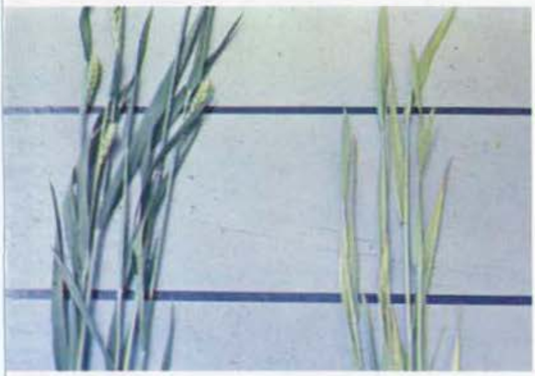
ORON DEFICIENCY ON ALFALFA

ZINC DEFICIENCY ON BEANS



ULFUR DEFICIENCY ON GRAIN

IRON DEFICIENCY ON PEACH

UNIVERSITY OF IDAHO
College of Agriculture

MICRO- *and* SECONDARY NUTRIENTS *for* *Idaho Soils*

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MICRO- AND SECONDARY NUTRIENTS FOR IDAHO SOILS

Consider This Before Buying

Variation among soils in Idaho makes diagnosis for use of micronutrients and secondary plant nutrients difficult. Soil pH, parent material, rainfall, other fertilizer used, lime content and crop needs all must be considered when determining kind and amount of nutrient to apply. The micronutrients needed by crops for normal growth are boron, chlorine, copper, iron, manganese, molybdenum and zinc. Secondary nutrients include calcium, magnesium and sulfur.

In any fertility program one should first determine the need of a certain nutrient, then apply it at a rate which will give a balance of nutrients for the crop's need. Excessively high rates of certain micronutrients may be toxic to crops and to animals that consume them.

Where a micronutrient shortage has been positively demonstrated, a profitable return can often be realized by correcting the deficiency. In southern Idaho the application of small amounts of zinc have increased returns from dry beans and corn substantially. Boron applications have proven profitable on alfalfa in northern Idaho.

Determining Your Soil Nutrient Deficiencies

When plants suffer from lack of an essential nutrient, deficiency symptoms may appear on leaves, stems or fruit. Symptoms are listed on the opposite page. You can learn to identify these symptoms by checking problem plants that may occur in your local area. Compare these with publications showing symptom expressions on foliage.

A tissue analysis can aid in confirming your diagnosis. If you are not sure of your diagnosis, collect tissue samples from affected and normal plants and have them analyzed.

Dilute concentrations of micronutrient solutions may be sprayed on certain plants to identify the symptom expressed. Spray applications are not satisfactory for potatoes or onions.

Be sure to look for insects such as aphids, leaf hoppers, nematodes and weevils, since their effect on plants may be quite similar to symptoms of many nutrient deficiencies.

AUTHORS

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Nutrient Deficiency Symptoms

Boron . . .	Death of growing point. Rosetting and die-back, defoliation, chlorosis. Internal tissue breakdown and corky tissue formation such as in apples.
Chlorine . .	Chlorosis.
Copper . .	Chlorosis and permanent wilting of upper leaves. In grain, it looks like frost damage. Poor pigmentation of carrot roots, small grain and onion bulbs.
Iron . . .	Chlorosis between veins appearing light green to white in color. Veins remain green. Death of terminal growth. Appears on new growth first.
Manganese .	Similar to iron but chlorosis between veins not so dominant on young leaves. Severe browning and dropping of leaves with maturity. Gray specks on oats and small circular dead spots may develop on underside of potato leaves.
Molybdenum .	Foliage greenish-yellow or yellow, similar to nitrogen deficiency. Cupping of leaf margin, mottling of lower leaves and dead tissue around the outer edges.
Zinc . . .	Rosette or little leaf on potatoes and trees. Chlorosis of leaves. On beans, older leaves are affected first, whereas iron deficiency shows up first on young leaves. Corn plants show broad yellow band between midrib and outer edge of leaf. Usually begins at base of leaf. Tips on onions are yellow and curled. Beans are light green with mottled chlorosis.
Calcium . .	Growing tips and roots poorly developed or may die. No marked foliar symptoms. Blossom end rot in tomatoes and pepper fruit and black heart disorder in celery.
Magnesium .	Chlorosis; severe browning and necrosis of lower leaves. Broad leaves show blotchy appearance. In corn, leaves show yellow streak with a chain of dead areas.
Sulfur . .	Entire plant becomes pale green or light yellow, quite similar to nitrogen deficiency, but affects youngest leaves first, whereas nitrogen deficiency appears first on older leaves.

Soil and Climatic Implications

Climatic conditions and soil types are often reliable clues to kind of nutrient needed. For example, on the acid soils in areas having high rainfall such as in northern Idaho, molybdenum, sulfur and boron are often needed on legumes and sulfur on grains and grasses. In southern Idaho on some of the high-alkaline and lime soils, zinc and iron are needed, and manganese may be needed.

Crop Requirements Vary

As shown below, crops require different amounts of available nutrients in soil to produce satisfactorily. Legumes require greater amounts of boron, calcium and molybdenum than grains and grasses. Corn, beans, onions, sugar beets and potatoes need higher levels of zinc, iron and manganese.

Crop Response to Micronutrients[1]

Crop	Manganese	Boron	Copper	Zinc	Molybdenum
Alfalfa	low	high	high	—	medium
Barley	medium	—	high	high	—
Beans	high	—	low	high	medium
Cabbage	medium	medium	medium	—	medium
Carrots	medium	medium	high	—	—
Clover	medium	medium	medium	—	medium
Cucumbers	medium	low	medium	—	—
Corn	medium	low	medium	high	—
Grass	medium	—	medium	—	—
Oats	high	—	high	—	—
Onions	high	—	high	high	high
Peas	high	—	low	—	medium
Potatoes	high	low	low	medium	—
Radishes	—	—	—	—	—
Sugar beets	medium	high	medium	—	—
Sweet corn	medium	low	medium	high	—
Wheat	high	—	high	—	—

[1]Michigan State University, Soil Science Department, Number 15, Official Publication, 1961.

Soil Analysis Can Help

Testing for total amount of micronutrients in a soil does not indicate availability. Certain tests may be helpful in identifying symptoms—for example in differentiating between zinc and manganese deficiencies. The soil pH can be useful in diagnosing needs since availability of certain nutrients is influenced by the degree of acidity or alkalinity. Highly acid soils tend to be low in available boron and copper but high in iron and manganese. Highly alkaline soils tend to be low in available iron, manganese and zinc. A pH range between 5.5 and 7.5 is quite favorable for availability of micronutrients. A laboratory test for available boron is the only micronutrient test recommended by the University of Idaho at the present time.

Plant Composition Ranges[1]

	Deficient	Normal	Excess
Calcium	< 0.5%	0.7-2.0%	
Magnesium	< 0.15%	0.3-0.8%	
Sulfur	< 0.15%	0.2-0.6%	
Iron	< 30 ppm	75-500 ppm	
Manganese	< 25 ppm	50-300 ppm	> 500 ppm
Zinc	< 20 ppm	40-100 ppm	> 300 ppm
Copper	< 6 ppm	8-20 ppm	> 50 ppm
Boron	< 20 ppm	30-90 ppm	> 200 ppm
Molybdenum	< 0.3 ppm	0.8-5.0 ppm	> 10 ppm[2]

[1]Michigan State University. Suggested guide only. For specific crops, these values may be considerably in error.
[2]Toxic to livestock.

Tissue Analysis, Another Check

The comparison of nutrient content between normal and problem plants from some specific area may also be helpful in identifying micronutrient needs. The table above lists plant composition ranges favorable for high production. Ranges of nutrient levels shown are quite general and should be used only as a guide. For specific crops, these values may be considerably in error. Be sure to look for excesses as well as deficiency amounts, since excesses may indicate a lack of balance in nutrients. For example, alfalfa plants growing poorly on very acid soils show higher accumulations of certain nutrients than normal plants.

Review Research and Field Demonstrations

Use results of research from state experiment stations and USDA when available to indicate nutrient need for specific soil and crop.

If no research has been done on micronutrient and secondary nutrient needs in your area or on similar soils, field demonstrations may be used. Apply various nutrients at recommended rates to strips in the field, making sure to mark areas so that yield and quality may be evaluated.

Soil Micronutrient Needs

Boron

Boron deficiency may occur on either acid or alkaline soils. In Idaho it occurs primarily on acid soils in the northern part of the state. Its greatest need has been shown on cut-over forest soils for establishing and growing of alfalfa and clovers. Crops such as alfalfa, clover and sugar beets require high rates of application. Crops such as grain, beans and peas are quite sensitive to boron and may be injured by application when not needed. This is one reason why one all-purpose micronutrient fertilizer cannot be used for all crops.

When soils test below 1 ppm of boron, it is recommended for use on alfalfa. On other crops a trial should be put out to evaluate needs. Two to four pounds boron per acre are suggested when applied to alfalfa or clovers. One to two pounds on other crops for demonstrational purposes.

Chlorine

This is the most recently identified micronutrient needed by plants. Most Idaho soils have a high available supply. Its use is not recommended.

Copper

No definite need for copper has been shown for crops in Idaho. Copper deficiencies are usually associated with peat soils such as found in diked land in Boundary and Benewah counties. No evidence is available to justify its use at present.

Iron

Iron deficiency is widespread in Idaho. The greatest need is by woody plants such as pine trees, shade trees, roses, certain ornamental plants, fruit trees and berries. Iron deficiency may occur on grasses, beans and other row crops where high soil alkalinity and lime appear. Frequent spray applications of iron sulfate are generally recommended to correct or prevent iron chlorosis. Iron chelates can also be used as sprays and in some cases soil applications have been successful.

Manganese

Available manganese decreases with increase in alkalinity. The deficiency is more common on high organic matter soils. On very acid soils, manganese can become toxic. No definite need for manganese on Idaho soils has been shown. Its apparent need would be on fruits, potatoes, sugar beets and berries. Foliar applications of manganese sulfate are preferred but soil application can be used. In Michigan, research has shown that manganese sulfate is more efficient than manganese oxide when broadcast to soil.

Molybdenum

Very acid soils in the northern part of Idaho have shown need for molybdenum fertilizer for production of legumes. Seed treatment with a few ounces of sodium molybdate per acre is a practical method to correct deficiency. Soil application with molybdated gypsum where needed at one pound sodium molybdate per acre has also proven practical.

Excess molybdenum in forages has been a problem in livestock in certain parts of the world. Toxicity is more pronounced when the copper content of forages is less than 5 ppm and molybdenum higher than 3 ppm.

Zinc

Zinc deficiencies generally occur on highly alkaline and lime soils, scraped or eroded areas, and are more pronounced in rotations following sugar beets. Deficiencies are more intense during cold, wet spring weather and occur on soils of all textures. Deficiencies may show in spots in a field or throughout a field.

Heavy use of phosphates on low-zinc soils can induce zinc deficiency in plants. In using phosphates, avoid rates higher than recommended. Crops identified with zinc deficiency symptoms include beans, corn, onions, potatoes and fruit trees.

Zinc sulfate sprays are recommended on woody-type plants at a dormant stage of growth, usually in February and early March. Soil applications are satisfactory for most other crops. One to two pounds of zinc chelate per acre applied below seed, or 10 pounds zinc as zinc sulfate broadcast and worked into the seedbed have given good results on Idaho soils where zinc is limiting growth. Research in other western states indicates that any zinc material soluble in dilute hydrochloric acid such as zinc carbonate, zinc oxide, zinc sulfate and zinc ammonium sulfite are satisfactory carriers to be applied to the soil. These materials have residual effect and provide available zinc to plants for up to 5 years.

Zinc is held firmly in the soil. It cannot be carried to plant roots by water. Roots must grow to the zinc; consequently, best results come from mixing zinc material in root zone. Plowing fertilizer material under is recommended.

Secondary Soil Nutrient Needs

Calcium

Deficiency symptoms seldom appear on field crops. Generally before calcium becomes a critical factor in limiting plant growth other soil problems appear, such as excess manganese and aluminum caused by excessive soil acidity. In Idaho, calcium is used primarily as a soil amendment; as in limestone to reduce soil acidity and in gypsum on alkali soils to replace sodium in soil reclamation.

Magnesium

No definite need for magnesium fertilizer has been shown for Idaho soils. Similar to calcium, its use is as a soil amendment primarily as dolomitic limestone, which is a mixture of calcium and magnesium carbonate.

Sulfur

The need for sulfur has been shown on most of the very acid soils in Idaho. Legumes, grains and grasses respond to ten to twenty pounds per acre of sulfur where no sulfur has been applied within the past three to four years. On alkaline soils, its use is primarily as a soil amendment applied on soils containing free lime to release available calcium for improving alkali soil conditions.

Caution in Bulk Blending of Micronutrients

When micronutrients are blended with the regular dry fertilizers a segregation may occur unless special precautions are taken. The particle size and specific gravity of the micronutrients blended should be similar to the regular fertilizer.

This segregation may be the result of vibration such as occurs in a truck or spreader or by ballistic action such as occurs when a blend is spread by a fan at the back of a bulk truck. Possible answers to physical separation include:

1. Spraying of $1\frac{1}{2}$ to 2 percent water on the fertilizer particles during blending phase to create a temporary adhesive condition.
2. Use of precision equipment to insure proper application. Direct application of micronutrients to soil by spraying can give uniform application provided the difficulties of proper mixing of solution can be overcome.

Since certain micronutrients have a toxic effect on plant growth when the application rate is greater than recommended, this segregation may result in the micronutrients being applied at excessive rates to a portion of the spreading area with little or none on the remaining area.

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