Drip Irrigation on Commercial Seed Carrots and Onions in Central Oregon, 2003

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Abstract

Drip irrigation was imposed May 2003 on portions of three existing sprinkler-irrigated carrot seed fields, one existing furrow-irrigated carrot seed field, and one existing sprinkler-irrigated onion seed field. The carrot seed fields were spring-planted stecklings. The onion seed field was established from seed in 2002. Soil moisture in both the drip-irrigated and sprinkler-irrigated plots was monitored with Watermark® sensors, which were used for irrigation scheduling in the drip-irrigated plots. Plots were farmed and harvested by the grower cooperators with commercial equipment following standard practices. Harvested seed was kept separate throughout the cleaning process. Carrot seed yields varied from a 135 percent increase to a 4 percent and 28 percent decrease under drip irrigation. Onion seed yields increased by 11 percent.

Introduction

In a cooperative effort with the vegetable seed industry, research was conducted to evaluate drip irrigation on seed carrots and onions at the Central Oregon Agricultural Research Center (COARC) during the 2000 and 2001 seasons. Results across the two seasons indicated a 100 percent increase in onion seed yield under drip irrigation compared to sprinkler irrigation, while carrots saw a 50 percent increase in seed yield under drip irrigation. During the 2001 season when disease was present in the plots, incidence of *Botrytis* was reduced five-fold in seed onions and *Xanthomonas* was reduced two-fold in seed carrots.

The project at the COARC generated a significant amount of interest from growers and the vegetable seed industry, spurring a commercial-sized evaluation of drip irrigation in 2002. The objective of the project was to take what was learned in these small plots and evaluate the potential for drip irrigation to increase seed yields, control disease, and reduce water consumption in seed carrots and onions with grower cooperators. Carrot seed yields consistently increased under drip irrigation compared to sprinkler irrigation. Increases were 15, 32, and 133 percent for each of the three locations, for an average increase of 45 percent. Onion seed yields decreased by 5 percent under drip irrigation. Water usage under drip irrigation was generally half of that used under sprinkler irrigation. The disease results were inconclusive. With promising results under commercial conditions, the experiment expanded in 2003 to four carrot fields and one onion field.

Methods and Materials

This study was conducted on four commercial carrot seed fields and one onion seed field. The carrot fields included a 19.1-acre field located north of Culver, a 17.9-acre field located south of Culver, a 22.8-acre field located on the Little Agency Plains, and a 24-acre field located on Agency Plains. The 5.4-acre onion field was located on Agency Plains. The sprinkler- and furrow-irrigated comparison plots were side by side with the drip-irrigated plots in the same field. The drip-irrigated portions were 55-88 percent of each field. The exception was the drip field located south of Culver whose sprinkler-comparison was a nearby 6.5-acre field. Variables evaluated in this study include yield, water usage, and disease pressure.

The carrot fields were grown from spring-planted stecklings. The onion field was planted according to the seed contractor's specifications in mid-July, 2002. Fields were sprinkler- or furrow-irrigated through the end of April 2002. In May 2002, a drip-irrigation system designed specifically for each field was assembled and installed by grower cooperators, under the direction of Jim Klauzer of Clearwater Supply. Fertilizer and pesticide treatments for onions and carrots were applied equally on both the drip-irrigated and sprinkler-irrigated plots.

The drip-tape delivered water at the rate of 0.15 gal/min/100 ft. The tape was installed 2-4 inches below the soil surface and offset 6-10 inches from the carrot row to minimize disturbing the roots. After installation, the drip tape was flushed and the ends rolled over and secured. The first irrigation with the drip tape was for 24-48 hours in order to set the wetting pattern.

Watermark soil moisture sensors were installed 8 inches deep in groups of three at multiple locations in each of the drip-irrigated plots to track soil moisture and determine irrigation scheduling. Installation was either in the carrot row or offset toward the drip tape, 2 to 3 inches. The target soil moisture level for carrot and onion seed was -40kPa throughout the season.

Moisture readings were taken three times per week from mid-May to mid-August. Whenever the average of the readings reached the target level, growers were requested to irrigate the drip carrots or onions for 8-12 hours. If the water did not sub close enough to the carrots, growers were asked to water for another 12-hour set. The sprinkler-irrigated plots were managed by growers according to their standard practices. Six Watermark soil moisture sensors were randomly placed in the sprinkler-irrigated plots to track the soil moisture and compare with the drip-irrigated plots.

Disease monitoring was conducted during the growing season. Initial samples of stecklings shipped into Oregon were assayed for *Xanthomonas campestris* pv. *carotae* to determine whether stecklings provided inoculum for infection of the fields included in the study. Plants were sampled in June and August from drip- and sprinkle-irrigated portions of each field. Foliage from 20 plants was collected from each location April 3, June 3, and August 3. The plant collectors disinfected their hands between samples to prevent

cross contamination. The bagged plants from each field were stored on ice in a cooler for transportation to a refrigerated facility (40-45^{o}F) at the COARC for processing. The presence or absence of symptoms of bacterial leaf blight was recorded for each plant sampled.

Plots were harvested by grower cooperators using commercial equipment. Onion seed was harvested in mid-August while carrot fields were harvested in September. Seed from the drip- and sprinkler-irrigated plots at each location were kept separate throughout harvest, storage, and seed cleaning. Seed cleaning was conducted by Central Oregon Seed (COSI) according to the specifications in the contract. Seed testing was conducted following Association of Official Seed Analysts (AOSA) standards.

Results and Discussion

Onion seed yields were increased by 11 percent under drip irrigation compared to sprinkler irrigation (Table 1). Unlike the previous year, carrot seed yields did not consistently increase in 2003. The only carrot field that experienced an increase was the field on Agency Plains whose yields rose by 135 percent compared to sprinkler irrigation. The carrot field north of Culver experienced the largest decrease, 28 percent. According to local industry thinking, this decrease was not due to drip irrigation, but rather to the layout of the field. The field had a slope of up to 8 percent and wide soil variations, including some very gravelly areas. It produced near its maximum capacity, but showed a decrease in the drip portion of the field because the drip portion had poorer soil conditions and included most of the hill. In contrast, the sprinkler-irrigated portion was more level and had better soil conditions. In early August the field was hit with hail, which may or may not have had a uniform effect. The carrot field south of Culver experienced a decrease of 4 percent, also thought to be due to soil differences. The sprinkler comparison for this field was in a nearby field with better soil and superior crop rotation. *Alternaria radicina* was a significant problem in the fourth carrot field located on the Little Agency Plains. Because the severity and extent of the root rot was variable throughout the field, both the drip and flood portions were harvested together and could not be evaluated for disease and yield differences.

Switching the type of drip tape used in 2003 may have adversely affected all the drip-irrigated fields. In 2002, water was delivered at 0.22 gal/min/100 ft, whereas in 2003 it was delivered at 0.15 gal/min/100 ft. Jim Klauzer felt this change would increase the effectiveness of the drip system, but due to central Oregon soil types this change was problematic. A flow of 0.15 gal/min/100 ft. was not enough for the water to properly sub over to the carrots. Often the water was still 4-6 inches from the carrot root at the end of the watering set. Even with some of the sensors placed closer to the drip tape than in 2002, average sensor readings were -5kPa higher.

Drip-irrigated plots used 36, 48, and 54 percent of the water of sprinkle-irrigated plots (Table 1). Much of the variation in water usage between fields was due to different row spacing and various male and female row configurations. When there are wider row spacings or more blank rows, less ground is watered, allowing even more water to be

conserved. When comparing water use on the furrow-irrigated field, drip-irrigation used only 26 percent of the water used to furrow-irrigate. On the onion seed, water use in the drip-irrigated plot was 44 percent of the sprinkler-irrigated plot.

Symptoms of bacterial blight were not observed on any of the stecklings sampled, but the pathogen was isolated from one root sample. During the second sampling period, *Xanthomonas* was detected in seven of the eight fields. The incidence of plants that tested positive ranged from 0 to 10 percent in drip-irrigated fields compared to 5 to 20 percent in the sprinkler-irrigated field. During the third sampling period, *Xanthomonas* was detected in all of the fields of the study. The incidence of plants that tested positive ranged from 5 to 70 percent in drip fields and 25 to 80 percent in the sprinkler fields.

Symptoms of bacterial blight were not widely evident in most fields sampled, although occasional plants could be identified. The incidence of carrot seed plants on which *Xanthomonas* was detected increased rapidly from early June to August 2003, when the pathogen was found in all fields sampled. In general, incidence of infested plants was greater in sprinkler-irrigated fields compared to drip-irrigated fields. Samples of seed harvested from each field surveyed were assayed for *Xanthomonas* and detected in each of the harvested seed lots. The population of the pathogen detected in these seed lots was similar, but slightly less for drip-irrigated fields than the sprinkler-irrigated fields.

Potential benefits associated with using drip-irrigation compared to sprinkler-irrigation include reduced fertilizer application when compared to broadcast application and the time spent to irrigate the field is much less during the busiest times of the year. Additionally, less area watered reduces the area of active weed growth and cuts weeding time in half. In 2003, percent germination of seed was the same under both drip and sprinkler-irrigation. The overall economic impact of drip irrigation was inconclusive in 2003.

Table 1. Comparison of yield, water usage, and soil moisture in carrot seed and onion seed grown under drip-irrigation and sprinkler-irrigation regimes, near Madras, Oregon, 2003.

	Agency Plains		South of Culver		North of Culver		Agency Plains	
	------Onion seed----		----------Carrot seed----------					
	Drip	Sprinkled	Drip	Sprinkled	Drip	Sprinkled	Drip	Sprinkl
Acreage	3.0	2.4	17.9	6.5	14	5.0	17	8.0
Yield (lbs/acre)	232	209	580	604	498	692	301	128
% of Sprinkled	111	100	96	100	72	100	235	100
% Germination	85	86	90	89	93	94	91	90
% of Sprinkled	99	100	101	100	99	100	101	100
Water usage (acre ft/acre)	0.4	0.9	0.6	1.8	0.8	1.6	1.1	2
% of Sprinkled	44	100	36	100	48	100	54	100
Soil moisture; low –kPa[1]	0.8	0.5	0.3	3	6.8	3.5	28	2.6
Soil moisture; high -kPa	55	76	62	66	64	45	64	45
Soil moisture average -kPa	29	32	25	27	40	22	40	18

[1]Kilopascal: when the soil is nearly saturated the reading is -15 kPa. As the –kPa gets higher the soil is getting drier.

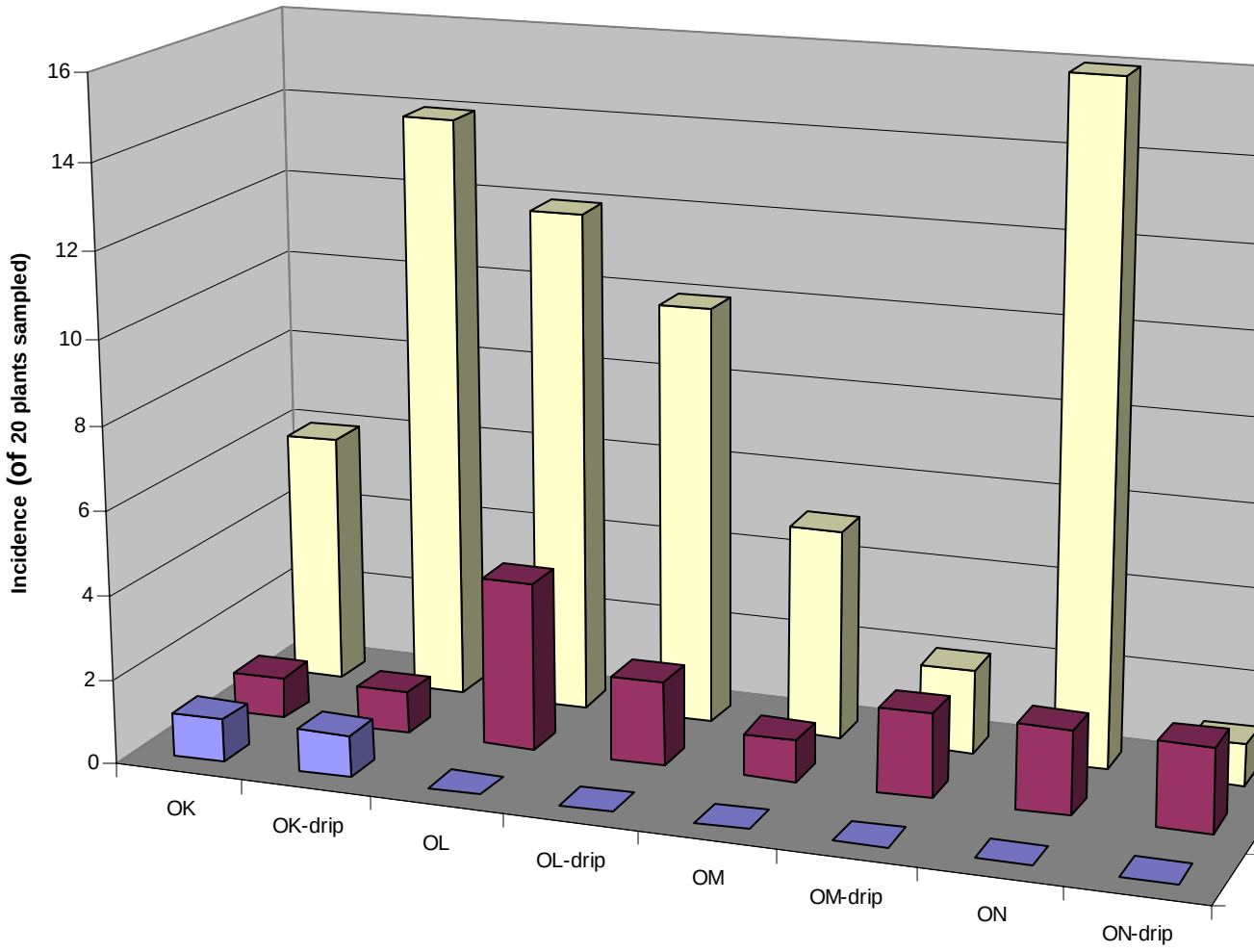

Figure 1. Number of samples from twenty carrot plants that tested positive for *Xanthomonas* in drip and non-drip plots, near Madras, Oregon, 2003.

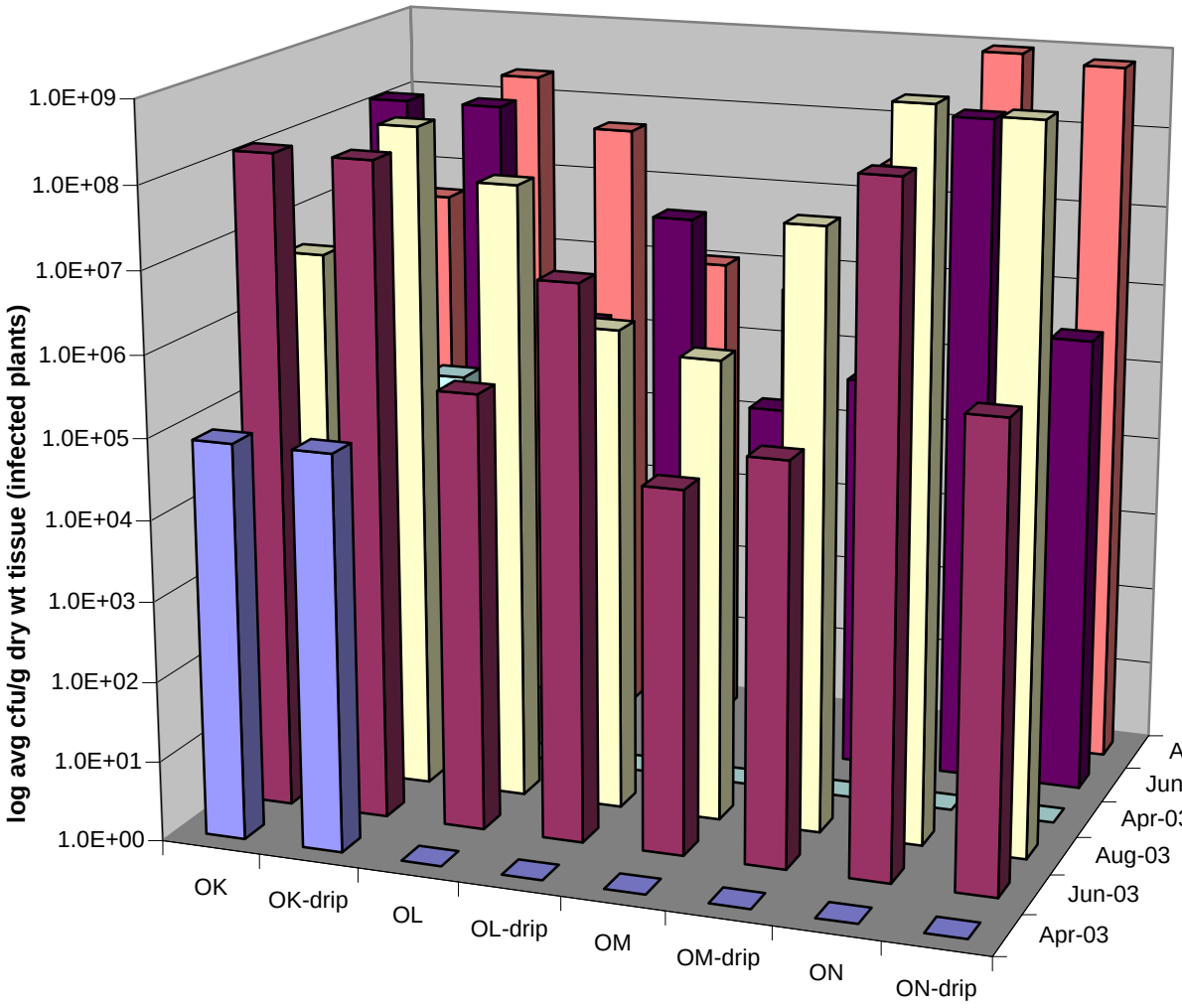

Figure 2. The population of *Xanthomonas* spores detected on carrot foliage in drip and non-drip plots, near Madras, Oregon, 2003.