PRELIMINARY REPORT ON USE OF A SPAD CHLOROPHYLL METER FOR EARLY DETECTION OF PLANT NITROGEN STATUS IN SUGARBEET

Peter Sexton

Abstract

In sugarbeets, petiole nitrate content is assayed through the season as a tool for indicating plant N status. This requires sending the petioles off for laboratory analysis. An in-field assay of plant N status would be more timely and perhaps less expensive than the petiole nitrate assay. The objective of this work is to determine the suitability of a hand held chlorophyll meter (SPAD meter) for determining sugarbeet N status. This is a work in progress, but from initial results it appears that the SPAD meter will not provide an early indication of N deficiency symptoms.

Introduction

This is a work in progress so only preliminary results will be reported herein. Excess N applied to the sugarbeet crop results in excessive top growth, decreased sugar percentage, and increased levels of impurities in the beet (Akeson et al., 1979; Ulrich and Hills, 1990; Winter, 1990). For this reason growers often limit N applied at planting and then monitor petiole nitrate through the season to determine whether their crop would benefit from additional applications of N. Petiole nitrate is a useful criteria for determining N status of sugarbeets (Ulrich and Hills, 1990), but there is a lag time between when samples are taken and when results are reported from commercial laboratories. Use of an in-field analysis providing immediate results would allow growers to make more timely decisions regarding whether to apply extra N or not. The SPAD chlorophyll meters give immediate results and have been used successfully for determining N status of corn *(Zea mays)* (Varvel et al., 1997) and rice *(Oryza sativa)* (Ladha et al., 1998) crops. It has also been tried and found not well correlated with N in mint (Mitchell et al., 1995) and tobacco (MacKown and Sutton, 1998). Near-infrared (NIR) spectrometry has been used for in-field determination of N status in cotton (Saranga et al., 1998). To our knowledge, there are no reports in the literature on the suitability of using a SPAD meter, nor NIR analysis, for determining N status of the sugarbeet crop. The objective of this work was to test these two methods against the standard of petiole nitrate analysis.

Materials and Methods

Three varieties of sugarbeet (Beta 8256, HM Canyon, and Crystal 203) were grown under 6 levels of applied N (0, 60, 120, 180, 240, and 300 lb N per acre) in a split plot design with N treatment being the main plot and variety as the subplot. Initial soil N was 58 lb per acre measured to a 2-ft depth. All plots were replicated four times. Subplots consisted of 6 rows, 6.1 m in length (20'), spaced 0.61 m apart (2'). The trial was planted on 6 June 1998 with a seeding rate of 8.2 plants m^{-2} (5 plants per foot of row). The stand was thinned to 0.18 m (7") plant to

plant spacing on 25 June. Weeds and insects were controlled with agrochemicals.

Relative absorbance measurements using a SPAD-502 chlorophyll meter (Minolta Camera Co., Japan) was taken on 10 leaves per plot at 47, 54, 61, 71, 74, 81, 94, 102, and 109 days after planting (DAP) for 'Beta 8256'. The other two cultivars were sampled on 47, 61, 74, and 109 DAP. Measurements were taken by removing the fifth or sixth leaf from 10 plants chosen at random from the plot. The leaves and petioles were placed in a paper bag in the shade immediately and within 15 minutes were placed within a refrigerator at 5°C. SPAD readings were taken on opposite sides of the leaf (two measurements per leaf) approximately one-third of the way down from the tip and about 3 cm in from the edge. The leaf blade was stripped from the petiole and each were dried separately at 70°C and ground for future analysis.

Plots were harvested on 15 October 1998. Bordered two row samples, 4.4 m long (14'6") were dug and topped for each plot. Plants were topped and fresh weight of tops and beets were determined in the field. Five beets were taken at random for sugar analysis complements of Spreckles Sugar Company. Sugar yield was calculated as the product of fresh weight per unit area and sugar percentage. Two beets from each plot were quartered and one-quarter from each were weighed, chopped, and dried at 90°C for future analysis.

If resources permit, we will analyze the petiole samples for nitrate and carbohydrate. Following this the samples will be submitted for NIR (near-infrared) analysis. At that point a comparison of SPAD reading, petiole nitrate, and NIR analysis will be possible.

Results and Discussion

Only preliminary results will be reported as sample analysis is ongoing. At this point, it appears that the SPAD meter will probably not provide an early indication of N deficiency. Over the course of the season SPAD readings declined as N deficiency symptoms began to develop in treatments receiving little N (Fig. 1). Nitrogen deficiency symptoms were discernable with the naked eye by 50 DAP, which was about when the SPAD meter began to show significant differences. So the SPAD meter did not provide advanced indication of N deficiency, although it did give a quantitative estimate of deficiency.

Top growth responded to added N, but beet and sugar yield did not (Fig. 2). Because of the late planting date, this should not be taken to mean that N fertilization of beets is not profitable in central Oregon. This trial was not conducted to answer that question. Earlier planting would have given the plants more time to grow and probably resulted in a greater response to N. What this data does show is that N deficiency occurring late in the season does not affect yield. Ulrich and Hills (1990) recommend that N fertility be managed so that the plants are N deficient during the last 4 to 10 weeks of growth in order to retard top growth and enhance sugar percentage.

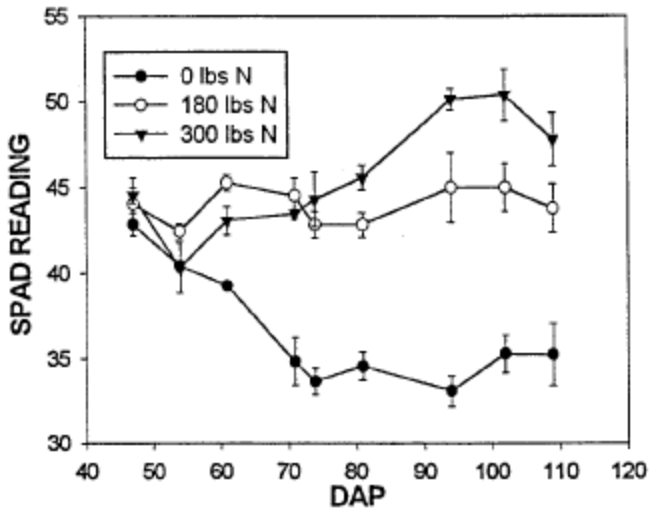

Figure 1. SPAD meter readings taken over the course of the season for 'Beta 8256' sugarbeet. Deficiency symptoms were discernable with the naked eye by 50 DAP in the zero added N treatment.

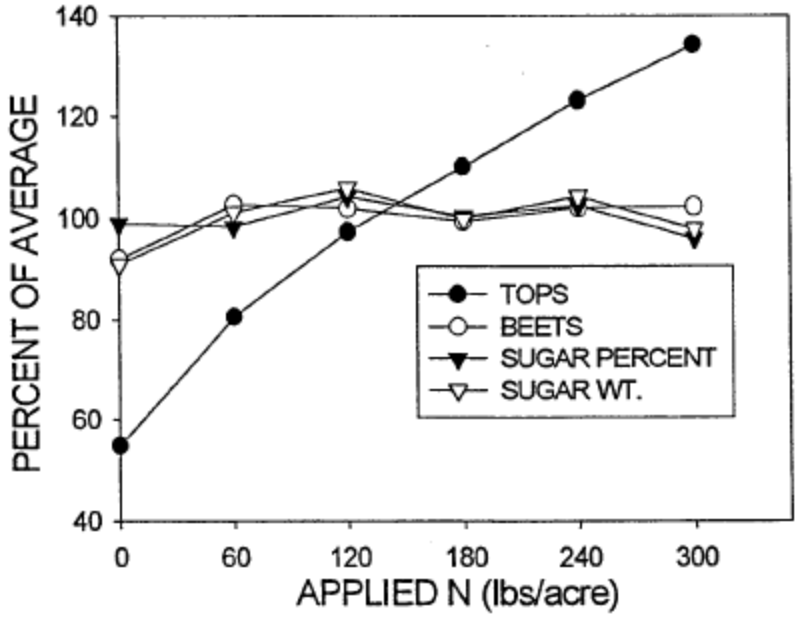

Figure 2. Response of top, beet, and sugar yields, and sugar percentage of beets to applied N in a late-planted N fertility trial conducted at Madras. For each variable, the data presented are means of three cultivars expressed as a percentage of the grand mean. This was done so that all the variables could be plotted in one graph.

Literature Cited

Akeson, W.R., D.G. Westfall, M.A. Henson, and E.L. Stout. 1979. Influence of nitrogen fertility level and topping method on yield, quality, and storage losses in sugarbeets in the Kansas, Colorado, and Nebraska growing areas. Agron. J. 71: 292-297.

Ladha, J.K., A. Tirol-Padre, G.C. Punzalan, E. Castillo, U. Singh, and C.K. Reddy. 1998. Nondestructive estimation of shoot nitrogen in different rice genotypes. Agron. J. 90: 33-40.

MacKown, C.T., and T.G. Sutton. 1998. Using early-season leaf traits to predict nitrogen sufficiency of burley tobacco. Agron. J. 90: 21-27.

Mitchell, A.R., N.A. Fanis, and J.E. Light. 1995. New tools for plant-response nitrogen testing of peppermint. p. 19-32. *In* Special Report 941. Agric. Exp. Stn., Oregon State University. Central Oregon Agricultural Research Center Annual Report.

Saranga, Y., A. Landa, Y. Shekel, A. Bosak, and U. Kafkafi. 1998. Near-infrared analysis of cotton leaves as a guide for nitrogen fertilization. Agron. J. 90: 16-21.

Ulrich, A., and F.J. Hills. 1990. Plant analysis as an aid in fertilizing sugarbeet. p. 429-447. *In* R.L. Westerman, J.V. Baird, N.W. Christensen, P.E. Fixen, and D.A. Whitney (ed.). Soil Testing and plant analysis. ASA, Madison, WI.

Varvel, G.E., J.S. Schepers, and D.D. Francis. 1997. Chlorophyll meter and stalk nitrate techniques as complementary indices for residual nitrogen. J. Prod. Agric. 10: 147-151.

Winter, S.R. 1990. Sugarbeet response to nitrogen as affected by seasonal irrigation. Agron. J. 82:984-988.