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Using a Chlorophyll Meter to Make Nitrogen Recommendations on Wheat

Efficient use of nitrogen (N) fertilizer is important to economical wheat production and to the quality of ground and surface waters. Insufficient N results in reduced wheat yield and reduced profit, compared to a properly fertilized wheat crop. However, excessive N produces wheat plants that are susceptible to lodging and disease, resulting in decreased yield and increased input cost. The potential for nitrate (NO_3) enrichment of ground and surface waters also increases with excessive N fertilization.

Researchers have been looking for ways to increase the efficiency of fertilizer N use. In recent years, intensive management studies have shown that split topdressings of fertilizer N after spring green-up may improve N efficiency and increase yields. The amount of fertilizer N recommended in February at spring green-up may be better determined by tiller counts, sometimes with the aid of deep soil samples. Deciding on the amount of N fertilizer for the March application (Feekes 5-6) is more subjective, but may be more important. A tissue test taken at Feekes 5 is the most precise way to determine the amount of N needed in March. While this test helps in making that decision, it is time consuming and, in many cases, unacceptable for the producer.

Chlorophyll and Leaf Content of N

An alternative to the tissue test is a chlorophyll test, using a chlorophyll meter to estimate N in the plant and aid in determining fertilizer N recommendations. The Minolta chlorophyll meter (model SPAD 502) can be used to make quick and easy measurements of leaf greenness, which is positively related to leaf chlorophyll content. Recent research indicates a close correlation between leaf chlorophyll content and leaf N content (Fig. 1). This is true because much of leaf N is contained in chlorophyll.

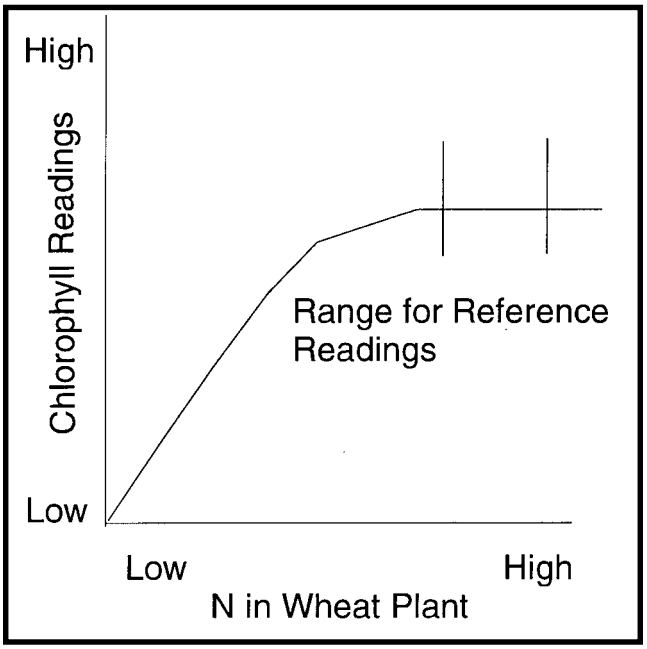

Figure 1. Effect of N in Plant on Chlorophyll Readings

Advantages of the Chlorophyll Meter

The chlorophyll meter is faster than tissue testing for N. Samples can be taken often and can be repeated if results are questionable. Chlorophyll can be measured at any time to help determine the crop N status. The chlorophyll meter allows "fine tuning" of N management to field conditions and reduces risk of under- or over-fertilizing the wheat crop. However, this is a tool to complement, not replace, other aspects of sound management. If a producer is already aware of the amount of N needed for his soil type, under his management conditions, and in normal weather

conditions, then the use of the chlorophyll meter will probably result in little or no change in the N recommended. The chlorophyll meter will be most helpful when a producer is unfamiliar with the situation or when conditions are unusual (manure use, excessive rains, high N carryover, etc.). The chlorophyll meter would also help people who are not highly trained to make N recommendations.

Factors Affecting Chlorophyll Readings

Several factors affect chlorophyll readings. Some wheat varieties are greener than others and will have higher readings. Stage of growth also affects the readings. Anything that causes the plant stress will affect the amount of chlorophyll in the plant and thereby affect the readings. Because plant chlorophyll and N levels are affected by so many factors, it is impossible to identify a universal meter reading that indicates sufficient N for all wheat. The readings must be calibrated for the variety and other environmental factors in order to be useful. Calibration is easy and can be accomplished by over-fertilizing three or more areas (small spots or strips) in the field with N and then taking reference readings from these areas to compare to the rest of the field.

Using the Chlorophyll Meter

Stage of Growth

The Feekes 5 growth stage, which usually occurs from mid- to late March in Kentucky, is the best stage for measuring chlorophyll and applying the last N fertilization. Chlorophyll readings and subsequent N recommendations made at the Feekes 6 growth stage, which usually occurs around the first of April in Kentucky, are also acceptable. Since readings taken at Feekes 4 growth stage are more inconsistent, the chlorophyll meter should not be used at this stage of growth.

The Feekes 5 growth stage, called the pseudo-stem erection stage, occurs as the stem is elongating. It is identified when the leaf collar of the first fully developed leaf from the top of the plant is approximately 2 inches above ground level. The Feekes 6 growth stage is jointing. At this stage, the joint, the growing part of the plant, is just above ground level; it can be located by squeezing the plant stem between the thumb and fingers or by splitting the stem open and visually observing it.

Establishing Reference Areas

The chlorophyll meter can be calibrated for the variety, previous crop, fertilizer and/or manure, and some other factors by establishing reference areas. The reference areas should represent the field as much as possible, but should not include areas that are imperfectly or poorly drained. The reference area should be either a strip through the field or at least three small areas in the field (Fig. 2). An excessive amount of N should be applied to these areas to develop maximum chlorophyll concentrations in the leaves (Fig. 1). When the fields are fertilized in February (Feekes 3-4), the reference areas should receive about 150 lbs/ac of actual N. At Feekes 5 (March), compare the average chlorophyll meter readings from the reference strips to those from the rest of the field. From these two readings, the need for additional N fertilizer at Feekes 5 can be determined.

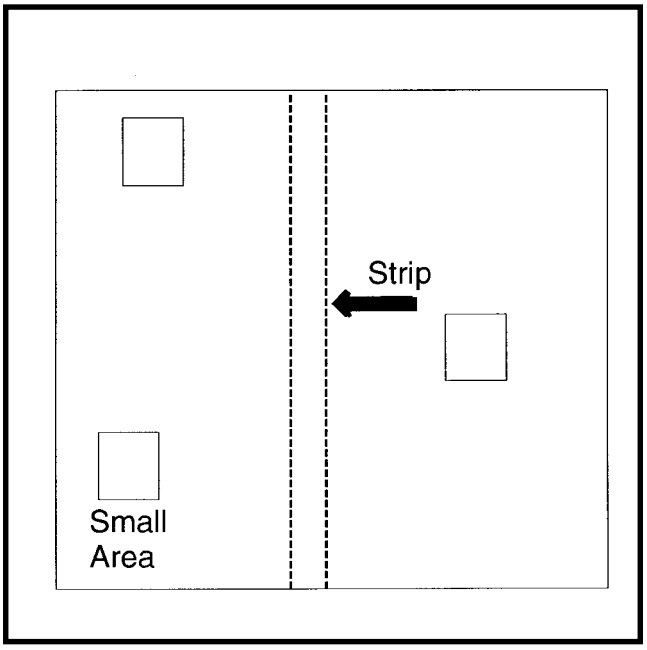

Figure 2. Field with small reference areas or strip of more than adequate nitrogen applied at "spring green-up"

Sampling

Collect the individual readings carefully to ensure their accuracy. Avoid taking readings from plants that are not representative of the crop. Individual readings will vary from plant to plant, but the goal is to collect 30 readings whose average represents the crop. The Minolta SPAD 502 collects and stores up to 30 individual readings and automatically calculates the average. Compare the average readings of 30 plants from the reference area and the adjacent bulk field.

Use the first fully expanded leaf from the top of the plant for each reading. A fully expanded leaf is one that has a collar surrounding the stem. After selecting the leaf to be sampled, take readings from a point one-half the distance between the leaf tip and the collar and halfway from the leaf margin to the mid-rib. Do this when the plant is at the Feekes 5 or 6 growth stage.

Interpreting Chlorophyll Meter Readings

After recording the average meter readings from the bulk of the field as well as from the reference areas, calculate an N recommendation as follows:

N = 6 + (7 x D)

N = N (lb/ac) needed at Feekes 5 for optimum growth.

D = Difference between average chlorophyll readings from the field and the reference areas where high levels of N were added in February.

Example:

1. Small reference areas or strips with high N (150 lbs/ac) added at Feekes 3 read an average of 52 at Feekes 5 growth stage.

2. Rest of field gives an average meter reading of 45.

3. 52 - 45 = 7

4. 6 + (7 x 7) = 55 Pounds N/acre recommended

Timing Fertilization

The chlorophyll meter is designed to read N applications at Feekes 5 or 6 regardless of any N applied previously. Readings indicate the N needs of a crop if no N was added to the field prior to the readings or if another application had been added a few weeks earlier. N added prior to the readings will take about three weeks to fully affect chlorophyll development.

Precautions

Take care not to use the chlorophyll meter when the plant is under stress because the readings will not be accurate. Poorly drained soil conditions, diseases, late winter freezes, and recent herbicide applications are the most common of these stresses.

- The condition to be most aware of is excessive wetness due to poor drainage. These soils can produce good wheat, but they are marginal during wet years. These types of soils will sometimes cause a marginal stress on the plant that may not be quickly evident to the eye, but will result in reduced chlorophyll readings. If this is the case, the chlorophyll readings will result in an inaccurate fertilizer N recommendation. Avoid collecting readings from areas of the field that are not well drained, from poorly drained reference areas, or from wet leaves because moisture can distort the readings.
- If areas of the field are diseased, causing the crop to be off color, avoid taking readings from these areas.
- Although severe late winter freezes in March are uncommon, they will cause the plant to turn light green to yellow and give inaccurate N readings. It will take two to three weeks for the plants to completely recover enough for readings to be accurate.
- On fields receiving manure applications, use the chlorophyll meter in conjunction with Nitrogen testing of 3-foot-deep soil samples.
- Extreme temperature changes can cause meter readings to fluctuate, so don't leave the meter in the direct sun (e.g., on a vehicle dashboard) or take it directly from an air-conditioned vehicle to the field on a hot day.

Where trade names are used, no endorsement is intended, nor criticism implied of similar products not named.

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