2004 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 2.5 acres on the loamy sand soil (3E), and the other comprising about 5.7 acres on the sandy clay loam soil (4E). Processing tomatoes (Heinz 9478) were transplanted on the loamy sand soil with plant populations of 33,105 plants per hectare and Heinz 9553 tomatoes were transplanted on the sandy clay loam soil with plant populations of 31,300 plants per hectare. The experiments consisted of three irrigation management treatments including 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 a near-by weather station, emitter flow rate and soil moisture retention characteristics from the loamy sand and sandy 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 sandy clay loam soil(4E), the broadcast fertilizer treatments had two 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); and the fertigation treatments had 2 splits of 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 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 at three locations in each treatment on the loamy sand soil (3E). Leaf petiole samples were taken once in all the treatments during the growing season on the sandy clay loam soil (4E).

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

Machine harvest yields were taken over the entire experimental fields for tomatoes on September 9, 2004 for the loamy sand (3E) and on September 27, 2004 for the sandy clay loam (4E) soils. 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 2004 growing season was extremely wet in May, about 132 mm above long-term average. The rest of the growing season (June, July and August) was close to the long-term average. The plants in the non-irrigated treatment of both soils experienced moderate water deficits during most parts of growing season in 2004.

On the loamy sand soil (3E), drip irrigation treatments were initiated on July 6 and terminated on August 26 with a total of 126.8 mm of water added. On the sandy clay loam soil (4E), drip irrigation treatments were initiated on July 3, and terminated in September 14, 2004 with a total of 185.6 mm of water added. On the loamy sand soil, drip irrigated and fertigated treatments had consistently higher available soil moisture (ASM) in the top 30 cm depth than non-irrigated treatments during July and August. On the sandy clay loam soil, the ASM levels in the top 30 cm depth for non-irrigated treatments were lower than drip irrigated and fertigated treatments, however, the ASM levels for all drip, fertigated and non-irrigated treatments were above 50 % during the growing season.

Leaf petiole sap NO_3-N and K concentrations were within sufficiency values during the month before harvest on the loamy sand soil. However, leaf petiole sap NO_3-N concentrations during the month before harvest on the sandy clay loam soil were low, especially for the fertigated plots.

On the loamy sand soil (3 E), marketable tomato yields in 2004 were increased by 60.9 % and 65.7 % under surface drip or fertigated (SDI) and sub-surface drip or fertigated (SSDI) plots relative to non-irrigated control (NI) plots (129.4 tonnes/ha for SDI, 133.2 tonnes/ha for SSDI, 80.4 tonnes/ha for NI). There was no significant difference in marketable tomato yields among surface drip, sub-surface drip, broadcast fertilizer and fertigation treatments. Three-year average (2002-2004), marketable tomato yields on the loamy sand were increased by 41 % for drip irrigation and fertigation relative to no irrigation. On the sandy clay loam soil (4E), average marketable tomato yields on the drip irrigated and fertigated plots were increased by 12 % relative to non-irrigated plots. Average marketable tomato yields under broadcast drip irrigated plots were increased by 23 % relative to fertigated and non-irrigated plots. There were only small differences in average marketable tomato yields between fertigated and non-irrigated plots. The low marketable yields for fertigated plots in 2004 were due to nitrogen deficiency as indicated by

low leaf petiole sap NO_3-N concentrations. Three-year average (2002-2004), marketable tomato yields on the sandy clay loam were increased by 25 % for drip irrigation and fertigation relative to no irrigation.

On the loamy sand, tomato soluble solids were higher for no irrigation than for drip irrigation and fertigation. There were no significant differences in soluble solids among all drip or fertigated tomatoes. On the sandy clay loam soil, the drip irrigated tomatoes have similar soluble solid than the non-irrigated tomatoes.

Drip irrigation and fertigation increased water use efficiency by 45% and 7% relative to no irrigation on the loamy sand and sandy clay loam, respectively. Drip irrigated and fertigated tomatoes on the loamy sand (3E) had much greater fruit N, P removals and total uptakes than the non-irrigated tomatoes, causing the nutrient N and P use efficiency to be greater by 56 % and 69 %, respectively, relative to no irrigation. However, on the sandy clay loam (4E), all the fertigated tomatoes decreased fruit N removals and total N uptakes, causing the N use efficiency to be reduced as much as 27 % relative to non-irrigated tomatoes.