Optimizing Soil Nitrogen Management for Processing Sweet Corn to Maximize Marketable Yield and Quality and Minimize Damages to Water Quality

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Executive Summary of 2003

Timely supply of nitrogen with sufficient but not excessive amount is essential to processing sweet corn to assure maximum economic yield and quality, while sustaining or improving the environmental quality. Soils often contain significant amount of available nitrogen carried over from previous crops and/or released through mineralization of soil organic matter. A testing tool must be available to determine wether processing sweet corn needs to be fertilized with nitrogen, and if such fertilizer nitrogen has to be applied at the optimum rate. New fertilization techniques for processing sweet corn must be developed for Ontario conditions. Nutritional information on processing sweet corn is also essential to establish database for Ontario nutrient management legislation.

The objectives of this experiment for the year of 2003 were 1) to develop a pre-side dress soil nitrogen test technique for processing sweet corn to predict the fertilizer nitrogen needs; 2) to determine the response of processing sweet corn to fertilizer nitrogen; 3) to evaluate the potential for post-harvest leaching losses of soil nitrogen as a function of fertilizer nitrogen rate; and 4) to develop an optimum nitrogen fertilizer rate which maximizes marketable yield and quality and minimizes losses of soil nitrogen to ground water.

In order to cover the possible variation caused by climatic conditions, the study was conducted on two sites: a Granby sandy loam soil at the Greenhouse and Processing Crops Research Centre (GPCRC), AAFC, Harrow, ON, and a fine sandy loam soil at Ridgetown, ON. At each site, nitrogen fertilizer at five rates including 0, 50, 100, 150 and 200 kg N ha^{-1} was applied to test the responses of processing sweet corn yield and quality and to create a range of initial soil available nitrogen levels for the development of PSNT (pre-sidedress soil nitrogen test). Two cultivars (GSS 9299 and Delmonte 2038) were included in the trial to test the potential variation caused by processing sweet corn variety. All nitrogen fertilizer was pre-planting broadcast-incorporated into the soil. The trial was managed following the local practices. Soil samples were taken at depth of 0-30 cm at post-planting, V4, V5, V6, and V7 stages and down to 60 cm at both post-planting and V6 stages. Soil samples were analysed for available nitrogen including nitrate and ammonia nitrogen. Soil samples were also taken shortly post-harvest at 0-100cm depth to determine the potential for soil nitrogen losses. Plant tissue samples (kernel, cob and stover) were taken at harvest and analyzed for total nitrogen content.

Threshold values for pre-side dress soil nitrogen test (PSNT) varied with soil sampling stage and depth and the geographic location. The threshold values ranged from 7 to 60 mg N kg^{-1} soil and decreased gradually with crop growth stage at the Harrow site. At the Ridgetown site, the threshold values were relatively similar, ranging from 26 to 34 mg N kg^{-1}, regardless of the sampling time. In general, by analysing the data from the past 2 years the threshold values of PSNT determined at the V4 stage by sampling soil in 0-30 cm were universally promising, but need to be confirmed with further studies.

Both total and marketable yields responded quadratically to fertilizer nitrogen at both Harrow and Ridgetown sites. The maximum marketable yield (18.7 Mg ha^{-1} for GSS 9299 and 48.7 Mg ha^{-1} for Delmonte 2038) was obtained with added nitrogen at 160 kg N ha^{-1} for GSS 9299 and 169 kg N ha^{-1} for Delmonte 2038 at the Harrow site. At the Ridgetown site, the marketable yield of 13.8 Mg ha^{-1} across both varieties was produced with fertilizer nitrogen added at 150 kg N ha^{-1}. Any fertilizer nitrogen exceeding the rate required for maximum marketable yield production resulted in significant increases in residual NO_3-N in soil profile (0-100 cm) after harvest and can cause damages to water quality. While further study is needed, it appears that an increased fertilizer nitrogen rate is required for processing sweet corn under the Ontario conditions, compared with the current OMAF recommendation, 90 kg N ha^{-1}.

Of the parameters measured on sweet corn quality, cob diameter and length varied with variety, but not the fertilizer nitrogen rate. Neither fertilizer nitrogen nor variety effect was found on the sweetness of sweet corn.

A calculated value of 8.6 and 3.5 kg N ha^{-1} fertilizer nitrogen was required to produce each tonne of processing sweet corn for GSS 9299 and Delmonte 2038, respectively, at the Harrow site. At the Ridgetown site, 10.9 kg N ha^{-1} of fertilizer nitrogen was required to produce each tonne of processing sweet corn, regardless of the variety.

Consequently, total crop nitrogen uptake including stover and grain nitrogen uptake ranged from 73 to 173 kg N ha^{-1} at the Harrow site and from 78 to 110 kg N ha^{-1} at the Ridgetown site. Of the total uptake, nitrogen removals (cob plus grain) were found quadratically relating to fertilizer nitrogen rate across two varieties at both Harrow and Ridgetown sites. Nitrogen removal increased with added fertilizer nitrogen and reached the maximum (66.8 kg N ha^{-1} at the Harrow site and 56.7 kg N ha^{-1} at the Ridgetown site) with fertilizer nitrogen added at 164 and 185 kg N ha^{-1} at Harrow and Ridgetown site, respectively.

Since different varieties were planted in 2003 than in 2002, there may be difficulties to compare the results obtained in the past 2 years, except for the threshold values of PSNT.