COMPARISON OF SPAD CHLOROPHYLL METER READINGS VERSUS PETIOLE NITRATE CONCENTRATION IN SUGAR BEET

Peter Sexton and Jim Carroll

Abstract

Comparison of SPAD meter readings versus petiole nitrate concentration for sugar beets grown under several levels of nitrogen fertilization shows that the SPAD meter lags about two weeks behind petiole nitrate assay in detecting nitrogen deficiency. From these results, it appears that even with the extra time required to send in petioles for analysis, the petiole nitrate assay still provides more timely results than do in-field measurements taken with a SPAD meter.

Introduction

This report follows through on work conducted in 1998 on N nutrition of sugar beet (Sexton, 1999), the purpose of which was to see if a hand-held chlorophyll meter (SPAD meter, Minolta Camera Co., Japan) could be used to replace laboratory measurement of petiole nitrate concentration. Currently, farmers use petiole nitrate concentration to guide in-season application of N. While petiole nitrate is a useful criterion for determining N status of sugar beets (Ulrich and Hills, 1990), 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. Our objective was to make a preliminary evaluation of the usefulness of the SPAD chlorophyll meter for determining N status of sugar beet.

Methods

Three varieties of sugar beet were grown as described earlier (Sexton, 1999) under six levels of N (0, 67, 135, 202, 270, and 337 kg N per ha) applied as urea before planting. Plots were laid out as a split plot design with four replications. Fertilizer treatment was the main plot and variety was the subplot. Three varieties -`Beta 8256,"}-/M Canyon,' and 'Crystal 203' - were used. Ten leaves were sampled from each plot at 47, 54, 61, 71, 74, 81, 94, 102, and 109 days after planting (DAP). SPAD readings were taken (two per leaf), leaf blades stripped off, and petioles dried and ground. Because of the expense involved, only petiole samples of 'Beta 8256' taken at 47, 54, 61, and 74 DAP were analyzed for nitrate concentration. Analysis was done at a commercial lab (Agri-Check, Umatilla, Oregon) using the current practice (ion-specific electrode), so the results match what the grower would see. Each date had four replicates corresponding to field replicates.

Results and Discussion

Petiole nitrate analysis as currently practiced was able to discriminate between treatments at least two weeks ahead of the SPAD meter - 47 versus 61 DAP, respectively (Fig. 1). Differences in SPAD meter readout before 61 DAP were not statistically significant, while differences between treatments in petiole nitrate concentration were statistically significant ($P < 0.001$) at all sample dates (data not shown). The extra time required for the SPAD meter to detect N deficiency obviates its advantage of providing an in-field measurement. The results from the petiole analysis taken at 47 DAP would be back before the SPAD meter could detect N effects at 61 DAP.

Initially, the SPAD readings were not well correlated with petiole nitrate concentration, but as the crop grew and differences between the N treatments became greater, the two measurements showed better agreement (Fig. 2). Plotting the SPAD readings versus petiole nitrate levels across all four dates suggests that once the crop drops below about 10,000 mg per kg petiole nitrate, the SPAD meter would be able to predict N status (Fig. 3). However, this may be too little too late for the SPAD meter to be a useful tool in guiding N fertilization.

At this point, it appears that the SPAD meter has limited utility for measuring N status of sugar beets. One possible way to improve its accuracy might be to take readings from leaves lower in the canopy, as older leaves will show N deficiency symptoms ahead of newer leaves. However, effects of disease or abiotic stress could be confounded with N effects influencing chlorophyll concentration of older leaves. This would make data hard to interpret.

Conclusions

Based on these results, it appears that:

1. The SPAD meter lags about 2 weeks behind petiole nitrate analysis in discriminating differences in sugar beet N status.

2. SPAD output was well correlated with petiole nitrate when nitrate concentration was below 10,000 mg per kg; above this level, the two values were not well correlated.

Literature Cited

Sexton, P.J. 1999. Preliminary report on use of a SPAD chlorophyll meter for early detection of plant nitrogen status in sugar beet. p. 42-45. *In* Special Report 1003. Agric. Exp. Stn., Oregon State University.

Ulrich, A., and F.J Hills. 1990. Plant analysis as an aid in fertilizing sugar beet. 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.

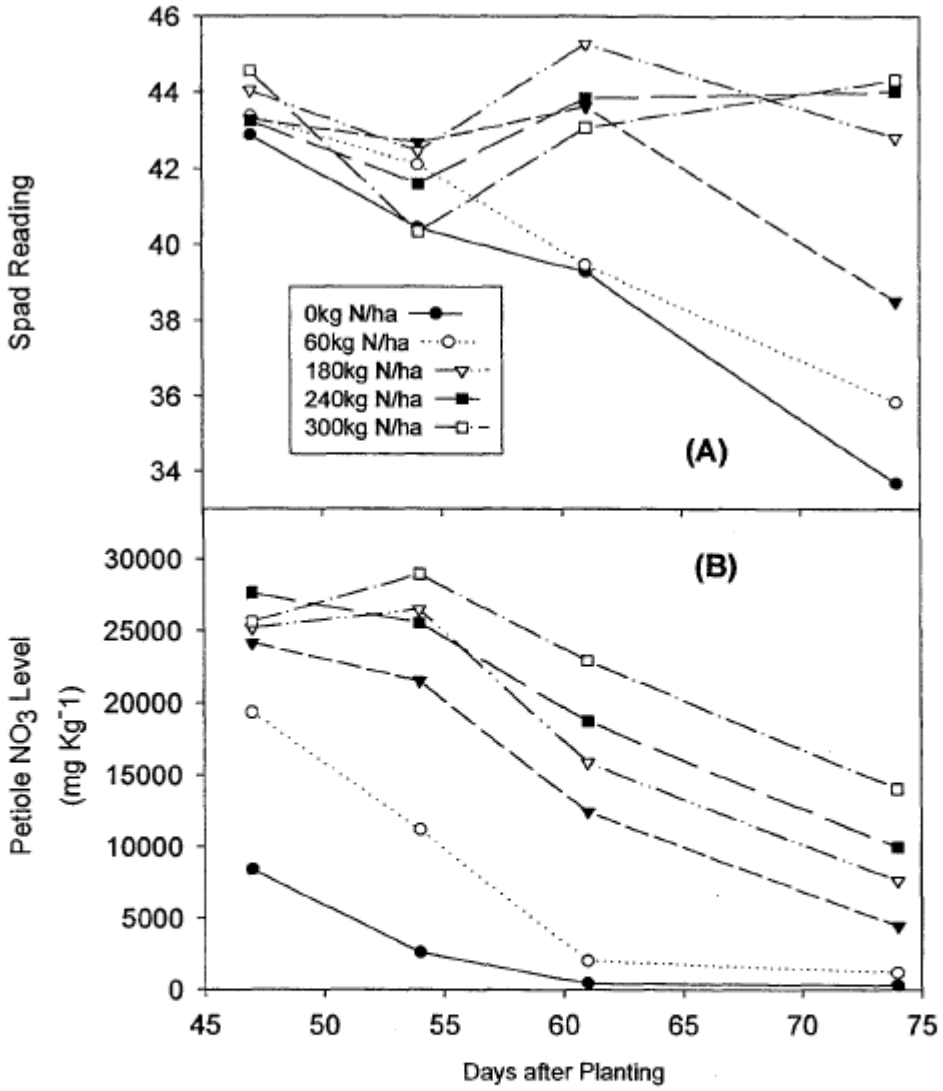

Figure 1. SPAD reading (A) and petiole nitrate concentration (B) during early season growth of 'Beta 8256' sugar beet grown at Madras, Oregon under six levels of N fertilization in 1998.

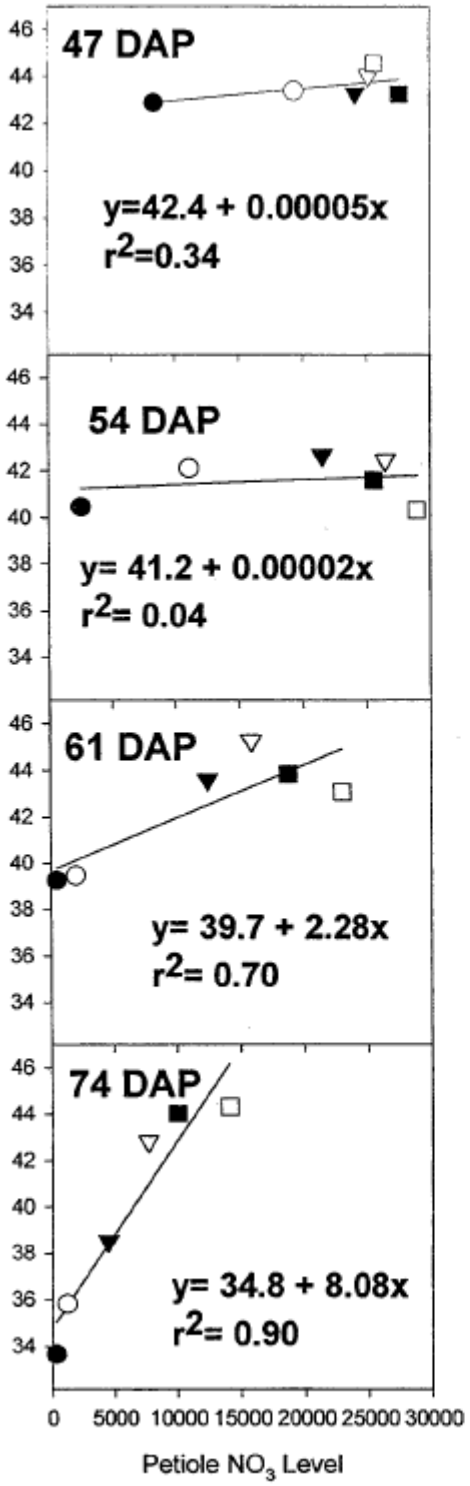

Figure 2. SPAD reading versus petiole nitrate at 47, 54, 61, and 74 DAP for 'Beta 8256' sugar beet grown at Madras, Oregon under six levels of N fertilization in 1998.

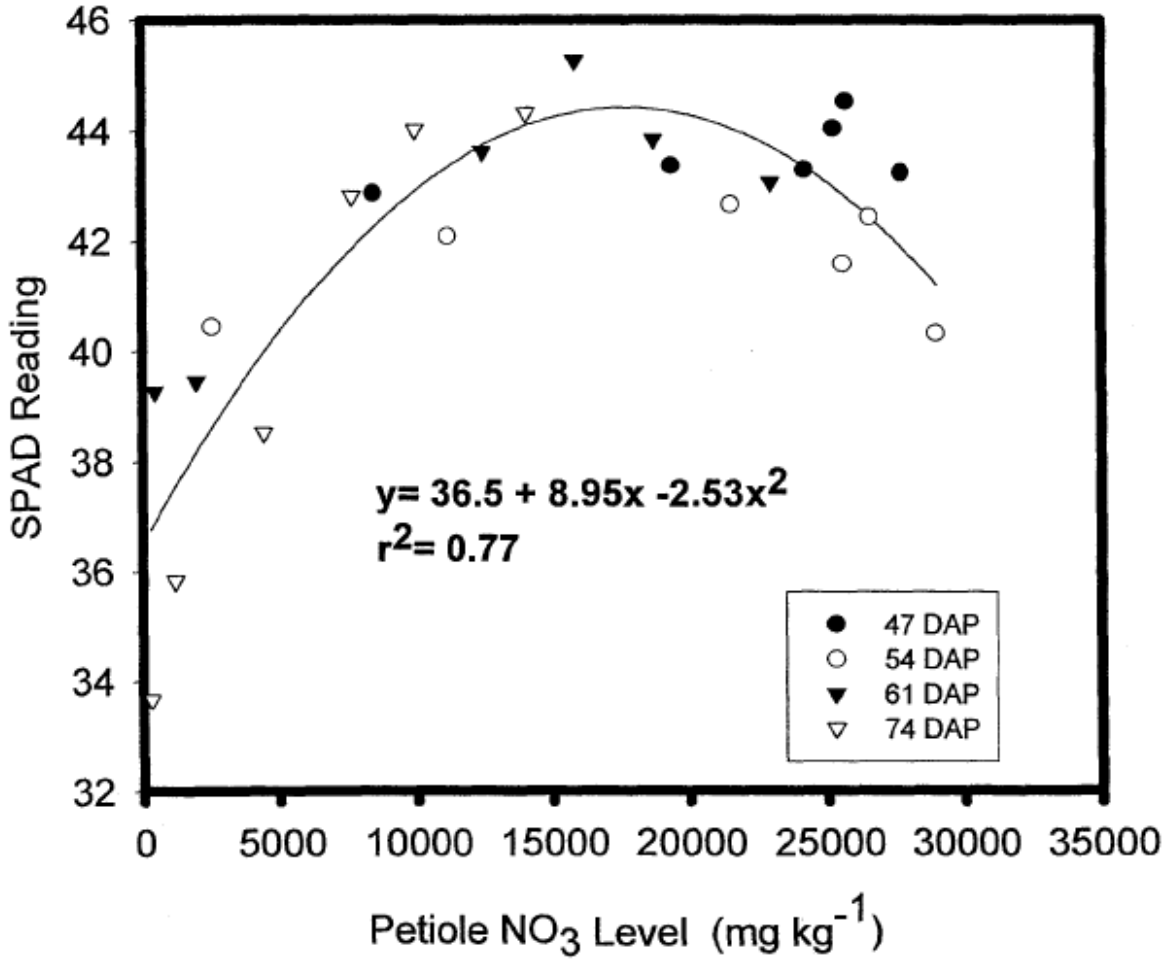

Figure 3. SPAD reading versus petiole nitrate concentration across 4 sample dates for 'Beta 8256' sugar beet grown at Madras, Oregon under six levels of N fertilization in 1998.