Agronomic and Environmental Consequences of Applying Fertilizer Nitrogen and Phosphorus to Processing Tomatoes and Green Peppers under Drip Fertigation

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Summary (2005)

Processing tomatoes and green peppers are high nutrient-demand crops, and the requirements can be further increased with increased yield potential resulted from improved water supply. Irrigation, especially drip irrigation/fertigation, has been largely adopted in southwestern Ontario for processing tomatoes and green peppers to overcome the frequent incidences of drought stress. However, excessive nutrient supply can have adverse impacts on water quality through surface runoff and leaching (nitrogen and phosphorus) and to air quality through gaseous emissions. New fertilization techniques must be developed for irrigated crops to maximize farmers' profits and to sustain or improve the environmental quality.

The long-term objectives of this study are 1) to develop optimum rates of fertilizer nitrogen and phosphorus for processing tomatoes and green peppers under drip fertigation, which are both economically and environmentally sound, 2) to determine the amounts of nitrogen and phosphorus required for each tonne production of processing tomatoes and green peppers, and 3) to determine the threshold values of petiole NO_3-N for processing tomatoes under Ontario conditions. The short-term objectives for 2005 were 1) to determine the relationships between fertilizer nitrogen and phosphorus rates and yield and quality of processing tomatoes and green peppers; 2) to determine crop nitrogen and phosphorus removals; and 3) to evaluate the potential leaching losses of soil NO_3-N.

The experiment was conducted in a Granby sandy loam soil in Harrow, ON. Treatments for processing tomatoes included 4 fertilizer nitrogen rates ranging from 0 to 360 kg N ha^{-1} and 3 fertilizer P rates ranging from 0 to 200 kg P_2O_5 ha^{-1}). For green peppers, treatments included 4 fertilizer N rates ranging from 0 to 240 kg N ha^{-1} and 3 fertilizer phosphorus rates ranging from 0 to 200 kg P_2O_5 ha^{-1}. Both trials were arranged in a factorial randomized completely block design, with 4 replicates.

Green peppers: The marketable yield was maximized at 38.5 tonne ha^{-1} with fertilizer nitrogen added at 203 kg N ha^{-1} (current OMAF recommendation: 70 kg N ha^{-1}). The result is consistent to what was obtained in 2003 (200.7 kg N ha^{-1}) and 2004 (277 kg N ha^{-1}). Green peppers require an increased nitrogen supply under drip fertigation.

An optimized combination of nitrogen (240 kg N ha^{-1}) and phosphorus (125 kg P_2O_5 ha^{-1}) was necessary, if large size of fruits are desired.
Fruit nitrogen removal ranged from 21 to 60 kg N ha^{-1}. Total above-ground nitrogen uptake ranged from 29 to 84 kg N ha^{-1}. Green peppers used 26% of nitrogen added with the production of maximum marketable yield, and thus have a low nitrogen use efficiency.

Amount of nitrogen required to produce each tonne of marketable yield varied from 0.28 to 5.2 kg N $tonne^{-1}$, depending on the level of target yield. When the maximum marketable yield is considered, the amount of fertilizer nitrogen required across the three years (2003-2005) was from 5.2 to 6.5 kg N $tonne^{-1}$.

Total above-ground phosphorus uptake ranged from 7.6 to 15.4 kg P ha^{-1}, with fruit phosphorus removal ranging from 5.2 to 11.3 kg P ha^{-1}. Both phosphorus removal and total uptake fell respectively into the same range as in 2004, and responded quadratically to nitrogen rate. This also applies to the relationship between total potassium uptake and fertilizer nitrogen rate.

Post-harvest soil NO_3-N increased with increases in fertilizer nitrogen rate in soil layer up to 100cm, a reflection of leaching that have occurred in the growing season. Prevention of nitrogen leaching loss is necessary for green peppers under drip fertigation/irrigation.

Processing tomatoes: Both total and marketable yields responded quadratically to nitrogen application. A maximum marketable yield of 112 tonne ha^{-1} was produced with 305 kg N ha^{-1} fertilizer nitrogen applied. This was consistent with the results obtained in 2003 (216 kg N ha^{-1}) and 2004 (292 kg N ha^{-1}). Processing tomatoes under fertigation requires more nitrogen than the current recommendation (90-120 kg N ha^{-1} for the soil under study) to develop the maximum yield potential and to obtain the highest profits.

Fruit nitrogen removal ranged from 63 to 185 kg N ha^{-1}, and total nitrogen uptake from 97 to 251 kg N ha^{-1}. Both nitrogen removal and total nitrogen uptake were related quadratically to fertilizer nitrogen rate.

Values of fertilizer nitrogen required for each tonne of marketable yield production ranged from 0.12 to 2.7 kg N $tonne^{-1}$, depending on the level of target yield. The values are similar, but bracket those obtained from past two years (2003 and 2004). The amount of nitrogen required for the maximum yield across three years ranged from 1.7 to 2.7 kg N $tonne^{-1}$.

Total phosphorus uptake ranged from 24.8 to 44 kg P ha^{-1} (57 to 100.8 kg P_2O_5 ha^{-1}), and responded quadratically to nitrogen rate. A coordinate supply of nitrogen and phosphorus is important to best meet crop needs.

Marketable yield was related to petiole NO_3-N concentrations at various stages from first blooming to fruit set, but levels of petiole NO_3-N at the early blooming stage (July 06) accounted for the majority of nitrogen contribution to yield. Nitrogen fertilization should be performed right before full blooming.

The threshold value of petiole NO_3-N at the early blooming stage was 2020 mg N kg^{-1}, which is consistent with the value of 1934 mg N kg^{-1} in 2003.

Post-harvest soil profile NO_3-N contents increased with fertilizer nitrogen rate, especially above the rate required for maximum marketable yield production. **A**ny excessive nitrogen applied would pose significant potential for losses, if not used by the crop during the growing season.

The optimized fertilization techniques are essential to maximize crop marketable yield, while minimizing adverse effects on environmental quality.