Nutri-Facts

Agronomic fact sheets on crop nutrients

Magnesium

NO. 6

Australia and New Zealand Grains Edition

Magnesium (Mg) is one of the macronutrients that is essential for both plant and animal growth and development. Mg is readily leached from acidic soils, therefore, recognising Australia's soil acidity problems there is an implication that the Mg concentrations in Australian soils are declining. An adequate supply of Mg to grain crops is particularly important as Mg directly affects grain production and quality. It is also important for the production of fodder crops as insufficient Mg intake in grazing animals can lead to disorders such as grass tetany.

In Australia, Mg deficiency Is not common, but the continued removal of Mg in crop and livestock products, along with the acidification of soils mean that growers and advisors should be aware that it may require remediation.

Magnesium in Plants

Mg is an essential plant nutrient and is required for normal growth and development to occur. Mg is the central atom in the chlorophyll molecule, which is responsible for photosynthesis and leaf colour. Mg also plays a role in protein synthesis, activating many enzyme processes, adenosine triphosphate (ATP) metabolism (energy storage), the movement of carbohydrates around the plant, plant respiration, and phosphate metabolism. Mg is also an essential part of animal nutrition, and adequate plant concentration will assist with healthy growth in both plants and animals that consume those plants.

Magnesium in Soils

Mg can only become available for plant uptake once it has been released into the soil solution through the process of mineral breakdown or the weathering of parent material. It can also be introduced in manure, through irrigation water, bio-solids or commercial fertilizer. Uptake is via mass flow when soil water is taken up.

Soil pH has a direct effect on Mg release from clay minerals, as well as plant uptake such that Mg availability decreases at low pH. Mg is a divalent cation, which can occupy sites on the exchange complexes in soils. Other exchangeable cations are Hydrogen (H), Aluminium (Al), Calcium Ca), Potassium (K) and Sodium (Na) and they compete for adsorption sites on soil particles and for plant uptake. Mg does not bind as tightly as some cations and therefore can be subject to leaching. The risk of leaching is greatest on soils with a pH below 7, and coarse textured (sandy) soils in areas of high rainfall or irrigation.

Nutrients that compete with Mg for crop uptake vary depending on the conditions of the soil. Ca and K are two of the most important nutrients that can increase the risk of Mg deficiency. When Ca or K levels are high in the soil, especially in soils naturally low in Mg, uptake by plants can be reduced. Mg also has very specific benefits in protecting against Al toxicity in acid soils. Deficiency symptoms often occur because of competition for uptake with other ions, rather than just a low soil Mg concentration. The concentration of these cations in the soil solution is important, not the ratios among them.

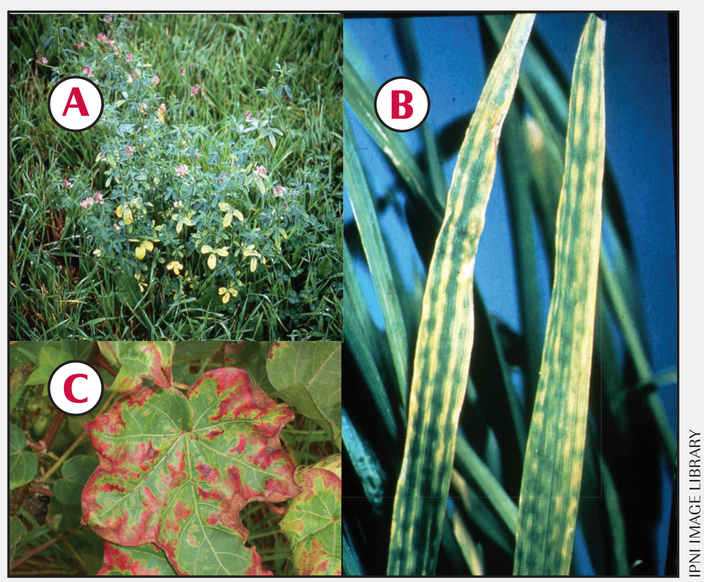

Figure 1. Mg deficiency symptoms, lucerne (A), wheat (B) and cotton (C).

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This Nutri-Fact is one of a series of fact sheets written by scientific staff of the International Plant Nutrition Institute (IPNI) that is focused on essential plant nutrients and their use. This series is available as PDF files at www.ipni.net/nutrifacts.

Magnesium Deficiency

Mg deficiency symptoms generally first appears on the older leaves and spreads to younger tissue under prolonged deficiency. Chlorosis of fully expanded leaves is the most visible symptom of Mg deficiency; with leaves turning a yellow, bronze or reddish colour while the leaf veins remain green (**Figure 1**).

When Mg is deficient, the movement of carbohydrates from the leaves to other parts of the plant is restricted. Without a steady flow of carbohydrates to the rest of the plant, tissues such as the roots and grains may not develop properly affecting yield and therefore crop profitability. Additionally, because carbohydrates are not being transported from the leaves to the rest of the plant, there is a build-up of carbohydrates in the leaves that signals the plant to slow down photosynthesis and produce fewer carbohydrates resulting in stunted plants and smaller root systems. Reduced root growth can inhibit the uptake of water and other nutrients, causing a cascade of nutritional problems.

Deficiency symptoms that occur during vegetative growth can be addressed but the early nutrient stress will not necessarily result in reduced yield. Tissue testing is a reliable guide to Mg whilst the critical (90% yield) plant tissue Mg concentration (whole shoots) was 0.15%, although values change with tissue taken and stage of growth.

Fertilizing with Magnesium

Fertilizing soils with Mg is necessary when the soil alone cannot supply enough to meet the crop needs.

Source: Table 1 shows some common fertilizer sources and their average Mg concentrations. Dolomite and hydrated dolomite are used most commonly to correct Mg deficiencies while simultaneously raising soil pH levels in acid soils. Sulfates are the more soluble Mg nutrient sources.

Table 1. Commercial sources of magnesium fertilizer.

Fertilizer name	Chemical formula	Typical Mg concentration, %
Keiserite	$MgSO_4 \cdot H_2O$	17
Struvite	$MgNH_4PO_4 \cdot 6H_2O$	10
Langbenite	$2MgSO_4 \cdot K_2SO_4$	11
Magnesium chloride	$MgCl_2$	25
Magnesium nitrate	$Mg(NO_3)_2 \cdot 6H_2O$	9
Magnesium oxide	MgO	56
Dolomite	$MgCO_3 \cdot CaCO$	6-20
Magnesium sulfate	$MgSO_4 \cdot 7H_2O$	9
Hydrate Dolomite	$MgO \cdot CaO/MgO \cdot Ca(OH)_2$	18-20

Rate: 25-50 kg of Mg/ha is generally sufficient as a soil application. Foliar applications are normally applied as a 1% solution to the point of runoff, although repeated applications may be necessary if an initial application does not result in long-term improvements.

Time: It is recommended that Mg be applied to the soil well before it is required by the crop to give it time to be mineralised and become available for plant uptake. When used as a foliar application, Mg should be applied to actively growing young leaves.

Place: Mg can be applied to the soil, either broadcast and incorporated into the soil or broadcast so that it can be washed into the soil by rain or irrigation. Foliar applications of soluble Mg sources are sometimes recommended for forage crops where Mg concentrations in plant tissues are too low for animal nutrition. This is particularly important for animals grazing pastures, as low Mg consumption can lead to grass tetany (hypo-magnesia). Foliar applications must usually be repeated since Mg is needed in large quantities. Alternatively direct animal supplementation can be used via licks or similar.

Soil tests designed to calculate the amount of exchangeable Mg in the soil are likely to be successful in estimating the soil Mg supplies that are available to plants and are a useful tool to help identify the need for Mg fertilization. In sandy soils, deficiency occurs when exchangeable Mg concentrations are less than 0.2 cmol(+)/kg. In clay soils deficiency occurs when Mg concentrations are less than 0.5 cmol(+)/kg.

Crop Response to Magnesium

When plants are deficient in Mg, increasing the Mg available to them can lead to increased growth and yield, especially if the problem is diagnosed early in plant growth. **Table 2** provides an example of a crop response to Mg fertilization. The data was collected over three years of trials using three different hybrid varieties of sorghum. Sorghum was grown on an acid, sandy loam soil that was low in Mg. Grain yield increased with increasing Mg applications, illustrating the importance of adequate Mg supply in the soil.

Table 2. Sorghum grain yield response to magnesium fertilization (Gallagher et al. 1975).

Mg rate, kg/ha	Grain yield, t/ha	Percent yield, %
0	4.70	--
15	5.41	15
30	5.40	15
45	5.88	25
60	6.06	29

References and Further Reading

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