SUL-PO-MAG® AGRI-FACTS

Antagonistic Effects of Nutrients

Many elements that are present in soils exert an effect on the behavior of other elements in soils. These effects can be either antagonistic or synergistic and they can have very important implications with respect to plant nutrition. In this edition of *Agri-Facts* we'd like to focus on those nutrients contained in Sul-Po-Mag, and concentrate on the antagonistic effects these nutrients have on each other, and also on other elements present in soil. The nutrients are potassium (K), magnesium (Mg) and sulfur (S).

Potassium/Magnesium

Potassium exerts a strong antagonistic effect on Mg. In fact, this is one of the strongest and most frequently encountered antagonisms in plant nutrition. Potassium induced Mg deficiencies have frequently been reported in many different crops. This antagonistic effect of K on Mg absorption is a major reason for including Mg in fertilization programs worldwide. Results from a sand culture experiment (Table 1) illustrate several important points concerning this relationship between K and Mg.

1. Increasing the K:Mg ratio in the growth medium from 1:1 to 20:1 markedly decreased % Mg in leaves at all growth stages.

2. Increasing the K:Mg ratio caused a reduction in leaf chlorophyll. This effect became more pronounced with maturity. Since Mg is a component of chlorophyll, these results are to be expected.

3. Increasing the K:Mg ratio had relatively little effect on Mg content of the fruit. This can be explained by the fact that storage organs (fruits, seeds, tubers etc.) have a high demand for Mg.

And since Mg is a mobile nutrient, plants in general have the ability to translocate Mg from leaves to storage organs.

Another important point as regards the relationship between K and Mg is the fact that Mg does not have a particularly antagonistic effect on the absorption of K. Very high rates of Mg fertilizers will indeed depress K absorption by plants, but this antagonism is not nearly as strong as that of K on Mg absorption.

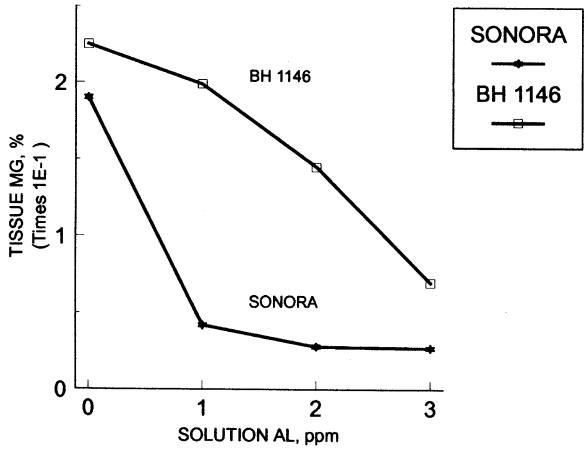
Table 1. K-Mg Relationships - Tomato, Sand Culture

Growth Stage	K:Mg Ratio	% Mg Terminal Leaves	% Chlorophyll
Transplant	1:1	1.72	0.41
	5:1	1.00	0.38
	20:1	0.74	0.35
Pre-blossom	1:1	1.48	0.36
	5:1	1.16	0.32
	20:1	0.62	0.27
Fruiting	1:1	1.24	0.32
	5:1	0.74	0.28
	20:1	0.62	0.11
		Fruit	
Fruiting	1:1	0.34	—
	5:1	0.34	—
	20:1	0.29	—

Aluminum/Magnesium

Aluminum (Al) also has a strong antagonistic effect on plant absorption of Mg. This relationship is particularly important under acid soil conditions. As soil pH decreases, the solubility and hence the activity of Al increases. Fig. 1 shows the effect of increasing Al levels on absorption of Mg by two wheat cultivars. The antagonistic effect of Al was especially striking in the Sonora cultivar. One ppm Al in the nutrient solution reduced % Mg in the leaf by nearly 80%.

Figure 1. Effect of Al on Mg Absorption by Two Wheat Cultivars.



It has recently been found that the reverse reaction also occurs — that is, Mg inhibits the absorption of Al. This effect of Mg is very important since a major reason for the general poor growth of plants under acid soil conditions is the toxic effect of Al. Applications of Mg to acid soils can partially counteract the effect of Al toxicity.

Manganese/Magnesium
Magnesium has also been shown to have an antagonistic effect on absorption of manganese (Mn). As is the case with Al, elevated levels of soluble Mn are often encountered in acid soils, and this often has a depressing effect on plant growth. Application of Mg to acid soils can reduce the harmful effects of high Mn levels.

Calcium/Magnesium
High levels of soil calcium (Ca), or applications of Ca containing soil amendments or fertilizers, have been reported to depress absorption of Mg. However, this antagonistic effect of Ca does not appear to be as strong as that of K on Mg absorption.

Ammonium/Magnesium
Nitrogen (N) fertilization has generally been reported to increase plant absorption of Mg. However, the chemical form of N in the fertilizer plays a very important role here. Whereas nitrate nitrogen (NO_3^-) generally enhances uptake of Mg, ammonium nitrogen (Nh_4+) can have a rather strong antagonistic effect on Mg absorption. The effects of N source at various rates of K on the uptake of Mg are shown in Table 2.

Table 2. Form of Nitrogen Affects Mg Uptake. Maize.

Nitrogen form	K rate (ppm)	% leaf Mg
	0	0.71
NO_3^-	50	0.57
	100	0.44
	0	0.33
NH_4^+	50	0.33
	100	0.30

The antagonistic effect of NH_4^+ on Mg uptake is not as commonly observed as the K-Mg antagonism, since NH_4^+ is fairly rapidly converted to NO_3^- (nitrification) in soils under most growing conditions.

Summary
Under high yield conditions and increasing rates of potash application, serious consideration should be given to include Mg in the fertility program. Don't let K-induced Mg deficiency become a yield barrier.

Continuous use of calcitic limestone can raise soil Ca levels to the point that the antagonistic effect of Ca on Mg absorption can depress yields. The same can be said regarding high application rates of gypsum.

Under acid soil conditions, consider the application of Mg to reduce potential harmful effects of Al and/or Mn.

When applying ammonium sources of N, such as anhydrous ammonia or ammonium sulfate at planting time, consideration should be given to Mg application. This is especially true if cold, wet conditions prevail early in the season, which retards the conversion of ammonium to nitrate. The application of a row fertilizer containing 2-3% Mg will help prevent ammonium-induced Mg deficiency at this critical stage of plant growth.