The SPAD Chlorophyll Meter: A Potential Rapid, Non-destructive Method of Leaf N Monitoring in Lentil

Hosein Zakeri, Rosalind Bueckert

Dept. Plant Sciences, Univ. Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8, Canada hoz130@mail.usask.ca

The SPAD Chlorophyll Meter (SPAD) measures the chlorophyll content of leaves, and can be used to estimate the nitrogen status of plants as an alternative to the nitrate tissue test. The leaf nitrogen monitoring in experimental plots consists of sampling, drying, weighing, grinding and finally the N measurement of the leaves. Data obtained in some crops like wheat, maize, barley and peanut from the SPAD chlorophyll meter showed reasonable estimation of leaf nitrogen characters (LNCs): %leaf N, specific leaf weight (SLW) and specific leaf nitrogen (SLN). Leaf color and the resulting SPAD reading however, may vary by cultivar, soil and air temperature; planting date, leaf stage, leaf position, plant disease, nutrient deficiency and plant stress. In this study, we hypothesized that the SPAD reading in lentil leaves could estimate leaf nitrogen content.

Minolta SPAD 502 Meter readings from eight cultivars of lentil grown in three different N fertility treatments: (no N, 50 Kg N/ha, and rhizobium inoculant, only) were recorded. Three plants per plot were selected randomly, a leaf from the 2nd to 4th uppermost fully expanded leaves was chosen, and one of its leaflets was read by SPAD, once. The whole leaf was detached after the reading, placed in a cooled plastic bag, transported to the laboratory for later processing. Measurements were repeated over the four stages of plant growth, 48 (pre-lowering), 62(flowering), 79(mid-pod filling) and 87 (late-pod filling) days after planting (DAPs). The day after the SPAD reading, the areas of the sampled leaves were measured, then leaves oven dried for 24 hrs at 70 ˚ C , weighed, ground and the total nitrogen measured by combustion. SLW was calculated as total leaf dry weight / leaf area (gr DW m^2) and SLN as total leaf N/leaf area (gr N m^2).

Analysis of variances for SPAD and LNCs showed significant differences between sampling dates and cultivars, but surprisingly not for fertility treatments. The highest SPAD reading occurred at 79 DAPs (mid-pod filling stage), but highest leaf nitrogen (% leaf N) was achieved at the first sampling (pre flowering stage). SPAD and LNCs differed significantly for time of season, but the pattern of ranking for each LNC among the treatments was not the same.

SPAD didn't correlate strongly with LNCs among sampling dates, cultivars and fertility treatments. To remove the cultivar effect, SPAD were correlated with LNCs for each cultivar, separately. The strongest correlation was achieved for SPAD - % leaf N and, unlike the SLN and SLW, this correlation (SPAD- % leaf N) was consistent among all cultivars. Correlation coefficients of % leaf N - SPAD from highest to lowest for each cultivar was: genotype 1308M-7 (0.61), Milestone (0.60), Rouleau (0.57), Plato (0.50), Sedley (0.46), genotype 1196D-5 (0.42), Blaze (0.36), and Viceroy (0.24). Inverse of LNCs values, eg. 1/LNC, were also correlated with SPAD. Greater coefficients were achieved for all cultivars when the inverse of % leaf N was correlated with SPAD, but not with 1/SLN and 1/SLW.

Weak correlations among four dates of sampling, fertility treatments and cultivars demonstrated that SPAD is specific to environment and cultivars. No effect of fertility on the % leaf N could explain a part of weak correlation between SPAD and LNCs in some cultivars, calibration of SPAD is usually done to reduce this shortcoming. Repeated reading from the same leaflet and taking more sub samples per plant could reduce errors of measurements. Finally, SPAD can be used to estimate the percentage of nitrogen in lentil leaves, provided the user pays attention to differences between cultivars, soil fertility, and time of SPAD reading during a day and, the crop growth stage. This work will be repeated for two more growth seasons in field and greenhouse, respectively.

References

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