fertilizers have been placed too close to the seed. Excessive salt levels will cause poor germination and seedling development. Established plants, such as ornamental shrubs, will wilt and show symptoms typical of drought. The soluble salt level is reported as the conductivity, in mmhos/cm, of a water extract. In general, plants can tolerate salt levels up to about 0.8 mmhos/cm. See ***Soil Test Note 8*** for further information on this test.

Boron (B)--Deficiencies of this trace element are uncommon in Delaware, but may occur on sandy soils in the southern half of the state. Alfalfa, broccoli, cauliflower, and beets have especially high boron requirements. See ***Soil Test Note 4*** for further information on this test.

Sulfur (S)--As with Mn and Zn, crop responses to sulfur rarely occur in Delaware. Prediction of economic responses to applied sulfur is difficult because in many Delaware soils there is sufficient sulfur in the subsoil (12-24" depth) to supply all crop needs. Surface soil testing (0-8") alone is therefore unlikely to accurately identify the situations where an economic response to sulfur fertilization will occur. Soil test results for sulfur can only be interpreted if a subsoil sample from the same field is included with a surface sample. In general, if the sulfur concentration in the surface soil sample is less than 2 lb/ac and is less than 20 lb/ac in the subsoil sample, sulfur may be recommended for certain crops.

OTHER ESSENTIAL ELEMENTS

Extensive research in Delaware and surrounding states has been and continues to be conducted on all essential elements for which soil tests may be useful. It is the philosophy of this laboratory to offer a soil test if (1) there is evidence of deficiencies on crops grown in Delaware, and (2) if the soil test is at least helpful in diagnosing these deficiencies. Not all of the soil tests offered are accurate at predicting crop responses and may be intended only to provide information to supplement other diagnostic tools such as crop appearance and plant analysis. This laboratory may discontinue certain tests, or offer new ones, as new evidence comes to light through research. The interpretation of the soil tests offered, as well as the general recommendations made without benefit of a soil test, represent the most current understanding of crop nutrient needs for Delaware soils.

ADDITIONAL INFORMATION

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

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SOIL TEST NOTES

NOTE 1: Explanation of Laboratory Tests

The University of Delaware Soil Testing Laboratory offers two types of soil tests: a comprehensive routine fertility test that is performed on all samples, and several special tests, offered on a request basis. An extra charge is added for each special test. A complete lime and fertilizer recommendation can generally be made from the routine test alone. The following is an explanation of the tests offered by this laboratory.

COMPREHENSIVE ROUTINE FERTILITY TEST:

Soil pH, Lime Requirement, Plant-Available Nutrients (P, K, Mg, Ca, Mn, Zn, B, and S) and Organic Matter

Soil pH and Lime Requirement --This test indicates whether a soil is acid (pH less than 7.0) or alkaline (pH greater than 7.0). All Delaware soils are naturally acid and, when first brought into production, require limestone to raise the pH. The optimum pH depends on soil type and crop to be grown.

In Delaware, the optimum pH for most crops is between 5.8 and 6.5. Alfalfa requires a slightly higher pH than most crops, while potatoes and "acid-loving" ornamentals do best at a somewhat lower pH.

When soils are too acid, plant growth is limited by aluminum toxicity and reduced availability of nutrients such as phosphorus, calcium, and magnesium. On the other hand, liming soils to excessively high pH values can lead to deficiencies of manganese and zinc. Therefore, it is extremely important to lime soils at rates based on soil tests results. Soil pH, in conjunction with the soil type and the optimal pH of the crop to be grown, is the basis for lime recommendations made by this laboratory.

Fertility Index Values--The results of P, K, Ca and Mg analyses for soil samples are expressed as *"Fertility Index Values"* or FIVs. The scale has no true units, such as lb/acre, but represents relative fertility levels that are related to the probability of a plant response to additions of a given nutrient. This assumes that no other factors such as temperature, moisture, disease, etc. are limiting yield. The following table summarizes the interpretation of the index value scale:

Table 1. UD Soil Test Interpretive Categories

Fertility Index Value	Soil Fertility Rating	Interpretation
0-25	Low	High probability of favorable plant response to applied fertilizer.
26-50	Medium	Low to moderate probability of plant response to applied fertilizer.
51-100	Optimum	Response to applied fertilizer is unlikely.
101+	Excessive	Soil concentration of nutrient is more than adequate for plant growth. Further applications will be uneconomical and may have undesirable effects on plant growth.

If the yield potential of a crop is very high, some fertilizer may be recommended even though the soil test level is "***Optimum***". However, the amounts recommended will be small, and are intended to maintain optimum levels. "Excessive" levels usually indicate only that no additional fertilizer is needed. Reductions in yield due to excessive fertility are rare.

Nitrogen (N)--Nitrogen is the most important nutrient for plant growth. There is, however, no reliable pre-plant soil test for N for use in Delaware at this time. In general, N available from previous fertilization or the breakdown of soil organic matter is inadequate for crop growth. N fertilizer recommendations, however, do take into account N supplied to crops from these sources. The recommended rate of fertilizer N is based on crop needs and management practices. Nitrogen contributions from legume cover crops, manures, composts, etc. are noted on the soil test report.

Phosphorus (P)--Phosphorus is one of the major elements, along with nitrogen and potassium, that are required by plants in large amounts. Inadequate soil P causes stunting of roots and tops and reduced yields. Generally, crops respond to added P fertilizer when the P index value is below 40 to 60. Intensive production of some crops may require P fertilization at higher soil test levels. In most cases, a P index value of 50 to 100 is considered optimal and should be the goal for top production.

Phosphorus fertilizer recommendations are made in units of pounds of P_2O_5 per acre or 1,000 sq. ft. The phosphorus content of fertilizer materials is expressed as percent P_2O_5.

Potassium (K)--Potassium is the third major element required by plants in large amounts. Inadequate soil K can lead to poor stem strength (lodging), reduced crop quality and poor yields. Generally, crops will respond to added K fertilizer when the index value is below 40 to 60, although higher soil test levels may be required for top yields of some crops. In most cases, maintaining a K index value of 60 to 100 should be the goal for maximum production.

Potassium fertilizer recommendations are made in units of pounds of K_2O per acre of 1,000 sq. ft. The potassium content of all fertilizer materials is expressed as percent K_2O.

Magnesium (Mg) and Calcium (Ca)--Magnesium and calcium are secondary elements that are normally supplied to plants through additions of limestone. Deficiencies of Ca and Mg can lead to reduced crop quality and poor yields. In general, both Ca and Mg index values should be greater than 50 for maximum production. In most cases, where Mg and/or Ca are low, the soil pH is also low and additions of limestone will correct both problems. The Mg and Ca index values are used to determine whether high magnesium (dolomitic) or high calcium (calcitic) limestone is required. The appropriate type of limestone for each sample is indicated on the soil test report. Occasionally, the soil Mg level will be low even though the pH is high, in which case a soluble Mg fertilizer such as magnesium sulfate (epsom salts) will be recommended.

Manganese (Mn) and Zinc (Zn)--Deficiencies of these elements are rare in Delaware, and if found, occur primarily in certain commercial crops grown on the sandy soils of Kent and Sussex counties when the pH is greater than 6.0. Manganese deficiency has been observed in over-limed soils with soybeans and may occasionally occur with corn and small grains. Other crops are able to obtain adequate Mn despite low soil levels. The Mn soil test is reported as pounds of Mn per acre. The critical Mn level, below which a response to Mn fertilizer is expected, ranges from 0 to 20 lbs/A, depending on the soil pH.

The likelihood of crop response to zinc is related to crop type, soil Zn level, soil pH, soil P level and climatic conditions in the spring (e.g. soil temperature). The Zn soil test is reported as pounds of Zn per acre and the critical level will range from 0 to 4 pounds per acre, depending on soil pH and phosphorus level. Economic crop yield responses to Zn are rare in Delaware.

See ***Soil Test Note 4*** for further information on interpreting Mn and Zn results.

Organic Matter (OM)--The organic matter test gives a general indication of the tilth, or quality of a given soil. Generally, a higher organic matter content means better soil quality, as nutrient and water holding capacities are greater, and improved aeration and soil structure enhance root growth. Most well-drained Delaware soils have low organic matter contents, (<3%). However, dark-colored, poorly-drained soils may have OM contents as high as 8 to 10%. Some growers may use the organic matter test when they are trying to increase soil OM levels through no-tillage cropping with cover crops or rotation of pasture sods with row crop production. Growers may also use the organic matter test to help determine herbicide rates. Because organic matter can tie up some herbicides, increased rates may be needed where the OM content is greater than 3%. Consult the label on individual herbicides for specific information.

SPECIAL TESTS (*Soluble Salts, Boron, Sulfur*)

Soluble Salts (SS)--This test is used primarily for greenhouse, nursery, and home garden soils where very high application rates of fertilizer may have led to a build-up of soluble salts. Excessive salt levels in field crop situations are relatively rare, unless banded