2002 OTRI EXECUTIVE SUMMARY

Project Title: Farm-Scale Processing Tomato Production using Surface and Subsurface Drip Irrigation and Fertigation

Researchers: C. S. Tan, T. Q. Zhang, W. D. Reynolds, C. F. Drury and A. Liptay, Agriculture and Agri-Food Canada, Research Branch, Greenhouse and Processing Crops Research Centre, Harrow, Ontario N0R 1G0

Objectives: The objective of this study is to determine the effects of surface and sub-surface drip irrigation and fertigation on: 1) the yield and quality of processing tomato; and 2) the efficiency with which processing tomato utilizes water and nutrients applied via surface and subsurface drip irrigation and/or fertigation.

Methodology:

The experiments were conducted on two fields owned by cooperating Producers: one comprising about 16 acres on the loamy sand soil (3E), and the other comprising about 5 acres on the clay loam soil (4E). Processing tomatoes (Heinz 9478) were transplanted on both fields with plant populations of 33,105 and 31,300 plants per hectare on the loamy sand and clay loam soils, respectively. The experiments consisted of three irrigation management treatments included non-irrigated control plots (NI), surface drip irrigated plots (SDI) and sub-surface drip irrigated plots (SSDI). Fertilizer treatments included both broadcast fertilizer and fertigation applied via the drip lines. The irrigation amount and frequency for drip and fertigation treatments were determined using corrected long-term potential evapotranspiration data from near-by weather station and emitter flow rate, along with soil moisture retention characteristics from both loamy sand and clay loam soils.

On the loamy sand soil (3E), broadcast fertilizer treatments had three fertilizer splits (44.8 kg N/ha, 89.7 kg P/ha, 22.4 kg K/ha before planting; 112 kg N/ha at the planting; 44.8 kg N/ha and 28 kg K/ha at the side-dressing). Fertigation treatments had 2 splits broadcast fertilizer (44.8 kg N/ha, 89.7 kg P/ha, 22.4 kg K/ha before the planting; 67.3 kg N/ha, 28 kg K/ha at the planting) and 112 kg N/ha applied through fertigation. On the clay loam soil(4E), broadcast fertilizer treatments had fertilizer splits (56.1 kg N/ha, 134.5 kg P/ha, 33.6 kg K/ha before planting; 134.5 kg N/ha at the side-dressing). Fertigation treatments had 2 splits broadcast fertilizer (56.1 kg N/ha, 134.5 kg P/ha, 33.6 kg K/ha before planting; 67.3 kg N/ha at the side-dressing) and 67.3 kg N/ha applied through fertigation.

Representative soil samples were collected from both loamy sand (3E) and clay loam (4E) soils at depths of 0-30 cm for soil texture determination , using the pipette method (Gee and Bauder, 1986). Intact soil cores (10 cm diameter by 10 cm long) were collected at three depths (0-10 cm, 10-20 cm and 20-30 cm) on both soils for determination of various soil physical properties. Soil samples were also collected at depths of 0-20, 20-40, 40-60, and 60-100 cm before planting and post-harvest for NO_3-N, NO_4-N and mineral-N determinations.

Time Domain Reflectometer (TDR) was used to measure volumetric soil water content between 5 to 25 cm soil depths. Measurements were made two times per week in all treatments in both fields. Leaf petiole nitrate and potassium measurements were determined using Cardy nitrate and potassium metres (Spectrum Technologies, Plainfield, IL). Samples were obtained once per week in three location in each treatments at loamy sand soil (3E). Leaf petiole samples were taken only once in all the treatments during the growing season on the clay loam soil (4E).

Machine harvest yields were taken over the entire experimental fields for tomatoes on August 22, 2002 for loamy sand (3E) and for clay loam (4E) soils on September 13, 2002. The yields were calculated as metric tonnes of marketable tomatoes per hectare. The soluble solid was measured and expressed as Brix. Plant tissue samples were collected and analysed for N and P contents, and total N and P removals were calculated by integrating with marketable yield.

Results and Discussion:

The plants in non-irrigated treatment on both loamy sand (3E) and clay loam (4E) soils were experiencing high temperatures and a severe water deficit (315 mm on the loamy sand soil; 280 mm on the clay loam soil) during the most parts of growing season in 2002. On the loamy sand soil (3E), drip irrigation treatments were initiated on June 27 and terminated on August 18 with a total of 193.5 mm of water added. On the clay loam soil (4E), drip irrigation treatments were initiated on June 19, and terminated in September 3, 2002 with a total of 164 mm of water added. Surface and sub-surface drip and/or fertigated plots had consistently higher available soil moisture (50 to 80 %) at the top 30 cm of rooting depths than non-irrigated plots throughout the entire 2002 growing season on both loamy and clay loam soils. Leaf petiole sap NO_3-N and K concentrations were within sufficiency values during a month before harvest on both soils. On the loamy sand soil, marketable tomato yields were increased by 52.3 % and 60.4 % under surface drip or fertigated (SDI) and sub-surface drip or fertigated (SSDI) plots relative to non-irrigated control (NI) plots (131.8 MT/ha for SDI, 138.8 MT/ha for SSDI, 86.5 MT/ha for NI). Marketable tomato yields under SSDI plots were increased only by 5.3 % relative to SDI plots. There was no significant difference in marketable tomato yields between broadcast fertilizer and fertigation on both SSDI and SDI plots. The results were expected because there was no evident of fertilizer leaching from soil surface and there was ample surface broadcast fertilizer available for plant uptake due to extreme low rainfall during the 2002 growing season as seen in leaf petiole sap NO_3-N and K concentrations were within sufficiency values for all the treatments. On the clay loam soil, marketable tomato yields were increased by 86.7 % under SDI plots relative to NI plots (117.1 MY/ha for SDI, 62.7 MT/ha for NI), while tomato yields under SSDI plots were increased by 44.2 % relative to NI plots (90.5 MT/ha for SSDI, 62.7 MT/ha for NI). Marketable tomato yields under SDI plots were increased by 29.5 % relative to SSDI plots. The observation of possible root intrusion at the sub-surface emitters prevent uniform water distribution could be explained the reduction of yields relative to surface drip irrigated treatments. The soluble solids of tomato were higher in the non-irrigated than drip irrigated and/or fertigated plots on both soil conditions. There were no significant differences in soluble solids among surface and sub-surface drip irrigated tomatoes with either broadcast fertilizer or fertigation. Drip irrigated and/or fertigated tomatoes increased water use efficiency by 32 % and 52 % relative to non-irrigated tomatoes on the loamy and clay loam soils, respectively. Both soil profile NO_3-N and crop nutrient N and P removals suggested that drip and /or fertigation tomatoes had higher nutrient N and P use efficiency than the non-irrigated tomatoes. On the loamy sand soil, subsurface drip and /or fertigated tomatoes also had greater nutrient N and P use efficiency than the surface drip and /or fertigated tomatoes. Furthermore, the largest decrease in soil profile NO_3-N and the highest crop N and P removals imply that subsurface fertigated tomatoes had the highest nutrient N and P use efficiency.