

Soil Test Levels And Crop Response To Fertilizers

One of the questions most frequently asked of soil scientists and consultants is, “My soil analysis showed a high level of nutrient ‘X’. Is all this ‘X’ actually available for uptake by plants? Might I see a response to applications of ‘X’?”

The answer to the first of these questions is not quite so simple. Theoretically, the level of a nutrient reported on a soil analysis form is indeed the amount available for plant uptake. Soil analysis techniques have been designed to extract *only* the amount of a nutrient that is available for plant uptake. This is the whole idea behind soil analysis work — to distinguish between “available” and “unavailable” soil nutrients. And many years of field and greenhouse evaluation studies form the basis of modern soil analysis methods.

However, the answer to the second questions is, yes, it is certainly possible to observe a response to a nutrient that tests in the “high” category. The next logical question would then be, “Why bother with soil testing?” The answer is that soil testing is an excellent tool for evaluating the fertility status of our soils and should form the basis for every farmer’s fertility program. However, soil analysis results are not infallible, in that plant uptake of a given nutrient is dependent on quite a few factors other than the “available” level of that nutrient in a soil.

Magnesium

When considering magnesium (Mg), there are several factors, both climatic and otherwise, that can have a marked effect on plant absorption of this nutrient.

- **Temperature:** As temperatures decrease, plant absorption of Mg likewise decreases. This can be said for most plant nutrients, but is especially true with respect to Mg. This was dramatically demonstrated in field trials in Canada in the late 1970’s as shown in Table 1.

Table 1. Mg Nutrition Of Corn Varieties During Cool And Warm Growing Seasons

Variety	% Mg In Dry Matter 1976 (Cool)	Mg Deficiency Rating 1977 (Warm)	Mg Deficiency Rating In 1976*
A	0.32	0.56	3
B	0.22	0.52	3
C	0.32	0.37	6
D	0.18	—	2
E	0.18	—	3

* 1 = very severe deficiency symptoms, 6 = no deficiency

It’s obvious that cool temperatures depressed absorption of Mg, especially in hybrids A and B. Also, all but one hybrid exhibited varying degrees of Mg deficiency symptoms during the cool 1976 season. No symptoms were observed on the three hybrids during 1977 — Mg levels were considerably above critical levels. This tells us that a response to Mg probably would have been observed in 1976, but not in 1977 — on the same soil, under the same Mg soil test level.

- **Soil Physical Conditions:** The physical condition of soils can affect the availability of many nutrients. With respect to Mg, the oxygen (O₂) level of a soil, or the degree of aeration, is very important (Table 2).

Table 2. Soil O₂ Levels Affect Mg Absorption

Tall Fescue Genotype	Forage Mg At Soil O ₂ Levels Of: 21%	2%
A	.58%	.27%
B	.43%	.28%
C	.33%	.16%

Mg uptake was markedly reduced *in the same soil* (and, thus, at the same Mg soil test level) as O₂ level decreased from 21 to 2%. Any condition that reduces soil aeration, such as flooding or compaction, will negatively affect Mg absorption.

Potassium

Magnesium is not the only nutrient whose availability is reduced due to soil compaction. Results from Wisconsin (Table 3) showed that potassium (K) in the starter fertilizer overcame the negative effects of soil compaction.

Table 3. Effect Of K On Corn Yields On Compacted Soil*

Soil Compaction Tons	Corn Yield, bu/A No K	Starter K Response 45 lb K ₂ O/A	bu/A
< 5	132	162	30
9	114	152	38
19	111	159	48

* Soil Test K = 102 ppm (high)

In this study, soil compaction had a marked effect on the response of corn to K.

Other Factors Which Impact On Nutrient Utilization Are:

- Soil pH.
- Nutrient interactions. High levels of fertilizer K depress Mg absorption.
- Hybrid or variety. Note in Table 1 that temperature had a much greater effect on Mg absorption by hybrids A and B than by hybrid C.
- Fertilizer placement.
- Soil moisture. Nutrients in general are more readily absorbed under optimum soil moisture conditions than under excessively wet or dry conditions.

While soil analysis should be an important and basic part of every fertility program, it must be understood that we sometimes see responses to fertilizers when soil analysis results indicate this should not be the case. In this regard, the following table (Table 4), published by a leading Midwestern university, is of interest.

Table 4. Response To Fertilizer Nutrients Based On Soil Analyses

Test Level	% Of Soil Responding
Very Low	100
Low	70-90
Medium	40-70
High	10-40
Very High	0-10

Summary

It is certainly possible to observe a yield response to a nutrient that tests in the "high" range. In soils testing

high in Mg, under cool, wet, early spring conditions, and when high amounts of K have been applied, it is not unusual to observe a yield response to Mg, especially from starter fertilizer.