Nitrate in Cranberry Irrigation Water-
Initial Observations during the 2005 Growing Season

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Some Wisconsin cranberry growers with upland marshes have persistent problems with excess vine growth. The greatest vine growth is in areas where there is higher water input than the rest of the bed, particularly next to sprinkler heads and at joints in above-ground irrigation lines (Fig. 1). This problem is most prevalent in beds irrigated with water containing high levels of nitrate. Growers using surface water or groundwater influenced by vegetable production are most likely to have nitrate in their irrigation water.

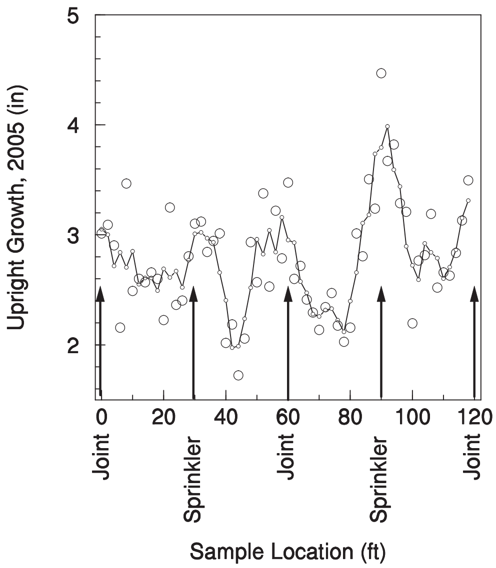

Figure 1. Current season upright growth as a function of position in the bed. Samples collected Dec. 2, 2005 in a transect along the location of the sprinkler line. Circles show average of 5 uprights sampled at each location; line is based on running average of 3 adjacent data points. Cultivar is Stevens.

Equivalent beds on this marsh with a different, low-N water supply do not show this pattern of vine overgrowth, indicating that water deposition alone is not responsible for the stimulation of vine growth.

As we all know, yield is depressed when excess nitrogen stimulates vine growth (Fig. 2). If nitrogen inputs for the bed as a whole are optimal, then the vines are "on the bubble" for response to nitrogen applications. Excess nitrogen will push them into excess vegetative growth. When irrigation water contains a nitrogen source, areas in the bed where water inputs are higher than average will receive higher than average levels of nitrogen.

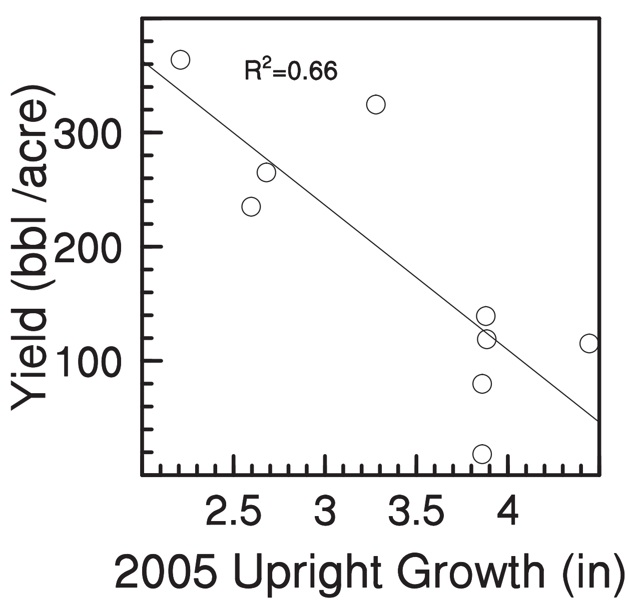

Figure 2 Relationship between current season upright growth (inches) and yield. Values based on berry fresh weight measured in 250 cm^2 quadrates from 4 different beds. Cultivar is Stevens.

To calculate irrigation water nitrogen inputs, we need to know 1) irrigation volumes (inches applied) and 2) nitrate concentration (parts per million (ppm) as nitrogen). The equation is: **pounds N per acre = 0.23 x inches water applied x ppm N.** Growers who had commercial laboratory measurements of high-nitrate irrigation water reported values up to 9 ppm nitrate N. Between July and September 2005, we measured nitrate concentrations ranging between 0 and 4 ppm in irrigation water from these same marshes.

Using this relationship, we can calculate the predicted distribution of nitrogen inputs within a bed based on measurements of irrigation inputs. Irrigation uniformity in older systems can be poor, with very high levels of water adjacent to sprinklers. Data collected by Teryl Roper and Tod Planer on irrigation uniformity from an older system provides an example of the potential distribution of nitrogen inputs at different concentrations of irrigation-water nitrogen (Fig. 3A). Based on this irrigation-water distribution, at 1 ppm nitrate-N, 1 inch of irrigation, and 5-fold greater irrigation water around the sprinkler, the area around the sprinkler-head receives 2 lbs/acre more N than the rest of the bed (Fig. 3B). At 9 ppm nitrate, a level reported by some growers in spring-time irrigation water measurements, a single irrigation of 0.11 inch would deliver 2 lbs/acre N to the area around the sprinkler head (Fig. C).

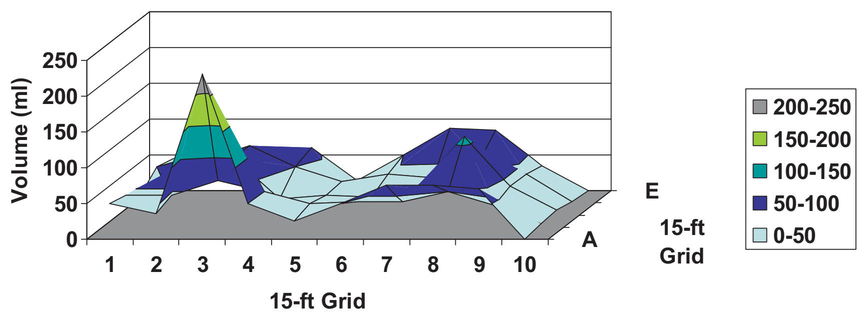

Figure 3A. Irrigation uniformity measurements. Peak inputs are adjacent to sprinkler heads. (Roper and Planer 2005 Cranberry School Proceedings)

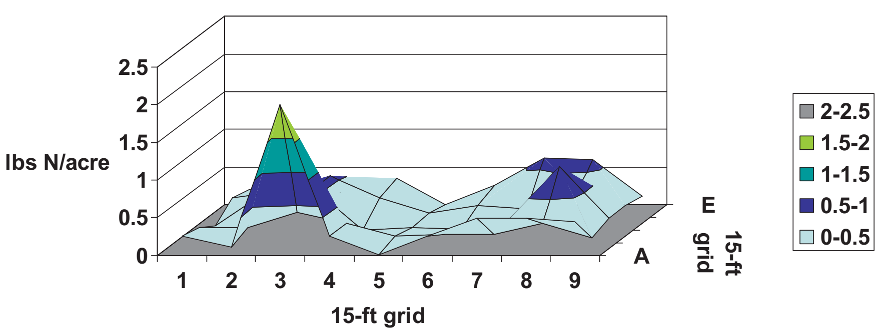

Figure 3B. Predicted nitrogen inputs from 1 inch of irrigation with water containing 1 ppm N.

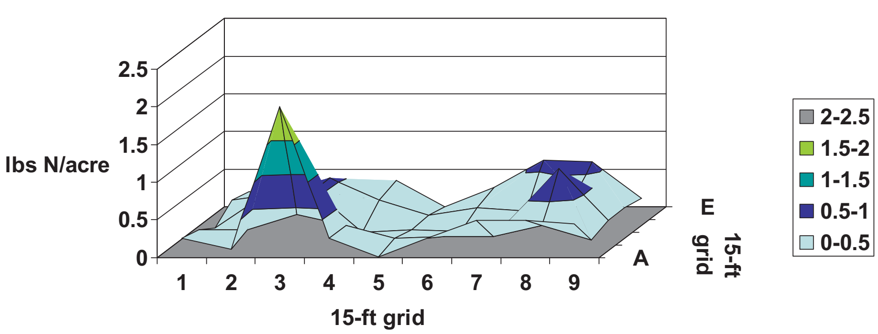

Figure 3C. Predicted nitrogen inputs from 0.11 inch of irrigation with water containing 9 ppm N.

We carried out trials of two kits for measuring nitrate in irrigation water in 2005. The kit from the Hach Company was less expensive ($59 for 50 tests) than the kit from Spectrum Technologies ($179), but required more time per analysis. Both are based on a chemical reaction that produces a colored product, with the color intensity linearly proportional to nitrate concentration. The Hach kit uses visual comparisons of sample color development with a color standard; the Spectrum Technologies kit uses an electronic photometer for analysis of sample color intensity. Each worked well, with grower measurements of irrigation water nitrate concentration very close to our laboratory measurements of the same samples (Fig. 4).

Ion exchange resin columns show promise for analysis of integrated N inputs in irrigation water. These resins are similar to those used in deionizing water, and can capture nitrate and ammonium in irrigation water flowing through them.

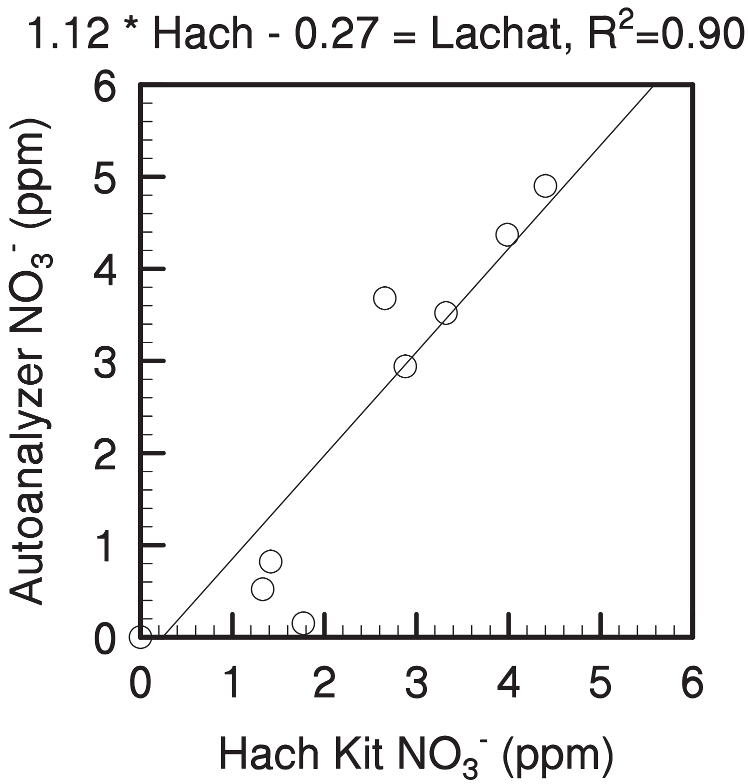

Figure 4. Grower measurements of irrigation water NO_3^- concentration vs. our laboratory measurements of irrigation water NO_3^- concentration. Samples were collected by growers, analyzed, and refrigerated for up to 4 weeks before our analyses.

The impact of excess vine growth stimulation by nitrogen-containing irrigation water depends upon the extent of yield depression and upon the area affected. In the bed sampled for Fig. 1, approximately 5% of the bed area had excess vine growth, with affected areas having predicted yields less than one third of the bed average.

There are several options for managing high-nitrate irrigation water that are worth considering. 1) Improving irrigation uniformity and reducing irrigation line leaks should make growth and yield more uniform, as both fertilizer N and irrigation-water N inputs would then be evenly distributed across the bed. 2) If multiple water sources are available, switching to a lower-nitrogen irrigation source should reduce excess vine growth. 3) Ultimately, this is a watershed-level issue. Improved nutrient management by vegetable growers and other non-point sources of nitrogen inputs to the watershed will provide the most reliable long-term solution to the problem.

Despite the evidence presented here that irrigation water containing nitrate may stimulate excess vine growth, nitrate is not recommended as a fertilizer for cranberry. Cranberry has much higher preference for ammonium. Nitrate would also be prone to rapid leaching, and would be rapidly lost from the rooting zone.