2003 OTRI EXECUTIVE SUMMARY

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

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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 3 acres on the sandy loamy soil (3E), and the other comprising about 4.6 acres on the sandy 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 sandy loam and sandy 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 sandy loam and sandy clay loam soils.

On the sandy loam 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 sandy 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 sandy loam (3E) and sandy 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).

Weather data were automatically recorded at both experimental fields, using Campbell CR 10 data logger. These measurements included precipitation, air temperature, solar radiation, relative humidity, vapour pressure deficit, potential evapotranspiration.

Machine harvest yields were taken over the entire experimental fields for tomatoes on September 1, 2003 for sandy loam (3E) and for sandy clay loam (4E) soils on September 7, 2003. 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 2003 growing season was relative wet. The plants in non-irrigated treatment on both sandy loam (3E) and sandy clay loam (4E) soils were only experiencing small water deficit during the most parts of growing season in 2003. On the sandy loam soil (3E), drip irrigation treatments were initiated on June 27 and terminated on August 13 with a total of 111.9 mm of water added. On the sandy clay loam soil (4E), drip irrigation treatments were initiated on July 2, and terminated in August 8, 2003 with a total of 74.7 mm of water added. Available soil moisture at the top 30 cm of rooting depths for drip and non-irrigated treatments were above 50 % level during the 2003 growing season on both sandy loam and sandy 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 sandy loam soil, there were only small differences in average marketable tomato yields between drip and non-irrigated treatments. Average marketable tomato yields under sub-surface drip irrigated plots were increased by 13.3 % relative to surface drip irrigated plots. Average marketable tomato yields under broadcast fertilizer were increased by 8.7 % relative to fertigated plots. On the sandy clay loam soil, average marketable tomato yields were increased by 17.8 % under drip irrigated plots relative to non-irrigated plots. Average marketable tomato yields under sub-surface drip irrigated plots were decreased by 7 % relative to surface drip irrigated plots. There were only small differences in average marketable tomato yields between broadcast and fertigated plots. 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 between surface and sub-surface drip irrigated tomatoes. However, tomatoes under fertigated plots on the sandy loam soil seemed to have lower soluble solid than tomatoes under broadcast plots. The drip irrigated tomatoes on sandy clay loam soil also have higher soluble solid than tomatoes on sandy loam soil. Drip irrigated and/or fertigated tomatoes increased water use efficiency by 9.2 % relative to non-irrigated tomatoes on the sandy clay loam soils but no difference in water use efficiency between drip irrigated and non-irrigated tomatoes on sandy loam soil. Drip and /or fertigated tomatoes had slightly higher total N and P uptake and removals than the non-irrigated control tomatoes on the sandy loam soil (3 E). However, on the sandy clay loam soil (4 E), all drip and/or fertigation treatments, except for sub-surface drip with broadcast fertilizer (SSB), decreased total N uptake and removal, because of the much reduced N concentrations in both fruits and stover.