Optimizing application of phosphorus and potassium to processing tomatoes under drip irrigation to maximize quality and yield while minimizing adverse impacts on water quality

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Processing tomatoes, a major high-value crop in Ontario, are high in nutrient demand. The nutrient needs can further increase with drip irrigation/fertigation due to the largely enhanced yield potential. Our studies in past five years showed that fertilizer nitrogen (N) rate required for processing tomato production with drip fertigation can be as high as 270 kg N/ha, 3 times of the current recommendation. With increased need for fertilizer N, other nutrients, such as phosphorus (P) and potassium (K), must be supplied accordingly in sufficient amounts to develop the maximum yield potential. On the other hand, over application of nutrients, especially P, can cause build-up in soil that may consequently contaminates water resource, as P is the key element controlling eutrophication of water bodies. In addition, more and more demand on quality (soluble solids, lycopene, and vitamin C) of processing tomatoes has become an emerging issue to producers from both processors and consumers. Application of fertilizer P and K for processing tomatoes must be optimized in a way that minimizes adverse effect on water quality, while improving product quality and maximizing marketable yield.

The long-term objectives of this study are 1) to develop the optimum rates of P and K with drip irrigation under Ontario conditions, that meet the needs for maximum quality and economic yield while minimizing the potential for P losses; and 2) to determine P and K removals. The short-term objectives for 2006 were 1) to determine the relationships between fertilizer P and K and yield and quality of processing tomatoes under drip irrigation in according with the newly developed N rate in Ontario; 2) to determine crop nutrient (N, P, K) uptake and removals; and 3) to evaluate the potential leaching losses of soil P and N.

The experiment was conducted in a sandy loam soil at GPCRC, Harrow, ON. The treatments included four fertilizer P rates ranging from 0 to 90 kg P ha^{-1}, four fertilizer K rates ranging from 0 to 600 kg K ha^{-1}, and two water management regimes including natural rainfall (non-drip irrigation) and natural rainfall enhanced with drip irrigation to best satisfy crop physiological needs in an optimum manner. The experiment was arranged in a complete factorial randomized block design, with four reps and a total of 128 plots.

Total yield of processing tomatoes responded quadratically to the application of fertilizer K. Drip irrigation increased total yield by 43%, compared with non-drip irrigation. Both green fruit yield and yield with blossom-end rot at harvesting decreased with increased fertilizer K rate, especially when drip irrigation was not applied. Maximum marketable yield was produced with potassium K at 358 kg ha^{-1} with drip irrigation. Without drip irrigation, marketable yield increased with increased K rate.

Drip irrigation increased fruit size by 21.5%. Although drip irrigation only slightly increased the fruit moisture content (by 0.8%), it decreased soluble solids content by 0.69%, or 13% relative to

no-irrigation. However, the reduction of soluble solids with drip irrigation was compromised to some extent with the application of fertilizer K.

Vitamin C content of processing tomato fruits decreased with added fertilizer K, when drip irrigation was applied. Increased fertilizer P increased the content of vitamin C, especially when K was not applied.

Drip irrigation increased N and P removal by 29% and 38%, respectively, compared with non-drip irrigation. Fruit P removal increased with increased fertilizer K application, when fertilizer P was applied. Both drip fertigation and fertilizer K application increased the use efficiency of N and P.

While drip irrigation reduced residual nitrate-N in 100 cm soil profile, increased fertilizer K application decreased residual nitrate-N when drip irrigation was not applied.

As a result, drip irrigation in combination with fertilizer K application makes the reduction of pollution potential of both soil N and P become possible, while high yield of processing tomatoes is produced with improved quality.

The study is to be continued in 2007.