Project Title: Development of Alternative Irrigation Practices to Improve Water-Use Efficiency, Nutrient Use-Efficiency and Water Quality for the Production of Processing Cucumbers on Coarse-Textured Soils

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Objective:

Two cucumber experiments were conducted in 2002 at the Agriculture and Agri-Food Canada's Southern Crop Protection and Research Centre, Delhi site to compare productivity, grade quality, water-use efficiency (WUE) and nutrient-use efficiency (NUE) of non-irrigated (NI) treatments to overhead (OH) irrigation, surface drip irrigation (DI), and sub-surface drip (SDI) irrigation. The project consisted of two independent studies, one investigating management of once-over harvested processing cucumbers and one investigating the management of multi-pick processing cucumbers.

Methodology:

A total of 8 treatments were evaluated for each of 2 harvesting methods. The treatments compared 2 trickle irrigation techniques (DI and SDI) each with three fertilization rates (below, at and above OMAF recommended rates), a control comprised of overhead sprinkler irrigation and a non-irrigated control treatment both fertilized at OMAF recommended rates. Vlaspik M, the processing once-over harvested cucumber cultivar and Fancipak, the processing hand-pick cucumber cultivar, were planted in 75-cm-wide rows at a rate of 177,000 and 93,000 plants per hectare, respectively, on June 11, 2002. All plots were established and maintained in accordance with recommendations for the production of processing cucumbers as outlined in OMAF publication 363 (Vegetable Production Recommendations).

Irrigation was triggered at soil moisture contents of 10% v/v water content in the overhead sprinkler treatment and terminated when the soil at the 10 to 25 soil depth reached field capacity (18% v/v). In both drip irrigation treatments, irrigation was triggered at 14% v/v trigger and was terminated when the soil in the wetted zone reached field capacity. Minimal amounts of irrigation water were applied when soil moisture contents were above the trigger to allow for fertigation.

Measurements of the weights of the once-over harvest and the cumulative yield of the individual multiple picks were used to assess plant productivity. Fruit size distribution at harvest (fresh) and brining quality (evaluated by industry) were used to assess fruit quality. Total aboveground plant phytomass and nutrient content will be compared to estimate total plant uptake and nutrient-use efficiency. Solute movement from the rooting zone was monitored

throughout the growing season from selective plots. This information, coupled with soil moisture data with depth, will be used to estimate the loss of nutrients from the rooting zone.

Results:

There were 16 (DI) and 13 (SDI) drip events for Vlaspik M totalling 8.5 and 6.1 cm of water respectively. For Fancipak there were 29 (DI) and 26 (SDI) drip events totalling 14.8 and 12.3 cm of water. There were 3 overhead (OH) events for Vlaspik M totalling 7.7 cm of water, and 5 overhead (OH) events for Fancipak totalling 12.7 cm.

Fancipak marketable yields in sub-surface (57.8, 64.4, 64.2 t/ha) and in surface drip irrigation (60.3, 58.8, 61.3 t/ha) were significantly higher than in overhead (44.4 t/ha) or non-irrigated (28.4 t/ha) treatments. Similarly, Vlaspik M marketable yields in sub-surface (14.7, 18.6, 18.7 t/ha) and surface drip (15.9, 17.4, 20.4 t/ha) treatments exceeded those of the overhead (9.4 t/ha) and non-irrigated (4.4 t/ha) treatments. Fancipak net returns were greater with surface ($16,400, $14,100, $15,700 /ha) and sub-surface drip ($15,200, $17,800, $16,200 /ha) irrigation systems than with overhead ($10,500 /ha) irrigation. Overhead irrigation was found to have significantly higher returns than the non-irrigated control ($ 7,300 /ha). Vlaspik M net returns were also higher with surface ($3,900, $4,000 and $4,800 /ha) and sub-surface drip ($3,400, $4,000 and $4,000 /ha) than with overhead ($2,600 /ha) irrigation. Net returns for the non-irrigated treatment were $0 for Vlaspik M (tare penalties were greater than the gross returns).

Irrigation WUE for Fancipak was 4.07, 3.97, and 4.14 t/cm with surface drip, 3.49 t/cm with overhead and 4.70, 5.23, 5.22 t/cm with sub-surface drip. With Vlaspik M, irrigation WUE was less with overhead (1.22 t/cm), than with surface drip (1.87, 2.04, 2.41 t/cm) and sub-surface drip (2.40, 3.05, 3.06 t/cm). Nutrient-use efficiency in Fancipak plots was significantly higher in sub-surface (723, 585, 459 kg/kg N) and surface (753, 534, 437 kg/kg N) drip irrigation treatments than in the overhead (403 kg/kg N) and non-irrigated (258kg/kg N) treatments at the similar and below OMAF recommended rates of fertilization. Vlaspik M NUE was significantly higher under sub-surface (277, 273, 225 kg/kg N) and surface drip (299, 256, 246 kg/kg N) irrigation treatments than in overhead (125 kg /kg N) and non-irrigated (59 kg/kg N) irrigation treatments at all rates of fertilizer. Subsoil water content measured to 1.3 m deep provided no evidence of deep percolation of water into the subsoil with any of the irrigation treatments.

The addition of irrigation water resulted in higher yields and returns than the non-irrigated control. However, drip irrigation resulted in further increases in yield, net returns and nutrient-use efficiency compared with overhead irrigation. Increased yields with drip irrigation compared are likely related to supplying nutrients through drip lines to the zone of maximum root density as opposed to mixing nutrients within the total soil volume when dry broadcast fertilization is used. The results also indicate some advantage of sub-surface drip over surface drip in terms of water-use efficiency for drip irrigation of cucumbers on coarse-textured soils.