Lack of Economic Benefits by Fungicides Applied Through Center-Pivot Irrigation Systems for Control of *Alternaria solani* on Potato

G. D. EASTON, Plant Pathologist, and M. E. NAGLE, Agricultural Technologist III, Department of Plant Pathology, Irrigated Agriculture Research and Extension Center, Washington State University, Prosser 99350

ABSTRACT

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In south central Washington, near the Oregon border, fungicides applied through center-pivot irrigation systems were evaluated for 3 yr for control of *Alternaria solani* on potato. Four applications of fentin hydroxide applied through a center-pivot irrigation system did not control *A. solani* or increase tuber yield. Four to six applications of chlorothalonil applied through a center-pivot system in August, before the onset of early blight, significantly reduced lesion numbers in all years of testing but did not increase yield.

Sprinkler systems have been used successfully to apply fertilizers (11,14), herbicides (15,16), fungicides (1,4,6,7,13), and insecticides (12). This method saves the grower time and energy.

In Idaho, control of early blight on potato cultivar Russet Burbank by chlorothalonil applied through either solid-set, portable, or center-pivot sprinkler irrigation systems was as effective as application by field sprayer or aircraft. Leaflet residues of chlorothalonil after the last fungicide application, however, were eight to 19 times less after center-pivot applications than those found after application by either field sprayer or aircraft. All methods significantly reduced early blight (13). In Colorado, control of early blight was comparable whether fungicides were applied through center-pivot irrigation systems or by aircraft on the susceptible potato cultivar Monona (6). Although both methods reduced disease severity in each of the 4 yr of testing, yield was significantly increased only during 1 yr. In Washington, fungicides applied by aircraft neither reduced early blight lesions nor increased yield in potato cultivar Russet Burbank grown under sprinkler irrigation (5).

We began evaluation of chlorothalonil and fentin hydroxide on potato as the fungicides became cleared by the Environmental Protection Agency for application through sprinkler systems for control of *Alternaria solani* (Ellis & G. Martin) L. R. Jones & Grout.

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MATERIALS AND METHODS

Center-pivot irrigation circles (40–50 ha) planted to Russet Burbank were divided into 4-ha, pie-shaped plots by either shooting angles at the center pivot with a surveyor's transit or measuring arcs at the outer circumference. Treatments of fentin hydroxide (Du-Ter F) (1 yr), chlorothalonil (Bravo 6F) (2 yr), and untreated (all years) were replicated and randomized at least four times.

Dye was injected into the center-pivot system with a high-pressure fertilizer-injector pump during irrigation to determine times to start or stop fungicide injections. This same pump was calibrated to inject 0.3 kg a.i./ha of fentin hydroxide and 1.26 kg a.i./ha of chlorothalonil in about 1.9 L of a chemical-water solution per minute at the fastest center-pivot travel speed.

Fentin hydroxide was injected on 8 June, 17 and 26 July, and 7 August 1973. Chlorothalonil was injected on 4, 13, and 23 August and 1 September 1976 and on 4, 11, 18, and 25 August and 2 and 9 September 1977.

Irrigation catch bottles with 9.5-cm-diameter metal funnels were placed about 61 m inside the outer circumference of each 4-ha plot to determine liters per hectare of fungicide-water solution applied.

At the start of fungicide treatments, early blight lesions were counted from a sample of 20 leaves collected biweekly at random from each plot in the vicinity of five or six subplots marked for harvest in June.

Aerial infrared pictures were taken each week in 1976 and 1977 to locate and document any visible differences in effects among treatments.

Five or six 6.1-m, single-row subplots in each 4-ha plot were harvested in mid-September. Samples from each plot were composited for yield and grade determinations.

RESULTS

Control plots during all three seasons averaged less than one lesion per leaf until early August (Table 1). Moderate to severe early blight developed at the end of August and lesion numbers increased rapidly to as many as 72.5 per leaf in 1977.

In 1973, fentin hydroxide was injected in the irrigation water four times at 38,680, 36,661, 36,895, and 35,614 (average 36,952) liters of solution per hectare. In 1976, chlorothalonil was injected four times at 55,136, 54,809, 54,314, and 59,222 (average 55,870) liters of solution per hectare, and in 1977, six times at 49,115, 42,103, 47,713, 61,747, 49,115, and 36,483 (average 47,713) liters of solution per hectare.

Plots sprayed with fentin hydroxide showed no control in 1973 (Table 1). Chlorothalonil-treated plots had significantly reduced lesion numbers in 1976 and 1977. By September, visual differences between chlorothalonil-treated and control plots were noted in the infrared photos in 1976 but not in 1977. Neither fentin hydroxide nor chlorothalonil applications significantly increased yields. Potato plants in these fields died prematurely by mid-September.

DISCUSSION

On the basis of appearance of the first lesions, the first fungicide application for early blight control should be in late July or early August in Washington (Table 1) (5). The four applications of fentin hydroxide made before 7 August did not give effective control and may have been applied before the presence of *A. solani* spores. In Idaho, however, only two applications of chlorothalonil through a center-pivot irrigation system on 26 July and 6 August controlled early blight until 27 August (13).

Chlorothalonil applied by sprinkler irrigation reduced the number of early blight lesions by one-half or more into September but did not increase yield (Table 1). These findings agree with those in Colorado (6,9,10), where *A. solani* was controlled with airplane, ground, and sprinkler applications of fungicides, but yields were significantly increased during only 1 yr.

Harrison et al (9) attributed lack of yield increase to late development of disease under Colorado conditions and the difficulty in measuring yield effects of defoliation by early blight in the presence of Verticillium wilt (8,10). Our results do

Table 1. Effects of fungicides applied by center-pivot irrigation on control of *Alternaria solani* and production of Russet Burbank potatoes

Year	Treatments[w]	Rate (kg a.i./ha)	Early blight lesions per leaf[x] 1-5 July	15 July	1-8 Aug.	13-23 Aug.	27 Aug.-2 Sept.	7-10 Sept.	U.S. No. 1 tubers (%)	Yield (q/ha)
1973	FH	0.3	...[y]	0.6 a[z]	2.1 a	8.0 a	27.1 a	...	65 a	710 a
	Control	None	...	0.8 a	2.0 a	9.5 a	31.7 a	...	63 a	716 a
1976	CH	1.26	0.1 a	0.3 a	0.2 a	6.9 a	6.3 a	11.3 b	74 b	650 a
	Control	None	0.2 a	0.0 a	0.1 a	9.1 a	10.3 a	38.6 a	72 b	649 a
1977	CH	1.26	0.01 a	0.0 a	1.4 a	0.9 a	15.7 b	7.2 b	60 a	693 a
	Control	None	0.1 a	0.0 a	2.8 a	2.3 a	72.5 a	46.6 a	54 a	686 a

[w] In 1973, fentin hydroxide (FH) was injected into irrigation water four times starting on 8 June in a solution averaging 36,952 L/ha. In 1976, chlorothalonil (CH) was injected four times starting on 4 August in a solution averaging 55,870 L/ha. In 1977, chlorothalonil was injected six times starting on 4 August in a solution averaging 47,713 L/ha.

[x] Average count of 20 leaves per plot.

[y] Data not recorded.

[z] Means with the same letter in a given year are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

not agree with those of Douglas and Groskopp (3), who were able to control early blight and increase yields in eastern and southeastern Idaho with ground-applied fungicides on sprinkler-irrigated potatoes.

Field-grown Russet Burbank potatoes are killed early by known (5,8,10,17) and unknown factors in Washington, even in fields that have had only one previous crop of potatoes. By August, early blight is especially severe on foliage of these physiologically aged, early-dying plants (2). However, even though chlorothalonil sprayed on potato reduced lesions of early blight, it was not expected to and did not control early dying and therefore did not increase yields. Early blight probably would not have been an economic problem in the absence of the other diseases, because in our area, it does not usually express itself on foliage in fields that do not have early dying.

We conclude from this and a previous study (5) that fungicides applied either by aircraft or through center-pivot irrigation for control of early blight do not provide economic benefits under growing conditions in Washington.

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