## Interpreting a Soil Test

A soil test value for all nutrients except nitrate-nitrogen is an ***index*** of the availability of that nutrient to plants in the soil being tested. The University of Minnesota Soil Testing Laboratory reports soil test results as parts per million (ppm) and should be thought of as an index of the relative level. Older soil tests reported relative nutrient levels as lb/A; however, this unit was confusing since many incorrectly interpreted the result as actual lb of nutrient in the soil when in fact it only represented a small fraction of the total nutrient in the soil. To convert an older soil test reading of lb/A to ppm, divide lb/A by two.

The probability of response to applied fertilizer can conceptually be determined from relative soil test levels. As shown in **Table 1**, the higher the soil test level, the lower the probability of response to applied fertilizer. Conversely, a low soil test level would have a high probability of response to applied fertilizer.

***Table 1.*** *Generalized relationship between relative soil test level and probability of response to applied fertilizer.*

| Relative Soil Test Level | Probability of Response to Applied Fertilizer |
|---|---|
| low | greater than 90% |
| medium | 60 to 90% |
| medium-high | 30 to 60% |
| high | 10 to 30% |
| very high | less than 10% |

In contrast to the other nutrients, nitrate-nitrogen is expressed as lb/A when sampled to a 2-foot depth since it is a measure of the actual amount of nitrate-nitrogen present in the soil rooting zone at the time of sampling. Samples taken to other depths are reported as ppm and the nitrate test result is not then used in making the nitrogen recommendation.

## Fertilizer Analyses and Calculating Fertilizer Rates

By convention, fertilizer phosphorus and potassium are expressed on the oxide basis, $P_2O_5$ and $K_2O$, respectively. In contrast, fertilizer nitrogen is expressed on the elemental basis, N. Minnesota state law requires that any material sold as fertilizer clearly shows the percent nitrogen expressed as N, percent phosphate expressed as $P_2O_5$, and percent potash expressed as $K_2O$ on the bag. The percentages of each nutrient on the fertilizer label are referred to as the grade of fertilizer and are guaranteed by the manufacturer. All fertilizer recommendations are based on the amount of N, $P_2O_5$, and $K_2O$ to apply per given area (usually per acre). Fertilizers can be sold as complete fertilizers, i.e., they contain all three primary nutrients—nitrogen, phosphorus, and potassium—such as 10-10-10, or they can be sold as single nutrient fertilizers such as 46-0-0 (only N), 0-0-60 (only $K_2O$), etc.

To determine the actual amount of nutrient in a given weight of fertilizer, multiply the percentage of nutrient by the weight of fertilizer and then divide by 100. For example, to determine the amount of actual nitrogen in 200 lb of urea (46-0-0): 200 X 46/100 = 92 lb of N. If 200 lb of 8-32-16 is applied per acre, then the total nutrients applied would be 16 lb N, 64 lb $P_2O_5$, and 32 lb $K_2O$.

If the fertilizer recommendation calls for a given amount of nutrient per acre, then to calculate the amount of fertilizer to apply, divide the recommended amount by the percent nutrient (fraction basis) in the fertilizer. For example, if the recommendation calls for 150 lb N per acre, and urea (46-0-0) is the fertilizer that will be used, the total amount of urea to apply per acre would be 150/0.46 = 326 lb urea per acre. If ammonium nitrate (33-0-0) is used, then 150/0.33 = 454 lb ammonium nitrate per acre would be required. Similar calculations can be made for phosphate and potash fertilizers.

## Soil pH Modification

Soil pH is an important chemical property that affects nutrient availability and microbial activity. In general, the optimum pH for most fruit and vegetable crops is between 5.8 and 7.0 for mineral soils and 5.4 and 6.2 for organic soils (peats and mucks). Two exceptions are blueberries and potatoes. Blueberries are adapted to acid soil conditions and grow best at a soil pH between 4.5 and 5.2. Potatoes can tolerate a wide range in soil pH; however, potato scab can become more of a problem in scab-susceptible varieties as soil pH increases above 5.3.

### Liming

Liming materials are used to increase the pH of soils. Not all soils in Minnesota need to be limed. In general, soils in the western part of the state were formed from limestone rocks and receive lower amounts of rainfall. Soils formed under these conditions have a high native pH. Many soils in eastern Minnesota were formed under conditions of higher rainfall and tend to be acidic. Intensive cropping and continuous use of manure and/or ammonium based fertilizers will acidify soils over time. In contrast, if high pH irrigation water is used on acid soils, soil pH may actually increase over time.

The need for lime is determined from a routine soil test. The pH value reported in a soil test indicates whether lime is needed, but cannot be used to determine how much lime is needed. The amount of lime to apply is dependent on reserve soil acidity, which is measured in the laboratory by the “buffer index” or SMP buffer test. The lower the buffer index, the more lime is required. In most cases, buffer index is related to soil texture and organic matter content. At the same soil pH value, soils with a high clay and organic matter content will require more lime than soils with a high sand and low organic matter content. The difference in lime application rates is determined by the SMP buffer index (**Table 2**). The SMP buffer test is not used if the soil pH is higher than 5.9 because of the high relative error above this level. The amount of lime recommended for mineral soils is that needed to raise the pH to 6.0 or 6.5. For peat and muck soils with a soil-water pH of 5.4 or less, lime is recommended to raise the pH to 5.5.

The amount of lime to apply is dependent on the type or quality of the liming material. The quality of a limestone is