Nitrogen Sufficiency Stalk Test for Sweet Corn

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Because growers generally wish to maximize yields, N fertilizer may be applied considerably in excess of needs of the crops. One of the best hopes for curtailing future overuse of N fertilizers is at the farm level. When farmers determine N fertilizer need based on available soil N levels and time applications according to crop requirement, they save money by not purchasing supplemental N fertilizer. Because chemical N fertilizer is also environmentally costly to over-apply or use carelessly, continued vigilance is needed in tailor usage based on crop requirement.

Nitrate (NO_3^--N) concentration of lower corn (*Zea mays indentata* L.) stalks has been used as a guide to determine of soil N sufficiency for grain production. For maximum yield, researchers have found stalk NO_3^--N concentration levels for field corn to be in the range of 0.5 to 2.0 g/kg (ppm) dry matter at or after physiological maturity of corn. However, sweet corn (*Zea mays rugosa* Bonaf.) is harvested at the early milk stage, so stalk NO_3^--N levels would be expected to differ from those of field corn taken at grain or silage harvest. The objective of this study was to examine lower corn stalk tissue as a test of N sufficiency in sweet corn-cover crop cropping systems.

Four years of data were obtained from two experiments involving cover crops [hairy vetch (*Vicia villosa* Roth), rye (*Secale cereale* L.), oat (*Avena sativa* L.)] and ammonium nitrate (NH_4NO_3) fertilizer in sweet corn ('Sweet Sal') production. These studies were conducted at the Agronomy Research Farm of the University of Massachusetts in South Deerfield, from fall 1994 to fall 1998. A quadratic-response-and-plateau (QRP) model for trend assessment and the Cate-Nelson method for separation of N responsive and non-responsive sites were used to describe the relationship between lower sweet corn stalk NO_3^--N concentration and relative sweet corn yield.

Cover crops were flail-mowed and incorporated and sweet corn was planted in all years. Nitrogen treatments were applied by hand as NH_4NO_3 sidedressed 6 inches away from the corn row when corn was 12 inches high. Ear and stover samples were taken from the center row in each plot when the majority of the ears were determined to be at the marketable harvest stage (early milk). Ears were removed from stover, and a determination was made as to whether ears were marketable or unmarketable. An ear viewed as marketable had to be at least 7 inches long including husk. Dry weight and number of ears were recorded for marketable and unmarketable ears. Corn yield is reported as number of marketable ears/ha (ears/ac = ears/ha x 0.454) and as dry mass of marketable ears in kg/ha (lb/ac = kg/ha x 0.892). Also, in the field, sections of five stalks were removed between 6 and 14 inches above the ground from corn plants harvested in each plot. Stalk samples were dried, ground, and analyzed to determine NO_3^--N concentration.

The relationship between corn yield and stalk NO_3^--N concentration was analyzed using a nonlinear (NLIN) regression procedure to fit a quadratic-response-and-plateau (QRP)

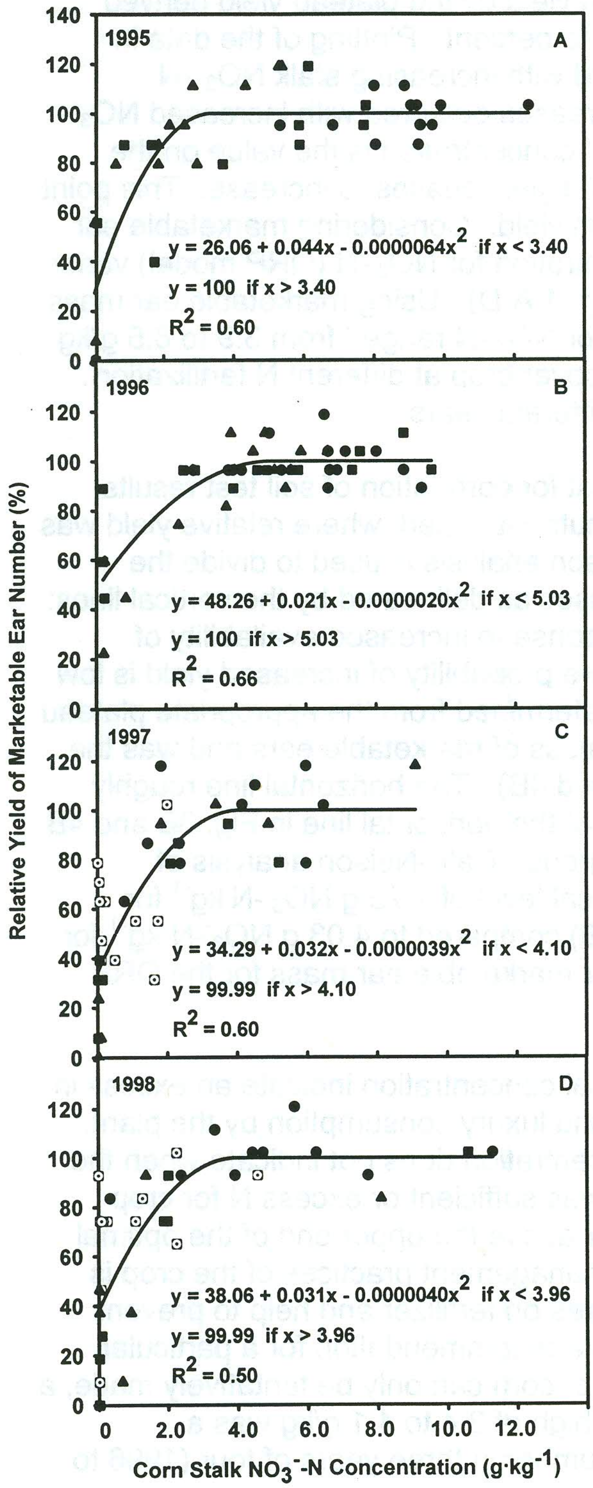

Figure 1. Relative yield of marketable ear number as a function of stalk NO_3^--N concentration in 1995 to 1998.

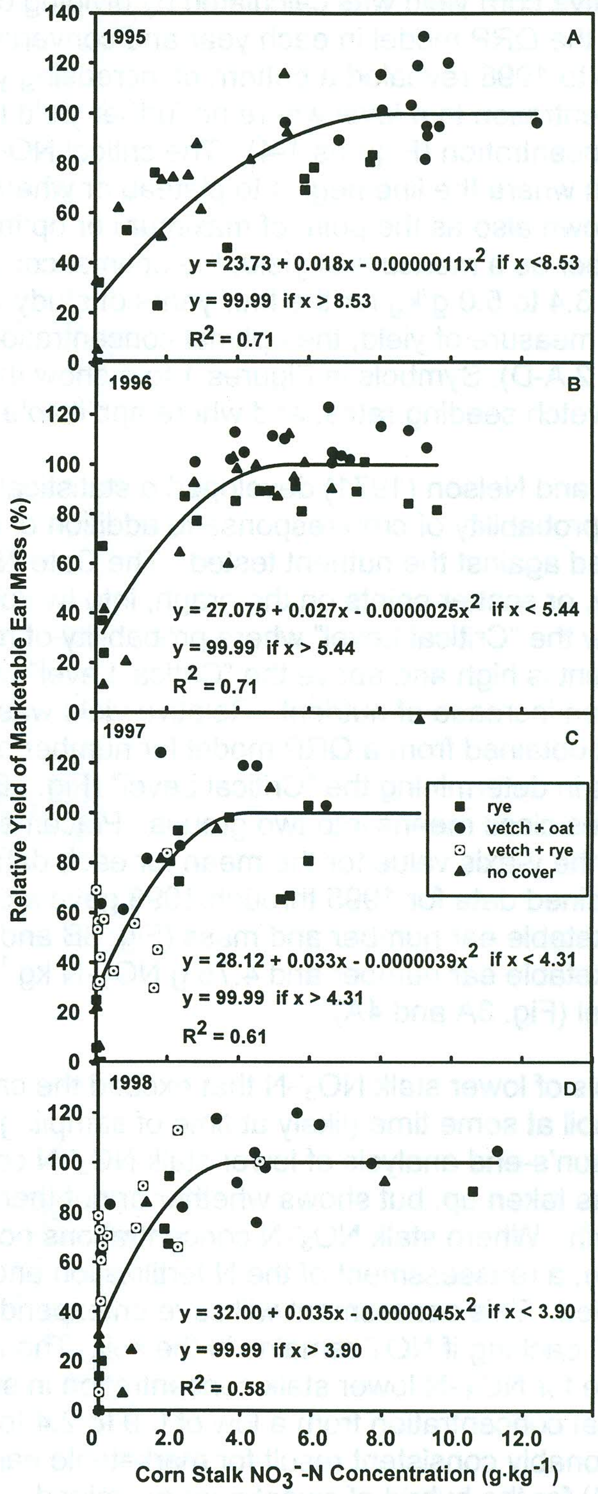

Figure 2. Relative yield of marketable ear mass as a function of stalk NO_3^--N concentration in 1995 to 1998.

model of relative corn yield and corn NO_3^--N stalk concentration for 1995 to 1998. Relative corn yield was calculated by dividing corn yield by the plateau yield derived from the QRP model in each year and converting to percent. Plotting of the data in 1995 to 1998 revealed a pattern of increasing yield with increasing stalk NO_3^--N concentration to a level where no further yield increases occurred with increased NO_3^--N concentration (Figures 1-4). The critical NO_3^--N concentration is the value on the graph where the line begins to plateau or where the yield ceases to increase. This point is known also as the point of maximum or optimum yield. Considering marketable ear number as a measure of yield, the optimal concentration for NO_3^--N (QRP model) varied from 3.4 to 5.0 g/kg for the four years of study (Fig. 1 A-D). Using marketable ear mass as a measure of yield, the optimal concentration for NO_3^--N ranged from 3.9 to 8.5 g/kg (Fig. 2 A-D). Symbols in Figures 1 to 4 show the cover crop at different N fertilization and vetch seeding rates, and where applicable, different years.

Cate and Nelson (1971) developed a statistical test for correlation of soil test results with probability of crop response to addition of a nutrient tested, where relative yield was plotted against the nutrient tested. The Cate-Nelson analysis is used to divide the array, or scatter points on the graph, into two classes as delineated by the vertical lines: below the "Critical Level" where probability of response to increased availability of nutrient is high and above the "Critical Level" where probability of increased yield is low with an increase of nutrient. Relative yield was determined from the appropriate plateau point obtained from a QRP model for number or mass of marketable ears and was the basis in determining the "Critical Level" (Fig. 3B and 4B). The horizontal line roughly divides class means into two groups. Placement of the horizontal line in Fig. 3B and 4B is at the y-axis value for the mean for each data group. Cate-Nelson analysis of combined data for 1995 through 1998 gave a critical level of 1.75 g NO_3^--N kg^{-1} for marketable ear number and mass (Fig. 3B and 4B) compared to 4.03 g NO_3^--N kg^{-1} for marketable ear number and 4.76 g NO_3^--N kg^{-1} for marketable ear mass for the QRP model (Fig. 3A and 4A).

Levels of lower stalk NO_3^--N that exceed the critical concentration indicate an excess in the soil at some time (likely at time of sampling) and luxury consumption by the plant. Season's-end analysis of lower stalk NO_3^--N concentration does not indicate when the N was taken up, but shows whether or not there was sufficient or excess N for crop growth. Where stalk NO_3^--N concentrations occur above the upper end of the optimal range, a reassessment of the N fertilization and management practices of the crop is needed. This assessment will save on expenditures on fertilizer and help to prevent NO_3^- leaching if NO_3^- remains in the soil. Though a recommendation for a particular range for NO_3^--N lower stalk concentration in sweet corn can only be tentatively made, a critical concentration from a low of 0.9 to 2.4 to a high of 3.4 to 4.1 g/kg was a reasonably consistent result for marketable ear number in three years of four (1996 to 1998) for the hybrid of sweet corn examined.

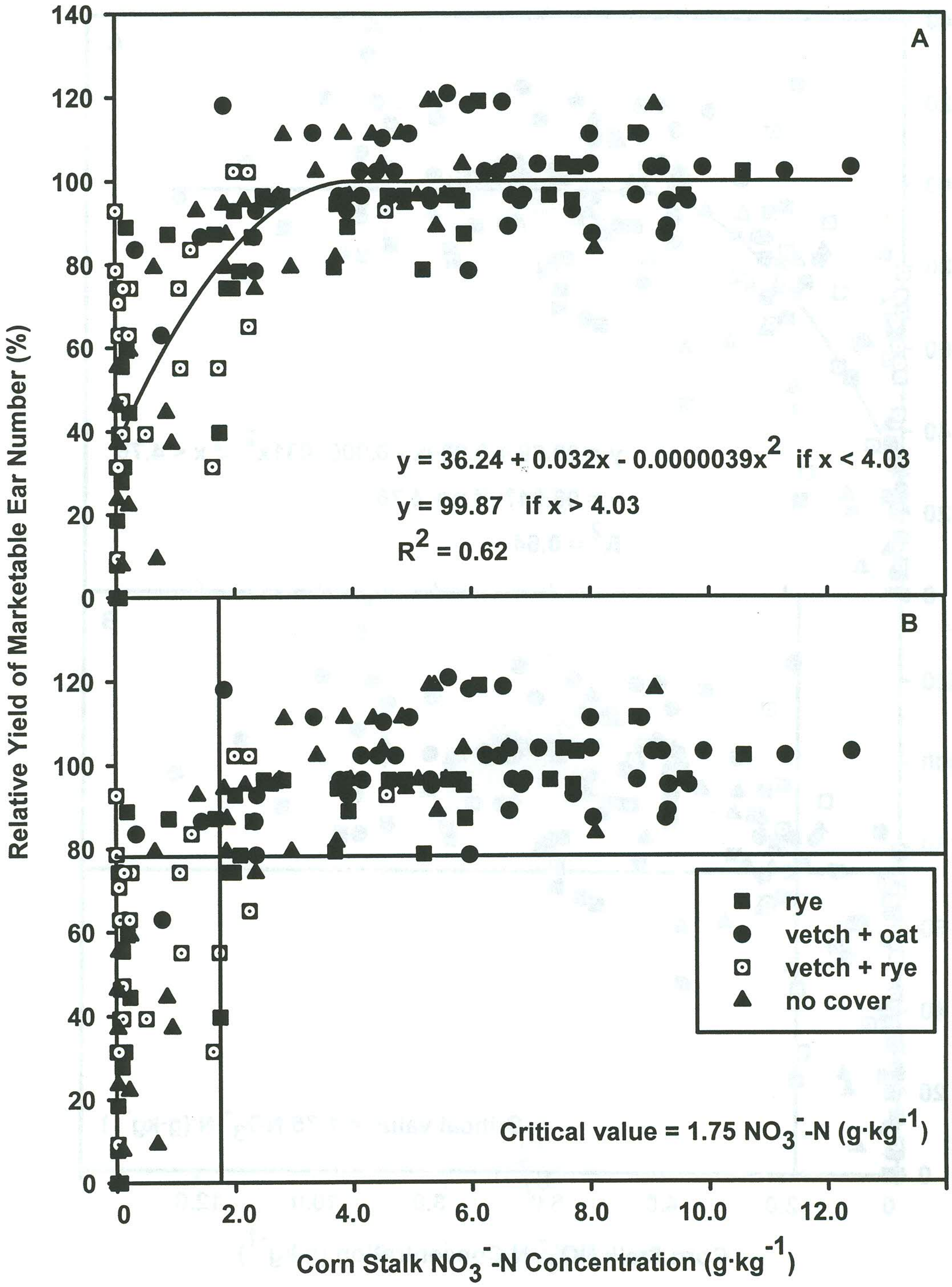

Figure 3: A. Relative yield of ear number from 1995 to 1998 using the QRP model.
B. Relative yield of ear number from 1995 to 1998 using the Cate-Nelson model.

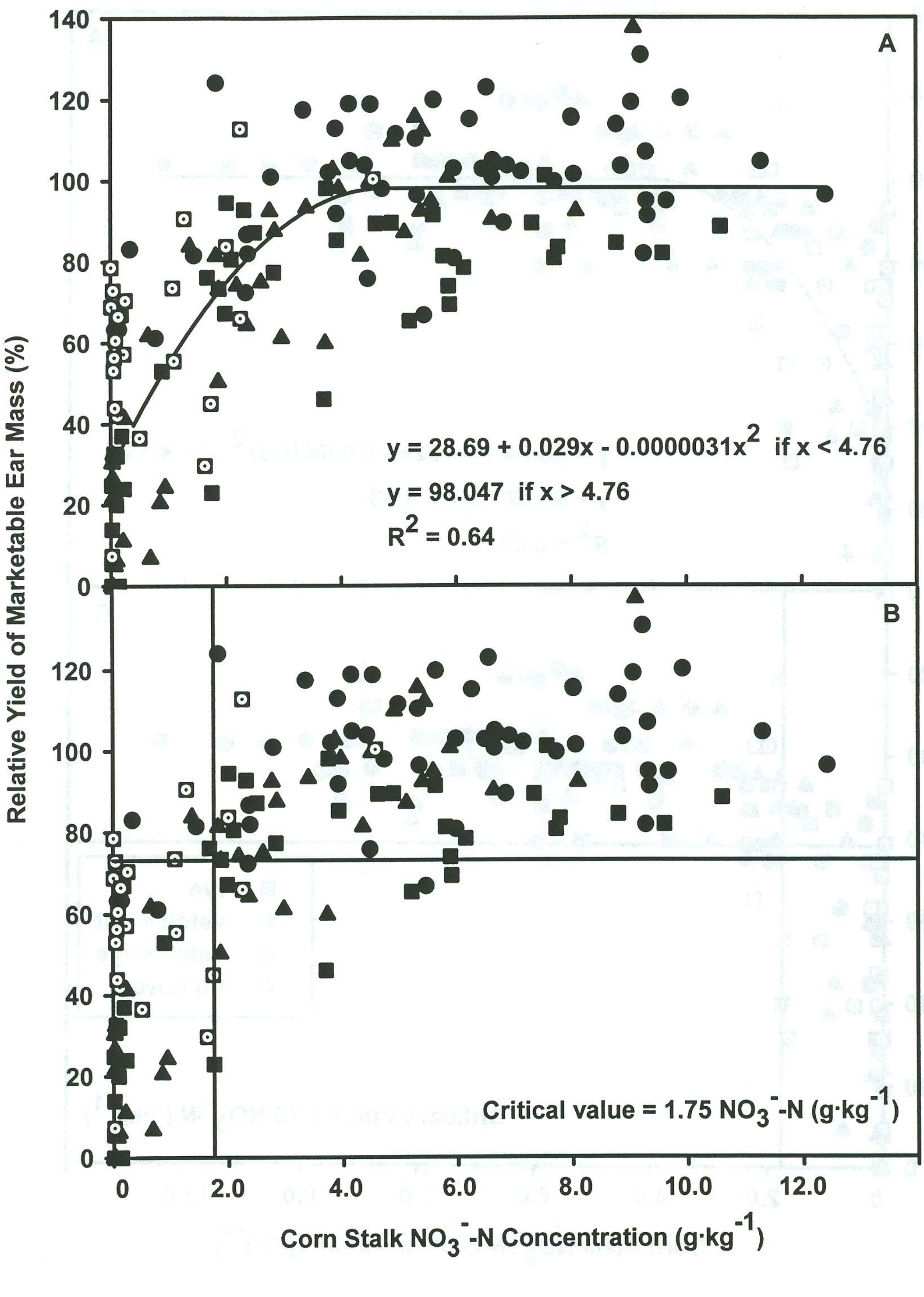

Figure 4: A. Relative yield of ear mass from 1995 to 1998 using the QRP model. B. Relative yield of ear mass from 1995 to 1998 using the Cate-Nelson model.