OPTI-SCIENCES, INC.

Application Note #0208

The Use of Fluorometers and Chlorophyll Content Meters in Difficult Nitrogen Deficiency Testing

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Nitrogen sufficiency levels below 95% of optimum can cause reduced crop yields and result in lower profits. Over fertilization, because of the higher cost of nitrogen can be expensive and of course, contribute to ground water contamination.(Peterson 2006) The ability to accurately determine the existing levels of nitrogen has become increasingly both financially and environmentally important.

Standard Chlorophyll Fluorometer measurement parameter Fv/Fm does not detect nitrogen deficiency at an early enough stage to be useful. (Baker N.R, Rosenquist E. 2004) Nitrogen levels have been measured in C3 plants using "Yield" with high light levels. (Cheng 2001)

There are now newer fluorescence tests that have had success in measuring nitrogen stress but they require more advanced research grade equipment. R. Strasser (2004) reports the ability to measure nitrogen stress with the K step in the OJIP test. Various fluorescence ratios have also been tested for nitrogen stress measurement but most are limited by too many variables to be useful (Cerovic 1999). In 2000 Samson discovered a fluorescence ratio, FRFex360/FRFex440, that can measure nitrogen stress and distinguish nitrogen stress from sulfur stress with reduced variables. Both of these tests are available on the new Opti-Sciences OS5p chlorophyll fluorometer.

Such advanced instrumentation as used by the researcher is not as easily ported nor affordable to local consultants or the producers who have a critical need for this information. Fortunately easy to use chlorophyll content meters have become a complimentary tool for the measurement of nitrogen stress and are quite cost effective with prices as low as $1,295.

The chlorophyll content meter uses absorption measurement techniques to determine chlorophyll content. Since nitrogen is a key element of the chlorophyll molecule, chlorophyll content can be used to determine the amount of nitrogen in plants. By measuring the "greenness" of the leaf and the leaf thickness by using two different wavelength ranges, chlorophyll content meters can provide an inexpensive and fast way to determine when nitrogen fertilization is necessary for optimal yield and profit as well to prevent over fertilization. (Peterson 2006) While leaf greenness may be affected by many factors it is sensitive to nitrogen deficiency and sulfur deficiency. Care must be taken to ensure proper analysis.

Todd Peterson and other researchers from the University of Nebraska at Lincoln have developed a technique using a chlorophyll content meter to determine the proper time for fertilization and the amounts of fertilizer necessary for optimal yield and minimal over fertilization. Before first fertilization, a soil test will determine the amount of nitrogen required. It is recommended that the entire field be fertilized with between 50% and 66% of the nitrogen recommended by the soil test before the six leaf stage in corn.

Peterson's group recommends the establishment of reference plant strips in three to five areas of a field to reflect accurate overall field conditions. These plants will receive nitrogen levels at or slightly above the nitrogen rate recommended by NEBGuide G74-714 "Fertilizer recommendations for corn" sufficient to prevent any deficiency. Reference plants act as a field calibrated standard that other plants in the field are measured against.

Testing with the chlorophyll content meter starts when the corn plant is one foot tall and continues until 20 days after silking. Peterson's group recommends taking measurements once a week from 30 different plants in a given area and in three to five different areas then average the readings. He then compares these averages to averages from the reference strip to determine "sufficiency index".

Sufficiency Index:

$$\text{Sufficiency Index} = \frac{\text{Average of Bulk Readings}}{\text{Average of Reference Strip Readings}} \times 100\%$$

When the sufficiency index is at or below 95%, 20 to 40 pounds of nitrogen per acre should be applied through fertigation for fast action.

Peterson found that the chlorophyll content meter will respond to the improved nitrogen levels within four to six days after fertigation.

A similar method was developed for nitrogen management of wheat at the University of Kentucky . (Murdock, Jones, Bowely, Needham, James and Howe 1997)

The cost of The Chlorophyll Content meter can be justified by eliminating the time and money required for many of the laboratory analysis tests. The use of the sufficiency index allows producers to take control of much of their own testing, test more often for more timely results, test whenever they want, and test at a savings.

For a comparison of the two dominant Chlorophyll Content Meters available refer to:
Nick Knighton and Bruce Bugbee, (2002) "A Comparison of Opti-Sciences CCM-200 Chlorophyll Meter and the SPAD 502 Chlorophyll Meter" from the Crop Physiology Laboratory – Utah State University. This paper is available on our Web site in the CCM-200 section or it can be found at Utah State University. The paper written by Peterson and others can be obtained at:
http://www.1anrpubs.unl.edu/epublic/pages/publicationDjsp?publicationId=648

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Cerovic Z, Sampson G., Morales F., Tremblay N., Moya I., (1999) Ultraviolet-induced fluorescence for plant monitoring : present state and prospects, Agronomie 19 (1999) 543-578

Cheng L., Fuchigami L., Breen P., (2001) "The relationship between photosystem II efficiency and quantum yield for CO2 assimilation is not affected by nitrogen content in apple leaves." *Journal of Experimental Botany, 52(362):1865-1872*

Murdock L., Jones S., Bowely C., Needham P., James J. and Howe P. (1997) "Using a Chlorophyll Meter to Make Nitrogen Recommendations on Wheat". Cooperative Extension Service University of Kentucky – College of Agriculture.

Peterson T.A., Blackmer T. M., Francis D. D., Schepers S. S., (2006)"Using a Chlorophyll Meter to Improve N Management", NebGuide G1632 University of Nebraska at Lincoln.

Samson G, Tremblay N., Dudelzak A.E., Babichenko S.M., Dextraze L., Wollring J., (2000) NUTRIENT STRESS OF CORN PLANTS: EARLY DETECTION AND DISCRIMINATION USING A COMPACT MULTIWAVELENGTH FLUORESCENT LIDAR Proceedings of EARSeL-SIG-Workshop LIDAR, Dresden/FRG, June 16 – 17

Strasser R.J, Tsimilli-Michael M., and Srivastava A. (2004) - Analysis of Chlorophyll a Fluorescence Transient. From Chapter 12, "Chlorophyll a Fluorescence a Signature of Photosynthesis", edited by George Papaqeorgiou and Govindjee, published by Springer 2004, PO Box 17, 3300 AA Dordrecht, The Netherlands, page 340