

Project Title: Alternative Irrigation Practices for the Production of Processing Cucumbers.

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Two cucumber experiments were conducted in 2003 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 with overhead (OH) irrigation, surface drip irrigation (DI), and sub-surface drip (SDI) irrigation. A total of 8 treatments were evaluated for each of 2 harvesting methods; once over and multipick harvests. The treatments compared 2 trickle irrigation techniques (DI and SDI) each with three fertilization rates, (below, at and above OMAF recommended rates), an overhead sprinkler irrigation and a non-irrigated control treatment both fertilized at OMAF recommended rates. Vlaspiik, 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 10, 2003. 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 when soil moisture contents fell to 10% v/v water content in the overhead sprinkler treatment and at 14% v/v for drip treatments, as indicated using automated reflectometers with rods placed 10 cm from an emitter, and 10-25 cm deep (for overhead and surface drip) or 15-30 cm deep (for buried drip treatments). Water was applied to bring the topsoil (for overhead) or wetted zone (for drip treatments) to field capacity (18% v/v). 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.

Once-Over Harvested Study

A total of 15 fertigation events occurred in both the DI and SDI treatments resulting in a total of 1.49 cm of water being applied to both irrigation treatments. From planting to the completion of harvest, a total of 125.2 mm of precipitation was received at the field site. This rainfall was sufficient to prevent soil moisture contents from falling below that required for overhead sprinkler irrigation. However, soil moisture content did fall below the required trigger for drip irrigation on July 21. On this date, 0.4 cm of water was applied to bring the total amount of irrigation water applied to 1.89 cm.

Marketable yields in the drip irrigated treatments fertilized at (DI: 27.1 t ha⁻¹; SDI: 26.1 t ha⁻¹) and above the recommended rates (DI: 26.8 t ha⁻¹; SDI: 28.7 t ha⁻¹) exceeded those of the non-irrigated treatment (22.3 t ha⁻¹) but were similar to the overhead irrigated treatment (24.1 t ha⁻¹). In contrast, yields of drip treatments fertilized at the lower rate (DI: 21.3 t ha⁻¹; SDI: 23.7 t

ha⁻¹) were similar to both the overhead sprinkler irrigated and non-irrigated treatments. Higher net returns were found under surface drip irrigated plots fertilized at (\$6.0 K ha⁻¹) and above (\$5.8 K ha⁻¹) the recommended rate than the non-irrigated (\$5.0 K ha⁻¹) but were similar to the overhead sprinkler irrigated (\$5.2 K ha⁻¹) treatment. However, only the higher fertilizer rate ((\$6.4 K ha⁻¹) in subsurface irrigation systems had higher returns than the non-irrigated and overhead irrigated plots. Total water-use efficiency was higher in the subsurface treatment fertilized at the higher rate (1.9 t cm⁻¹ ha⁻¹) and overhead sprinkler irrigation (1.9 t cm⁻¹ ha⁻¹) treatments than in the surface (1.4 t cm⁻¹ ha⁻¹) and subsurface (1.6 t cm⁻¹ ha⁻¹) drip irrigated plots at the lower fertilization rates. However, similar water-use efficiencies were found among the remaining treatments. Total water-use efficiency decreased with increasing fertilizer application rates and was significantly higher at the recommended and above recommended fertilizer application rates than the lower fertilization rate in both drip irrigation systems. The highest nitrogen-use efficiencies were found in the low fertilization rate in the subsurface drip system (394 kg kg⁻¹ ha⁻¹) which was similar to those found in the surface drip system at (362 kg kg⁻¹ ha⁻¹) and below (355 kg kg⁻¹ ha⁻¹) the recommended fertilization rate. Nitrogen-use efficiency declined with increasing fertilization rates with a higher nitrogen-use efficiency found in the lowest fertilization rate compared with the higher fertilization rate both the subsurface and surface drip systems. Similar nitrogen-use efficiencies were found among the non-irrigated (297 kg kg⁻¹ ha⁻¹), overhead sprinkler irrigated (321 kg kg⁻¹ ha⁻¹) and drip systems fertilized at the higher nitrogen rate (DI: 298 kg kg⁻¹ ha⁻¹; SDI: 319 kg kg⁻¹ ha⁻¹) .

Multipick Experiment

Drip irrigation plots were fertigated every 2 to 4 days from the end of June until 26 August in the multipick study. In early growth stages, drip treatments were watered for a minimum amount of time to allow fertilizer additions to maintain the fertigation schedule, which, along with rainfall, maintained water content at field capacity. A total of 19 fertigation events were applied throughout this period, resulting in the addition of 1.85 cm of irrigation water or 22% and 30% of the total water addition in the surface drip and subsurface drip treatments, respectively. By mid-August, soil moisture contents had fallen to levels that triggered drip and overhead sprinkler irrigation. Thereafter, there were 7 irrigation/fertigation drip applications resulting in the addition of 0.55 cm and 4.25 cm or 78% and 70% of the total irrigation water applied for surface drip and subsurface drip treatments, respectively. There were 2 overhead sprinkler irrigation events in the multipick study resulting in 5.93 cm of irrigation water applied. From planting to the completion of harvest, a total of 194.2 mm of precipitation was received at the field site.

Fancipak was harvested 11 times from 29 July to 2 September. At recommended (59.8 t ha⁻¹) and higher (62.6 t ha⁻¹) than recommended fertilizer application rates, Fancipak marketable yields in surface drip irrigation were significantly higher than in overhead (48.3 t ha⁻¹) or non-irrigated treatments (43.3 t ha⁻¹). However, in subsurface drip treatments, yields were

only higher than overhead irrigated and non-irrigated plots at the higher than recommended fertilizer rate (58.6 t ha⁻¹). Fancipak net returns were greater with surface and sub-surface drip irrigation systems at recommended (DI: \$18.4 K ha⁻¹; SDI: \$16.3 K ha⁻¹) and higher (DI: \$19.3 K ha⁻¹; SDI: \$16.7 K ha⁻¹) than recommended fertilizer application rates but similar at lower than recommended fertilizer application rates (DI: \$13.8 K ha⁻¹; SDI: \$14.5 K ha⁻¹) than the overhead irrigation treatment (\$14.2 K ha⁻¹) and the non-irrigated control (DI: \$12.5 K ha⁻¹). A significant increase in returns was found with the increase in fertilizer rate in the surface irrigated system but were similar among the fertilizer rates in the subsurface drip system. Total water-use efficiency of marketable cucumbers was not found to be different among the irrigation treatments fertilized at the recommended fertilizer application rate (NI: 2.2 t cm⁻¹ ha⁻¹; OH: 1.9 t cm⁻¹ ha⁻¹; DI: 2.1 t cm⁻¹ ha⁻¹; SDI: 2.2 t cm⁻¹ ha⁻¹). Total water-use efficiency was higher at the recommended and above recommended fertilizer rates than the below recommended rate in the surface drip system but was not found to be different among the various fertilization treatments in the subsurface drip treatments (below: 1.9 t cm⁻¹ ha⁻¹; at: 2.2 t cm⁻¹ ha⁻¹; above: 2.3 t cm⁻¹ ha⁻¹). Finally, nutrient-use efficiency (NUE) in Fancipak plots was significantly higher in sub-surface and surface drip irrigation treatments at recommended (DI: 543 kg kg⁻¹ ha⁻¹; SDI: 543 kg kg⁻¹ ha⁻¹) and below (DI: 617 kg kg⁻¹ ha⁻¹; SDI: 634 kg kg⁻¹ ha⁻¹) recommended fertilizer application rates than those found in the non-irrigated treatment (394 kg kg⁻¹ ha⁻¹). Similarly, surface drip had higher nutrient-use efficiencies with below and at OMAF recommended rates of fertilization than the sprinkler irrigated treatment. However, nutrient-use efficiency was higher than the overhead sprinkler treatment only at below the current recommended application rate.

The 2003 season was marked by cooler temperatures and higher precipitation than either the 2001 or 2002 seasons. As a result, additional water was applied early in the growing season to apply fertilizer materials and increased the amounts of total water applied in the drip irrigation treatments. The 2003 results suggest that a yield response with drip irrigation systems over sprinkler and no irrigation occurs even in years where irrigation requirements were low. These preliminary results also indicate some advantage of sub-surface over surface lines in terms of water-use efficiency for drip irrigation. Nutrient-use efficiency was improved significantly through the use of drip irrigation systems with higher nutrient-use efficiencies being found at similar and lower rates of fertilization in the drip system compare to the sprinkler and non-irrigated treatments. Finally, both types of drip irrigation continue to appear to have significant advantages in terms of yield and returns as compared to overhead irrigation, particularly if nutrients are also supplied through the drip lines. This may provide opportunities to reduce fertilizer application rates below those currently recommended for conventional production systems, thereby, reducing costs to producers without reducing yields but reducing the risks of environmental contamination.