (K), sulphur (S) and magnesium (Mg) are applied in kilogrammes per hectare based on soil test results and the crop's grain yield potential. Micro nutrients such as copper (Cu), manganese (Mn) and zinc (Zn) on the other hand are required in much smaller amounts – grammes/ha – one thousand times less! But balanced supplies of both major and micronutrients are essential to maximise grain yield and profitability.

Soils and micronutrient supply

In general, micronutrients are plentiful but some soil types deliver sub-optimal quantities. For example, light/sandy or peaty soils can deliver low to medium amounts. Other relevant factors are soil pH, soil structure, seed bed conditions (consolidation), soil temperature, soil moisture and recently applied lime.

Figure 1: Soil moisture is the medium of trace element mobility and uptake by the plant roots. Dry soil conditions in April and May can result in numerous trace element deficiencies (Cu, Mn and Zn) in spring cereal crops.

Test soils every three to five years and take an S4 (pH, LR, P, K, Mg, Cu M<n, Zn) soil sample on a range of tillage soils on the farm. This is your starting point in detecting possible nutrient deficiency. Maintain a soil pH 6.5 and apply lime based on the soil test to improve soil pH. Take care not to use excessive amounts of lime as that can reduce the availability of micro nutrients for a number of years.

Table 1: Guide to nutrient deficiencies depending on soil factors and visual symptoms and suggested treatments

Nutrient	Soil Factors	Soil Analysis	Visual Symptoms	Soil Treatments	Foliar treatments
Copper	Low or high soil pH / Light textured soils / Soils over granite or sandstone / Peaty soils	Good Indicator	Yellowing / withering leaf tips & spiraling of leaves / Secondary tillering	Apply copper sulphate 15-20kg/ha & incorporate	GS 1 to 4 leaf stage / Tillering
Manganese	High soil pH (<7.0) / High soil P (>15ppm) Light textured / peaty soils / unconsolidated seedbeds / dry soils / poor rooting	Poor Indicator	Interveinal chlorosis / patches of pale green limp growth / oldest growth affected first / greening of tram lines	Soil Mn application ineffective. Seedbed consolidation	Seed treatments on very deficient soils Foliar application GS 14 / 21 - 31
Zinc	Light textured soils with high soil pH (>7.0) + P (>15ppm) or Low soil (<6.0) / High organic matter soils. Clay soils with high Mg can fix Zn	Good Indicator	Leaf chlorosis with pale green, yellow color / leaf bleaching.	Seedbed application 20-30kg/ha zinc sulphate & incorporate	Apply during early tillering (GS 22-25)

GS – growth stage

Figure 2 Warning signs of restricted manganese uptake in spring barley. Three to four times more leaf production in tractor wheel tracks (darker green).

Manganese and cereal crops

Manganese deficiency is one of the most common deficiencies in cereals, especially on naturally high-pH or recently limed soils.

Manganese deficiency in crops can reduce yield by 30-60% in extreme cases. Yield responses to Mn are found where cereals are growing in soils of pH 7 or more or when the easily reducible Mn level in soil test falls below 50mg/l.

Soil analysis (for easily reducible manganese) is an indicator of soil Mn availability. However, this is not fully reliable for predicting the occurrence of Mn deficiency. Leaf analysis is a more reliable test for possible Mn deficiency.

Transitory Mn deficiency can also occur as a result of the conversion of Mn++, the plant-available form that is found in the soil solution, to manganese oxides and hydroxides which are unavailable to plants. This process occurs when Mn comes into contact with oxygen and is more likely during drying weather conditions or low soil moisture levels.

Anything which increases the amount of air in the soil, such as loose seedbeds or dry soils, can induce manganese deficiency. Seedbed consolidation plays an important role in increasing Mn availability by increasing root to soil contact and reducing Mn oxidation.

Manganese deficiency that occurs as a result of dry soils will often be corrected by a good spell of rain. Manganese deficiency can be controlled by applying foliar sprays of Mn compounds with manganese sulphate (this requires high water volumes and check mix/product compatibility). Application should be repeated if the symptoms persist.

> Anything which increases the amount of air in the soil, such as loose seedbeds or dry soils, can induce manganese deficiency

Chelates and inorganic compounds of Mn are also effective and should be applied once a Mn deficiency is identified as early action will reduce yield loss. These have the added advantage of being applied in lower volumes of water, and compatibility with certain fungicide and other pesticides.

Manganese-treated seed and manganese-treated fertilisers can be effective. Applications of manganese sulphate to the soil will not eliminate long-term deficiency. See Table 1 for information on copper and zinc.

Farmer focus

David Walsh-Kemmis farms just outside Stradbally in Co Laois. Spring malting barley, the main crop on the farm, is grown to supply the on-farm brewery. David's farm is currently one of the monitor farms which is participating in the Teagasc/Boortmalt joint malting barley development programme.

"We altered our early crop management to alleviate the problem of manganese deficiency," says David. "We started by identifying the worst-affected areas on the farm so that they could be given special attention in the following cropping season. For us, seedbed preparation plays a key role. Over-tilled and loose seedbeds can accelerate manganese problems in crops and seedbed consolidation is an essential part of how we combat the problem."

A move to disc drills and away from power harrow-operated one-pass drills has made it easier to achieve firmer seedbeds.

"Pre-sowing pressing of the soil and post sowing rolling has major benefits for improving seed to soil contact and seedbed consolidation," says David. "We will also apply foliar manganese on the most affected cropping areas: 2.5kg/ha at the two-leaf stage and repeating the application at first or second node. This minor nutrient can have a big impact."