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

T.Q. Zhang, C.S. Tan, J. Warner, C.F. Drury & D.W. Reynolds, Agriculture and Agri-Food Canada, Harrow, Ontario N0R 1G0

J. W. Zandstra, Ridgetown College, University of Guelph, Ridgetown, Ontario, N0P 2C0

Executive Summary

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 whether 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 2004 were 1) to develop a pre-side dress soil nitrogen test technique for processing sweet corn to predict 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 ranging from 0 to 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 leaching 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. The threshold values ranged from 8 to 31 mg N kg^{-1} soil, with the highest values occurred at V4 and V5 stages and the lowest at the V6 stages at the Harrow site. The threshold values then increased at the V7 stage. The results indicate clearly that soil NO_3-N may have been fluctuated

substantially, possibly due to the variation of weather conditions (temperature and precipitation), which affect the mineralization rate of soil organic nitrogen and the leaching of NO_3-N. Whether PSNT is a valid and applicable approach to predict yield response of sweet corn to nitrogen fertilization needs to be further determined, even if it has been used for field corn.

Both total and marketable yields responded quadratically to fertilizer nitrogen at both Harrow and Ridgetown sites. The maximum marketable yield (10 ton ha^{-1}) was obtained with added nitrogen at 132 kg N ha^{-1} at the Harrow site. At the Ridgetown site, the marketable yield of 11 ton ha^{-1} across both varieties was produced with fertilizer nitrogen added at 209 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. 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}.

Both cob length and diameter was consistently bigger for variety Delmonte 2038 than for variety GSS 9299 at both Harrow and Ridgetown sites. However, fertilizer nitrogen rate affected both cob length and diameter only at the Ridgetown site. Cob length across two varieties responded quadratically to fertilizer nitrogen rate, with the maximum of 20.1 cm produced at fertilizer rate of 164 kg N ha^{-1}. Similarly, cob diameter was also related quadratically with fertilizer nitrogen rate, with its maximum obtained at 164 kg N ha^{-1}, which was identical to that required for the maximum cob length. The value is slightly lower than that required for the maximum marketable yield. However, the negligible reduction in cob size with increases in fertilizer nitrogen rate may still be worth of doing to maximize the marketable yield.

Sweetness of sweet corn across both varieties was the highest with fertilizer nitrogen rate up to 12 kg N ha^{-1} and then declined with increases in fertilizer nitrogen rate at the Harrow site. At the Ridgetown site, sweetness of sweet corn for the variety of GSS 9299 decreased slightly with increases in fertilizer nitrogen rate, while there were no effects found for the variety of Delmonte 2038. Thus, high rate of fertilizer nitrogen may slightly reduce the sweet corn quality, depending on the variety.

The values of fertilizer nitrogen required to produce each ton of marketable yield varied, depending on the level of target yield. The calculated values ranging from 0.8 to 13.3 kg N ha^{-1} fertilizer nitrogen was required to produce each tonne of processing sweet corn at the Harrow site. At the Ridgetown site, the values of 1.2 to 16.7 kg N ha^{-1} of fertilizer nitrogen was required to produce each tonne of processing sweet corn. Clearly, the amount of fertilizer nitrogen required for unit yield production of processing sweet corn varied with the target yield level and the climatic conditions which may have altered the fertilizer nitrogen use efficiency.

Consequently, total crop nitrogen uptake by stover and cob ranged from 114 to 177 kg N ha^{-1} at the Harrow site and from 28 to 115 kg N ha^{-1} at the Ridgetown site. The calculated fertilizer use efficiency decreased significantly with increased fertilizer rate, implying that the significant contribution of mineralization of soil organic nitrogen to crop nitrogen needs and thus the importance of pre-side dress soil nitrogen test. A new method for soil nitrogen test rather than PSNT must be developed.