

low B requirements such as corn, small grains, and soybeans, rarely, if ever, require fertilization with B.

Excessive B applications will usually not harm crops such as alfalfa but can severely damage subsequent crops such as snap beans which are very sensitive to excessive levels of B.

Boron is best applied in a broadcast, mixed fertilizer. Banded applications of B are not recommended due to potential seedling injury. If B must be banded, the rate should not exceed 0.5 lb/acc actual B, and the band should be at least 2 inches below and 2 inches to the side of the seed. Foliar sprays can also be used to correct B deficiencies. Use 0.5 to 1.0 lbs/acc actual B in 30 to 50 gallons of water.

MOLYBDENUM (Mo)

Molybdenum deficiencies have been noted on broccoli and cauliflower grown in Delaware soils. Deficiency of Mo is more likely when the soil pH is less than about 5.7 and liming will often correct Mo deficiency. Deficiency of Mo in broccoli and cauliflower is easily recognized by the "whiptail" appearance of the leaves. The leaf edges are curled inward and the leaf twigs along the mid-rib giving an overall whip-like appearance.

For broccoli and cauliflower, it is recommended that 3 to 4 ounces per acre actual Mo be applied each year with the broadcast fertilizer to prevent deficiencies. Correction of deficiencies in midseason can be made by applying 0.5 lb/acc actual Mo as a foliar spray.

Legumes such as soybeans and alfalfa require Mo for effective root nodulation and nitrogen fixation. Thus, mild Mo deficiency results in apparent N deficiency (yellowing of older leaves). Deficiencies of Mo on these crops have not been positively identified in Delaware. Again, maintaining a proper soil pH will tend to prevent Mo deficiencies. However, if a grower is unable to obtain good root nodulation, despite inoculation of the seed with N fixing bacteria, he is encouraged to make a trial application of Mo. Use 0.5 lb/acc actual Mo as a foliar spray or 1 ounce/acc as a seed treatment. **CAUTION: Mo is toxic to livestock. Do not graze animals on forage that has been sprayed with Mo until after a soaking rain.**

COPPER (Cu)

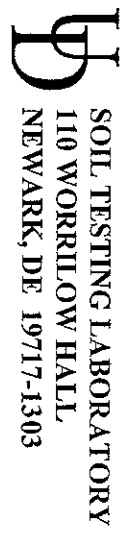
Copper deficiencies have not been noted on any crop in Delaware for many years. There is a possibility of finding Cu deficiency on newly cleared land. Contact your local County Extension office for more information on copper.

ADDITIONAL INFORMATION

Additional information may be obtained from University of Delaware Cooperative Extension Service offices in Newark, Dover, and Georgetown.

Revised by:

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October, 2002



SOIL TEST NOTES

NOTE 4: Secondary and Micro-Nutrients

Your soil test report contains suggested applications of limestone and major nutrients (N, P, K) required for optimum yields and also indicates possible needs for trace elements. For those trace elements indicated, read the appropriate section in this note for information on determining needs as well as rates and methods of application.

MANGANESE (Mn)

Manganese deficiency on soybeans is widespread in Delaware, particularly on sandy soils with pH values greater than 5.8 and high organic matter contents. The visual symptoms are a yellow color between the leaf veins, particularly in the younger leaves. Levels of less than 20 ppm Mn in the upper leaves sampled at early bloom indicate potential Mn deficiency.

Manganese deficiency on corn has not been widely reported, but may occur under the same conditions as for soybeans. Visual symptoms are a yellow striping in the upper leaves but this is not unique to Mn deficiency. Levels of less than 20 to 30 ppm Mn in the ear leaf at early silk may indicate a need for Mn.

Small grains may be deficient in Mn when grown on high pH soils. General yellowing along with gray-brown spots on the upper leaves indicate Mn deficiency.

The Mn soil test may be helpful in confirming deficiencies. The following table gives the minimum Mn level required for optimum growth at different soil pH values.

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Soil pH	Minimum Soil Test Mn Level Required for Optimum Growth
5.0	0
5.5	4
6.0	8
6.5	12
7.0	17
7.5	21

Correction of Mn Deficiencies

- Foliar Application**--When symptoms appear spray with 1 to 2 lbs/ac actual Mn in 20 to 50 gallons of water. Manganese sulfate, manganese oxide, or manganese chelate may be used. Repeat application if symptoms reappear. Avoid mid-day applications of Mn-sulfate as plants may burn. Manganese can be applied with pesticides and herbicides where compatible and if doing so is in compliance with label restrictions.

- Banded Application**--Apply 8 to 10 lbs/ac actual Mn in a fertilizer band 2 inches below and 2 inches to the side of the seed. The same materials listed above may be used. Band applications of acid forming fertilizers such as ammonium sulfate and DAP may correct Mn deficiency in corn without application of Mn fertilizers.

- Broadcast Application**--Broadcast applications of manganese are not recommended due to the high rates required (20 to 40 lbs/ac) and the short-lived effectiveness of this method of application.

ZINC (ZN)

Zinc deficiency is not commonly identified in Delaware but is suspected of occurring in corn grown on sandy, high pH soils. High soil phosphorus levels and cold, wet soil conditions also promote Zn deficiency. Visual symptoms are white or pale yellow bands on

either side of the mid-rib mainly on the lower half of the leaves. The symptoms appear soon after seedling emergence and often disappear later in the season. The effect of mild Zn deficiency early in the season on grain yields is uncertain. Zinc levels of less than about 20 ppm in the ear leaf at silking indicate potential Zn deficiency.

Correction of Zn Deficiencies

- Broadcast Application**--Apply 10 to 12 lbs/ac actual Zn as zinc sulfate or zinc oxide, or apply 2 to 3 lbs/ac Zn using zinc chelate. Broadcast applications should correct Zn deficiencies for several years.

- Banded Applications**--Apply 6 to 8 lbs/ac actual Zn as zinc sulfate or zinc oxide, or 1 to 2 lbs/ac Zn as zinc chelate in a 2" x 2" fertilizer band. This method requires yearly applications to correct Zn deficiencies.

- Foliar Application**--Apply 1 lb/ac actual Zn as zinc sulfate or zinc oxide, or 0.5 lbs/ac Zn as zinc chelate, in 20 to 50 gal. of water. Spray the plants when they are 6 to 8 inches tall, and repeat application if symptoms reappear.

SULFUR (S)

Sulfur deficiency has not been positively identified in many instances in Delaware. However, it is suspected of occurring in corn, especially under irrigation on sandy soils.

Identification of S Deficiencies

- Visual Symptoms**--Corn leaves are yellowish, particularly between the leaf veins. All leaves, younger and older, show these symptoms unlike nitrogen deficiency where the older leaves are affected first.

- Plant Analysis**--Sulfur levels of less than about 0.20% and/or N:S ratios of greater than about 12 in the ear leaf at early silk indicate potential S deficiency. Samples taken early in the season are not reliable indicators of sulfur deficiency.

- Soil Test**--A sulfur soil test has not yet been calibrated for Delaware soils. Research on this problem is continuing.

Correction of S Deficiencies

If, based on the above criteria, S deficiency is suspected of limiting yields in previous years, it can be corrected by broadcasting 40 lbs/ac actual S as ammonium sulfate (24% S) or gypsum (19% S) at planting. Banded ammonium sulfate at 20 to 30 lbs/ac actual S should also be effective.

BORON (B)

In Delaware, boron deficiency is likely to occur on alfalfa and several vegetable crops, particularly when grown on sandy soils low in organic matter. Deficiencies of B are more likely during dry periods. Responses to applied B have not been found on grain crops grown in Delaware.

In general a boron recommendation can be made for crops, requiring B without consideration of a soil test. The B soil test, while not a precise indicator of B availability, may be useful for improving the B recommendation. The boron soil test may be interpreted as follows:

Soil Test Interpretation	Soil Test Boron
Low	0.00 - 0.70
Medium	0.71 - 1.40
High	>1.40

Crops with high boron requirements include alfalfa, beets, broccoli, cauliflower, and cabbage. These crops should receive 3 lbs/ac actual B when the soil test is low, 2 lbs/ac actual B when medium, and 0 to 1 lb/ac actual B when the test is high. Crops with medium boron requirements include asparagus, carrots, muskmelons, radishes, tomatoes, and clovers. These crops should receive 2 lbs/ac actual B when the soil test is low, 0 to 1 lb/ac actual B when medium and no B when the test is high. Crops with