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

T.Q. Zhang, C.S. Tan, J. Warner, C.F. Drury, D. Reynolds, A. Hamill, A. Liptay
Greenhouse and Processing Crops Research Centre, Agriculture and Agri-Food Canada, Harrow, Ontario N0R 1G0 zhangt@agr.gc.ca

Executive Summary for year 2003

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' profit and 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 ton increase of processing tomato and green pepper yield, and 3) to determine the threshold values of petiole NO_3-N for processing tomatoes for Ontario conditions. The short-term objectives for 2003 were 1) to determine the relationships between fertilizer nitrogen and phosphorus rates and yield and quality of processing tomatoes and green peppers under drip fertigation; 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 at the GPCRC, Harrow, ON. Treatments for processing tomatoes included 4 fertilizer nitrogen rate (0-360 kg N ha^{-1}) and 3 fertilizer P rates (0-200 kg P_2O_5 ha^{-1}). For green peppers, treatments included 4 fertilizer N rate (0-240 kg N ha^{-1}) and 3 fertilizer phosphorus rates (0 200 kg P_2O_5/ha). Both trials were arranged in a factorial randomized completely block design, with 4 replicates.

Green peppers: The marketable yield of green peppers was maximized at 30.2 Mg ha^{-1} with added fertilizer N at 200.7 kg N ha^{-1}, a rate much higher than that is recommended by the OMAF publication 363. It was clear that green peppers require an increased nitrogen supply under the current practices with drip fertigation. Green pepper yield increased linearly with increases in fertilizer phosphorus application.

A calculated value of 6.65 kg N ha^{-1} fertilizer nitrogen was required to produce each tonne of marketable yield. The value was 1.4 times higher than what was in 2002, when a 3.1 kg N ha^{-1} was required to produce each tonne of marketable yield, presumably due to the increased natural precipitation in 2003 which may has enhanced the leaching losses of soil nitrogen and thus resulted in a reduced fertilizer nitrogen use efficiency.

Green pepper stover uptake of nitrogen ranged from 13 to 39 kg N ha^{-1} and phosphorus from 3.5 to 8 kg P ha^{-1}. Stover uptake of nitrogen and phosphorus increased with increases in fertilizer nitrogen and phosphorus rates due to the enhanced biomass production.

The maximum removal with fruit harvesting was 52 kg N ha^{-1} for nitrogen and 10 kg P ha^{-1} for phosphorus. Increased fertilizer phosphorus application increased fruit nitrogen removal by green pepper harvesting.

Total nitrogen uptake ranged from 30 to 89 kg N ha^{-1}. Total phosphorus uptake ranged from 7 to 18 kg P ha^{-1} and increased linearly with increases in fertilizer nitrogen rate.

Fertilizer nitrogen applied at 240 kg N ha^{-1} increased significantly soil profile NO_3-N contents, which was corresponding closely to the fertilizer nitrogen rate required for maximum green pepper production found in this study. Any fertilizer nitrogen above the rate required for maximum yield production can cause damages to water quality and reduction in farmers' profits.

Increased fertilizer phosphorus application increased remarkably the total nitrogen uptake and the fertilizer nitrogen use efficiency. Consequently, increased fertilizer phosphorus application reduced the loss potential of soil residual NO_3-N and the possible adverse effect of excessive fertilizer nitrogen application on water quality.

Processing tomatoes: The yields of processing tomatoes responded quadratically to the added fertilizer nitrogen, with the maximum marketable yield of 130 Mg ha^{-1} produced at 216 kg N ha^{-1}. Any fertilizer nitrogen added at rates above what was required for the maximum marketable yield caused excessive vegetative growth and produced additional green or culled fruits by the harvesting stage. Increases in fertilizer nitrogen rate or petiole NO_3-N concentrations reduced soluble solids content. However, increases in stover phosphorus content increased soluble solids content.

A calculated value of fertilizer nitrogen required for each tonne of marketable yield production was 1.7 kg N ha^{-1} in 2003. This is comparable with the value of 1.5 kg N ha^{-1} $tonne^{-1}$ in 2002.

Phosphorus removal by fruit harvest ranged from 28 to 39 kg P ha^{-1}.

A threshold value of petiole NO_3-N concentration existed to obtain the maximum marketable yield of processing tomatoes under fertigation. Any petiole NO_3-N concentrations either below or above this threshold value can cause reduction in yield. The threshold value of petiole NO_3-N concentration ranged from 1700 to 1934 mg N kg^{-1} in 2003, depending on the growing stage.

Added fertilizer nitrogen increased post-harvest soil profile (0-100 cm) NO_3-N contents. Any fertilizer nitrogen added above the rate required for maximum yield production would remain in soil and cause potential damage to water quality.