Comparison of drip and sprinkler irrigation in Brussels sprouts: water use, nitrogen, and crop yield.

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Introduction

Brussels sprouts are typically irrigated using hand-move sprinkler lines on the central coast of California. After establishing transplants, as many as 10 to 14 days may pass between sprinkler irrigations. The long irrigation interval is possible because the evapotranspiration rate is lower on the coast compared to a few miles inland and because Brussels sprouts have a rooting depth of 2 to 3 feet. Nitrogen fertilizer is typically applied to Brussels sprouts by a combination of preplant fertilizer incorporated in the beds followed by 1 or 2 sidedressings of fertilizer in bands in the beds, and finally by fertigating through the sprinkler water after the canopy is too dense for tractor traffic.

Drip irrigation may offer several advantages over sprinklers for Brussels sprouts production. Windy conditions which are common adjacent to the coast can greatly reduce the uniformity of sprinklers, but do not affect the uniformity of drip systems. For situations where pumping capacity is limited, drip systems can be designed to apply water at low rates so that they can irrigate more acreage during a single irrigation than sprinklers. Irrigation run-off is also minimized using drip irrigation. Finally, fertilizer can be applied to the crop through the drip system so that nutrient applications can be matched to the uptake rate of the crop.

Demonstration trial comparing drip and sprinklers

We divided an 8 acre Brussels sprout field located near Ano Nuevo, California into 2 management zones to compare the benefits of using drip and fertigating nitrogen to the standard grower practice of using hand move sprinklers and sidedress applications of nitrogen fertilizer. Transplants in the Grower Standard (GS) zone were established and grown with hand move sprinklers. Transplants in the best management practice (BMP) zone were also established with sprinklers, but after establishment, shallowing buried drip tape (3- 4 inches deep), was used to irrigate the crop until harvest. The crop was transplanted on June 28th, 2006 and harvested December 5th, 2006. Surface water was used to irrigate the crop. A total of 247 lb of N/acre were applied to the GS zone and 228 lb of N/acre were applied to the BMP block. All nitrogen fertilizer was applied through the drip system for the BMP block at weekly intervals of 7 to 24 lbs of N per acre until the end of September. A majority of the N fertilizer (189 lbs of N/acre) was sidedressed in the GS zone, and the remaining fertilizer was applied by injection through the sprinklers.

Results

Crop water use

The seasonal evapotranspiration of the crop was estimated using canopy cover measurements and reference ET data averaged from the nearest CIMIS stations (Santa Cruz, Pajaro). Cumulative crop ET was estimated to be 13.7 inches between transplanting and harvest for both zones (Table 1). Irrigation was scheduled in the BMP zone using crop ET and soil moisture monitoring data after the drip system was installed, between July 12 and December 5th. A total of 12.3 inches of water were applied to the BMP zone by overhead sprinklers and drip and 12.7 inches were applied to the grower standard (GS) zone using overhead sprinklers. Rain events added an additional 2 inches of water to the crop during October and November. Irrigation efficiency was 96% for the BMP and GS zones. No run-off was measured from either management block. Soil moisture at the 8 inch and 18 inch depths of the GS block was drier than measured in the BMP block (Fig. 1). Soil moisture tensions at the 8 inch depth was generally maintained between 20 and 60 centibars in the BMP block and between 40 and 100 centibars in the GS block (note that high moisture tensions indicate drier soil conditions). Soil moisture tensions at the 18-inch depth were also lowest in the BMP block. Soil moisture declined in both blocks during October, but rain events raised moisture levels in November.

Soil nitrate leaching

Estimated drainage was approximately 0.6 and 0.5 inches for the BMP and GS blocks, respectively, assuming soil moisture storage was 0 (Table 1). The low amount of drainage in both blocks would not be expected to cause large losses of N through nitrate leaching during the cropping cycle. Nevertheless, soil nitrate levels in the GS zone were much higher than levels measured in the BMP block during the season; and therefore nitrate was more likely to leach below the root zone in the GS block if subsequent winter rains were heavy. Highest soil nitrate-N levels were 240 ppm at the 1 foot depth in the GS block during August (Fig. 2). Subsequent samples demonstrated that nitrate levels at the 2 and 3 foot depths reached 49 and 23 ppm, respectively, in the GS block during September.

Crop yield

Bulk (biomass) and marketable yields were highest in the BMP zone. Yield increases in the BMP area were presumably due to less culled sprouts and greater small-sized sprouts than harvested in the GS zone (Table 2). The crop appeared more uniform in height and taller in the BMP zone compared with the grower standard zone. Water use efficiency (biomass/applied water) was slightly higher in the BMP block (1.0 tons/inch for the BMP treatment and 0.9 tons/inch for the GS treatment, Table 1).

Conclusions

Drip irrigation provided a more uniform moisture and nitrate level in the soil during the season than hand-move sprinklers and increased yields using less nitrogen fertilizer than side-dressing. This was a preliminary trial that was not replicated, but shows that drip may offer some significant benefits for Brussels sprouts production on the central coast while also addressing regulations to improve water quality by minimizing run-off and nitrate leaching.

Acknowledgements: The authors would like to thank the Central Coast Regional Water Quality Control Board and Santa Clara Valley Water District for the opportunity to participate in this project and funding to carry out the monitoring activities.

Table 1. Water use summary for Brussels sprouts in BMP and grower standard zones, 2006.

Treatment	Applied Water[x]	Crop ET	Runoff	Δ Soil Moisture [y]	Drainage	Irrigation Efficiency
	---------- inches ----------					%
BMP	14.3	13.7	0.0	--	0.6	96.0
Grower Standard	14.2	13.7	0.0	--	0.5	96.2

[x] includes 1.97 inches of rainfall

[y] not estimated

Table 2. Brussels sprout biomass and marketable yield in BMP and grower standard zones, 2006.

Treatment	Bulk Yield	Marketable Yield	Large size	Small Size	Culls	Water Use Efficiency[x]
	---- tons/acre ----		--------- % ----------			tons/inch
BMP	14.8	10.7	28.7	43.6	28.5	1.0
Grower Standard	13.0	8.8	31.7	34.7	37.7	0.9

[x] water use efficiency = bulk yield/applied water

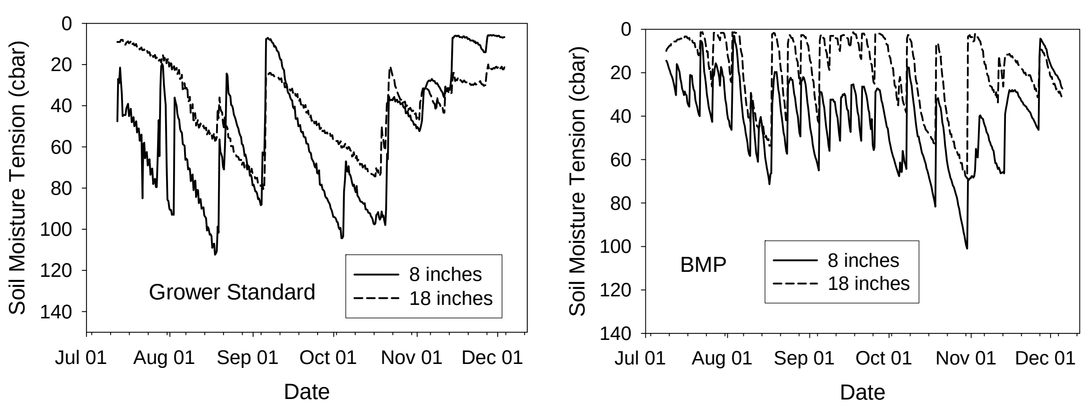

Figure 1. Soil moisture tension in best management practice and grower standard blocks.

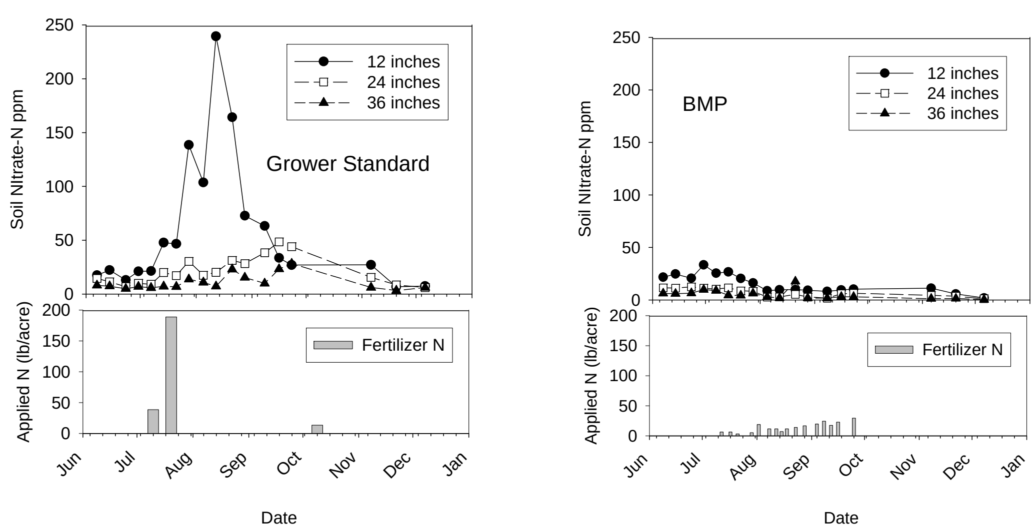

Figure 2. Soil nitrate levels in BMP and GS blocks and corresponding nitrogen fertilizer applications.