Sims, Albert L.<sup>1\*</sup>, John T. Moraghan<sup>2</sup>, and Larry J. Smith<sup>1</sup>, Univ. of Minn., ARC Bldg, 2900 University Ave., Crookston, MN 56716, and North Dakota State Univ., Walster Hall, P.O. Box 5638, Fargo, ND 58105. Sugar beet canopy influences on spring wheat response to fertilizer nitrogen.

## ABSTRACT

Maximum sugar concentration in sugarbeet is achieved when sugarbeet canopies become nitrogen (N) deficient prior to harvest, a symptom indicated by a yellowing of the canopy. In the Red River Valley of North Dakota and Minnesota sugarbeet fields will frequently have canopy colors that range from yellow to dark green across a single field indicating variability in late season N status of the canopy. At harvest these canopies are returned to the soil and are subject to decomposition and canopy N mineralization. Fertilizer N recommendations of the crop following sugarbeet are generally based on soil tests of samples taken immediately after sugarbeet harvest. The recommendation is determined by subtracting soil nitrate-N from a predetermined amount of the necessary N (generally 135 kg ha<sup>-1</sup>). Analysis conducted on soil samples taken after the sugarbeet harvest will not account for N in the sugarbeet canopy and thus the recommendation is not adjusted for the potentially mineralizable N. Previous research has indicated that 1 kg of N in green and yellow sugarbeet canopies is equivalent to 0.5 and 0.25 kg of N fertilizer, respectively. Modern technologies such as aerial and satellite photography, Global Position Systems (GPS), and Geographical Information Systems (GIS) can be utilized to identify and locate areas in the field according to sugarbeet canopy color variation.

Objective: The objectives of this experiment were to: 1) determine if sugarbeet canopy color, as observed from an aerial photograph, can be used to modify N fertilizer recommendations for the following crop; 2) to determine the variation of spring wheat response to fertilizer N rates among field locations that varied in sugarbeet canopy color.

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Methods and Materials: An aerial photograph was taken of a sugarbeet field just prior to harvest in the fall of 1996. Six sites were selected within the field based on visual determination of the canopy color in the aerial photograph. Three green canopy sites, one yellow-green canopy, and two yellow canopy sites were selected. Prior to harvest each site was geographically located via GPS and physically burying a metal disk for later identification. Sugarbeets were hand harvested from three randomly selected rows 3.66 m long at each site for determination of sugarbeet root yield, sugar concentration, loss to molassis and sugarbeet canopy dry matter accumulation and N concentration. After the entire field was harvested, GPS and the buried metal disk was used to relocate each site within the field. At each site a fertilizer N experiment was set up consisting of five N rates and either 4 or 5 replications. Urea was broadcast and incorporated at rates of 0, 45, 90, 135, 180 kg N ha<sup>-1</sup> in plots that were 2.44 X 9.14 m. Soil samples were taken to 1.2 m from the 0 N rate plot within each replication of each site to determine fall residual soil nitrate-N. The following spring (1997) hard red spring wheat was planted at each site. At anthesis plant samples were taken from 1.2 m of 4 rows in each plot and analyzed for dry matter accumulation and N concentration. Final grain yield and grain protein were determined by machine harvesting a 1.52 X 4.11 m area in each plot then analyzing for grain dry matter and N concentration.

Results: Sugarbeet root yields averaged 58.8, 52.0, and 46.0 Mg ha<sup>-1</sup> in the three green canopy sites, vellow-green canopy site, and two yellow canopy sites, respectively. Sugar concentration was near or exceeded 200 g kg<sup>-1</sup> in the yellow-green and yellow canopy sites. In the green canopy sites sugar concentration ranged from 137 to 163 g kg<sup>-1</sup>. Nitrogen returned to the soil in the three green sugarbeet canopies ranged from 369 kg ha<sup>-1</sup> (site 1) to 266 kg ha<sup>-1</sup> (both sites 3 and 4). The yellow-green canopy (site 2) returned 124 kg N ha<sup>-1</sup> and the two yellow canopies (Sites 5 and 6) returned 72 kg N ha<sup>-1</sup> to the soil. Soil nitrate N levels in the upper 60 cm of the soil profile were 461, 122, and 35 kg nitrate-N ha-1 in green canopy sites 1, 3, and 4, respectively. The other three yellow-green and yellow sites averaged 18 kg nitrate-N ha<sup>-1</sup>. With a spring wheat yield goal of 3.36 Mg ha<sup>-1</sup>, fertilizer N recommendations would have been 0, 11, 101, and 118 kg N ha<sup>-1</sup> in green canopy sites 1, 3, and 4, and the other three sites, respectively. Total dry matter accumulation and total N accumulation at anthesis was not significantly different among N fertilizer rates at the three green sugarbeet canopy sites. However, delayed tillering in sites 3 and 4 resulted in less overall biomass than at site 1. Tillers at site 1, 2, 5 and 6 were headed at the anthesis sampling. At sites 3 and 4, tillers were not in flag leaf at the time of sample. At the time of final grain harvest, tillers at sites 3 and 4 had headed and matured and contributed towards the final grain yield. Total dry matter and N accumulation at anthesis significantly increased with N fertilizer rates in the yellow-green and yellow sites. Generally total dry matter and N accumulation increased over the entire range of fertilizer N rates at all three sites, but the greatest increases occurred at the two yellow canopy sites (Sites 5 and 6). There was no significant spring wheat grain yield response to fertilizer N rates at any of the three green sugarbeet canopy sites. Yields averaged 3.03, 3.36, and 3.23 Mg ha<sup>-1</sup> at sites 1, 3, and 4, respectively. There was a significant yield response to N rates at the yellow-green and yellow sugarbeet canopy sites. In all three sites yields tended to maximize with 45 to 90 kg fertilizer N ha<sup>-1</sup> with yields maximizing near 3.57, 3.30, and 3.03 bu A<sup>-1</sup> at sites 2, 5, and 6, respectively. Lodging was a major problem in sites 1, 5 and 6 which may have limited grain yields, especially in the sites 5 and 6. Spring wheat grain protein was not responsive to fertilizer N in the green canopy sites, maximized at 90 kg fertilizer N ha<sup>-1</sup> in the yellow-green canopy site, and increased over the entire fertilizer N rate range in the two yellow canopy sites.

Conclusions: Aerial photographs were useful in separating sites within a sugarbeet field where canopy color could be distinguished. Green canopy sites varied in residual soil nitrate-N level. Nevertheless there were no responses of any of the spring wheat variables measured to fertilizer N regardless of residual soil nitrate-N levels. In non-green sugarbeet canopy sites residual soil nitrate-N levels were low. Spring wheat yields and grain protein did respond to fertilizer N rates, but lodging may have limited that response in the yellow canopy sites. This experiement strongly suggests that green sugarbeet canopies returned to the soil can supply sufficient N, through mineralization, to meet the needs of the following years spring wheat crop. Yellow-green and yellow canopies can provide some needed N through mineralization, but N fertilizer will still be required for optimum spring wheat yields. It is apparent that management of sugarbeet canopy N, especially in green canopies, can reduce overall N fertilizer costs for the following crop. Management of this N may also help in the management of residual soil N levels that will have an impact on sugarbeet production later in the rotation.

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