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Soils (Fertility)

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ROLE OF MICRONUTRIENTS IN EFFICIENT CROP PRODUCTION

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Micronutrients are essential plant mineral nutrients taken up and utilized by crops in very small quantities. Traditionally, we have relied on what was present naturally in the soil together with amounts added as impurities in fertilizers and pesticides as the source of micronutrients for crop growth. In recent years however, deficiencies of micronutrients have been diagnosed more frequently; and many farmers are beginning to take a closer look at their general availability.

It is extremely important to be able to recognize and correct micronutrient deficiencies. When micro-nutrients become a limiting factor water, fertilizer and other high-energy production inputs may be wasted, since a plant will only grow and develop to the extent that its most limiting growth factor will allow. For example, acorn crop might be unable to utilize the last 20 pounds of nitrogen applied, if it does not have adequate supplies of the micronutrients.

Table. 1. Relative Energy Content of Major Corn Inputs in Terms of Gasoline Equivalents per Acre.

Production input	Energy content in gasoline equivalents
Fertilizer (mainly nitrogen)	40 gal./acre
LP gas (for crop drying)	20 gal./acre
Tillage and cultivation	10 gal./acre
Herbicides and insecticides	5 gal./acre

Table 1 gives a rough estimate of the relative energy content of major inputs for corn, expressed in terms of gasoline equivalents. As can be seen nitrogen is the single largest energy input (where there is no irrigation.) Once this fertilizer is committed to the crop, everything must be done to insure the highest output from that commitment of energy. Drought or insect problems or a micronutrient deficiency can result in reduced production and, thus, the waste of nitrogen--and energy.

The purpose of this publication is to provide information on micronutrient needs of common Indiana field crops and how to prevent deficiency problems. Discussed are the elements involved and the amounts used by crops in Indiana where deficiency problems are likely to occur, how to diagnose them and how they can best be corrected.

MICRONUTRIENTS NEEDED BY FIELD CROPS

There are seven micronutrients required by plants--zinc (Zn), manganese (Mn), copper (Cu), iron (Fe) boron (B), molybdenum (Mo) and chlorine (Cl). Of these no deficiencies of iron or chlorine have been diagnosed in field crops in Indiana, although iron deficiency is found in some lawns. On the other hand, zinc deficiency of corn, manganese deficiency of soybeans and boron deficiency of alfalfa are the most common problems encountered.

Table 2 lists the amounts of each micronutrient (except chlorine) needed to produce high yields of corn, soybeans and alfalfa.

Table 2. Approximate Per-Acre Micronutrient Uptake by Corn, Soybeans and Alfalfa in Indiana.

	Nutrient uptake by--		
Micronutrient	150-bu. corn	60-bu. soybeans	6-ton alfalfa
	lbs./acre		
Iron (Fe)	1.90	1.70	1.80
Manganese (Mn)	0.30	0.60	0.60
Zinc (Zn)	0.27	0.20	0.24
Boron (B)	0.16	0.10	0.30
Copper (Cu)	0.10	0.10	0.06
Molybdenum (Mo)	0.008	0.01	0.02

DIAGNOSING MICRONUTRIENT DEFICIENCIES

Both soil testing and plant analysis can be useful in diagnosing micronutrient deficiencies. Testing the soil for micronutrients has become a widely-accepted practice in recent years. However one must recognize that micronutrient soil tests are not as reliable as the tests for soil acidity (pH) or for phosphorus (P) and potassium (K) content.

The major limitation of current micronutrient soil testing is that it measures only the *quantity* of nutrients present, not their *availability*. Much work is still needed in correlating soil micronutrient content with availability to the plant.

For this reason plant analysis is also very important in deficiency diagnosis. By combining plant analysis with soil tests more accurate assessment of the micronutrient status of soils and crops can be attained.

There are two ways to use plant analysis. One is to monitor a crop's nutrient status; the other is to diagnose any problem situations that might occur.

As a monitoring tool plant analysis can point out existing or potential problems before visual symptoms develop. Table 3 is a guide for sampling corn, soybeans small grain and forage legumes including when to sample what plant parts to collect and how much material is needed. While analyses can be run on other plant parts and on samples collected at other times the growth stages and plant parts listed in the table allow for the most reliable readings.

Table 3. Plant Sampling Guide for Diagnosis of Micronutrient Deficiencies.

Crop	Stage of development	Plant part to sample	Quantity needed

Corn	Up to 12 inches tall	Entire plant above ground	30 plants
	12 inches to tasseling	Topmost fully-developed leaf	20 leaves
	At silk initiation (too late if silks have turned brown)	Top ear leaf	15 leaves
Soybeans	Up to 12 inches tall	Entire plant above ground	30 plants
	12 inches to early bloom	Uppermost fully-expanded trifoliate leaves (leaves only, discard petiole or stem)	50 leaves
Small grains	Up to 12 inches tall	Entire plant above ground	30 plants
	Before heading	Uppermost leaves	30 leaves
Legumes for hay	Before flowering until early bloom	Top 6 inches of the plant	30 plants

If problems develop don't wait for the suggested sampling times to get a plant analysis. Collect separate plant samples from both problem and normal-appearing plants. Generally if plants are not at the ideal growth stages take the whole plant if less than 12 inches tall or the top fully-developed leaves if over 12 inches tall. A soil sample should also be taken from each area.

For further information on how to take plant and soil samples what materials are needed and where to get the testing done contact your county Extension agent or local fertilizer dealer.

WHERE DEFICIENCIES OCCUR AND HOW TO CORRECT THEM

Following is a brief discussion of where in Indiana micronutrient deficiency problems are likely to occur and how they are best prevented or corrected. Table 4 summarizes the soil and crop conditions that favor development of micronutrient problems.

Table 4. Potential Soil and Crop Conditions for Micronutrient Deficiencies.

Micronutrient	Soil condition	Crop
Manganese (Mn)	Black sands Mucks Poorly-drained depressional soils with pH >6.2	Soybeans Small grains Corn
Zinc (Zn)	High pH soils (>7) Cool wet soils High phosphorus rates	Corn
Boron (B)	Sandy soils Highly-weathered soils with low organic matter	Alfalfa Red clover Sugar beets Corn
Copper (Cu)	Organic soils Black sands	Wheat Corn Soybeans
Molybdenum (Mo)	Acid prairie soils	Soybeans

Manganese

Manganese deficiency is most likely to occur in soybeans small grains and occasionally corn and particularly in two soil regions of Indiana - (1) the black sands of the Kankakee River Valley and (2) the heavy depressional soils of northeastern Indiana. Deficiencies have also been noted in heavy depressional soils in other areas of the state especially when the pH is above 6.2-6.3.

Manganese deficiency can be corrected two ways: (1) by applying a row fertilizer containing manganese or (2) by applying a foliar (leaf) manganese spray early if deficiency symptoms occur.

For mineral soil 5-8 pounds per acre of elemental manganese can be incorporated into the row starter fertilizer as either manganese sulfate or powdered manganese oxide. (For organic soils the rate is 10 pounds or more; therefore, consider foliar rather than soil treatment). Since manganese is rapidly converted to unavailable forms applications should be made annually. Broadcast applications are not recommended.

The per-acre rate for foliar applications is 1-2 pounds of manganese as manganese sulfate (only 1 pound if plants are small). Be especially careful if using manganese chelates since some carriers can cause considerable leaf burn at high rates. Generally, the application rate of chelates is lower than other sources, because of the leaf burn problem. Follow manufacturers directions carefully when applying any material.

Zinc

Zinc deficiency is observed most frequently in corn and occurs throughout the state. Conditions which favor zinc deficiency are: (1) high pH generally above 7: (2) high soil phosphorus especially when combined with high rate of phosphorus as a row starter and (3) cool wet soil conditions.

Zinc can be applied broadcast a a per-acre rate of 2-3 pounds of zinc as a chelate *or* at 10 pounds of zinc as zinc sulfate or finely-divided zinc oxide. Broadcast applications usually remain effective for several years.

Zinc can also be added to starter fertilizers at the rate of 1/2 - 1 pound of zinc as a chelate *or* 3 pounds as zinc sulfate or finely-divided zinc oxide. Row applications usually have little residual effect and must be repeated annually.

If zinc deficiency symptoms appear, a foliar spray of 1 1/4 pounds of zinc sulfate in 30 gallons of water per acre should give marked improvement. Then when corn is grown in subsequent years, broadcast or row applications of zinc should be used as a preventative measure.

Boron

Boron deficiency is most commonly noted in alfalfa, though it has also been observed in red clover and corn. Generally boron deficiencies are confined to the sandy soils of northern Indiana and to the residual and oldest glacial soils of southern Indiana.

Boron can be applied either by broadcasting granular borate with mixed fertilizers or by spraying soluble borate with liquid fertilizer or compatible pesticides. *Boron-containing fertilizers should not be applied in close contact with seed for any crop,since boron will injure germinating seeds.*

For highly-responsive crops such as alfalfa, rates of 2 - 4 pounds of boron per acre are recommended. For less responsive crops such as corn, 1/2 - 1 pound is recommended. Foliar sprays can also be used: but to prevent toxicity problems reduce the rates to 0.1 - 0.5 pound of boron.

Copper

Wheat corn and soybeans occasionally are found to be copper deficient. Such deficiencies are most apt to occur in acid organic soils, such as the Adrian muck, but can also show up on the black sandy soils of northwestern and north central Indiana.

Copper is generally applied broadcast at a per-acre rate of 3-6 pounds copper as copper sulfate or copper oxide. But it can also be banded in row fertilizer at a rate of 2-3 pounds using the same sources, or applied as a foliar spray using 2 pounds basic copper sulfate in a minimum of 30 gallons of water per acre.

Molybdenum

Molybdenum deficiency of soybeans has been found on certain acid prairie soils in northwestern Indiana.

The recommended molybdenum fertilization procedure is to use 1/2 ounce of sodium molybdate per bushel of seed as a planter box treatment, or 2 ounces of sodium molybdate per acre in 30 gallons of water as a foliar spray. However, be extremely careful in the application of molybdenum since 10 ppm in forage is toxic to ruminant animals.

JUST GOOD MANAGEMENT

Neither the diagnosis of micronutrient deficiencies nor the treatment to eliminate them is complex or expensive. Given the current price of fertilizer land labor and other production inputs, it makes sense to do everything possible to ensure that the yield of your crop is not limited by a micronutrient deficiency. Such a deficiency effectively wastes all the dollar-expensive and energy-intensive inputs that we commit to a crop today

Attention to the availability of micronutrients for field crops is just good management!

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