Effect of Row Width on Spray Penetration, Spur Blight Incidence, and Yield of Heritage Red Raspberry

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ABSTRACT

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Rows of Heritage red raspberry were adjusted to widths of 46, 91, and 137 cm (18, 36, and 54 in., respectively). Spray deposition in the row centers significantly decreased and canker length significantly increased with each increase in row depth. Canker length was significantly greater in the 46- and 91-cm rows on unsprayed canes than on canes sprayed with fungicide in the same row width. There were no significant differences in canker length on sprayed and unsprayed canes in the 137-cm row. Number of cankers per cane was signficantly less on sprayed canes in 46-cm rows than any other treatment. There were no significant differences in canker number on unsprayed canes in the 46-cm row and sprayed or unsprayed in the 91- and 137-cm rows. Total yield was significantly greater from sprayed than from unsprayed canes in the 46- and 91-cm rows. There were no significant differences in yield between sprayed canes in the 46- and 91-cm rows or between sprayed and unsprayed canes in the 137-cm row.

Spur blight of red raspberry (*Rubus idaeus* L.) is caused by the fungus *Didymella applanata* (Niessl) Sacc. (4). Damage from this disease results from blighting of spurs on the fruiting canes and killing of lateral buds (1). Spur blight is becoming a serious problem in Ohio, especially on the cultivar Heritage. In 1976, 23% of all raspberries planted in Ohio were of this cultivar (2); since then, 67% of all new plantings (approximately 81 ha) have been Heritage.

In many commercial plantings, present chemical control recommendations are not providing adequate spur blight control. After surveying several plantings, it was evident that row width may be a factor affecting disease control. Plants of Heritage reproduce vegetatively by rhizomes and, unless rows are managed properly, row width rapidly increases. The purpose of this study was to evaluate the effect of row width on spray penetration into the row and concomitant incidence of spur blight.

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MATERIALS AND METHODS

The experiment was established in 1980 on a 4-yr-old planting of Heritage red raspberry at Wooster, OH. The rows (2.44 m [8 ft] between rows) had never been trained to width and were approximately 1.52 m (60 in.) wide. Number of canes per square meter was approximately 107 (10/ft^2). All canes were cut off on 11 March 1980, and 5.5-m sections within each of three rows (replicates) were trained to 46, 91, and 137 cm wide in a randomized block design. Rows were maintained at the desired width by passing a rotary cultivator along each side. The planting was fertilized at the rate of 112 kg/ha (100 lb/acre) actual nitrogen (ammonium nitrate at 336 kg/ha [300 lb/acre]). Current chemical control recommendations for disease control were followed (3). Captan 50W was applied at the rate of 3.59 kg/ha (3.2 lb/acre) in 935 L (100 gal) of water on 14 and 30 May, 16 and 30 June, 7 and 28 July, 11 and 25 August, and 8 September. Sprays were applied with a Mity Mist air-blast sprayer (F. E. Myers Bros. Co., Ashland, OH 44805) at a pressure of 21 kg/cm^2 (300 psi) and a tractor speed of 3.2 km/hr (2 mph).

Measurements of spray penetration into the row were made on 15 July. Metal clips were attached to aluminum conduit poles measuring 2.54 cm in diameter at 25, 50, and 75 cm from the base. A glass microscope slide (7.6 × 2.5 cm) was placed in each clip and the pole placed in the center of each row so that slides were parallel to the row and vertical with respect to the ground. Three poles (1 m between poles) were placed in each 5.5-m section of row for each row width and replicate. Permethrin (Ambush 2E) pyrethroid insecticide (ICI United States Inc., P.O. Box 208, Goldsboro, NC 27530) was applied alone at the rate of 224 g a.i./ha (0.2 lb/acre) using the air-blast sprayer as previously described.

Slides were collected after spraying down one side of each row. In addition,

Table 1. Effect of row width on spray penetration, spur blight severity, and yield of Heritage red raspberry, 1980

Row width (cm)	Permethrin deposited in center of row[w] (μg/cm^2)	Length per cane[x] (cm)	Number of cankers per cane[x]	Total yield per 5.5 m of row[y] (kg)
46	0.512 a[z]	10.43 a	1.33 a	12.8 a
91	0.281 b	18.07 b	2.26 b	13.8 a
137	0.062 c	26.87 c	2.47 b	16.4 b

[w] Based on permethrin (pyrethroid insecticide) deposited on nine microscope slides per each of three replicates per row width. Permethrin was applied to one side of each row with an air-blast sprayer at a pressure of 21 kg/cm^2 (300 psi) and a tractor speed of 3.2 km/hr (2 mph).
[x] Means of 100 randomly selected canes from each of three replicates per row width.
[y] Mean of all fruit from 5.5 m of row from each of three replicates per row width.
[z] Numbers followed by the same letter within columns are not significantly different at $P = 0.05$ according to Duncan's new multiple range test.

Table 2. Effect of row width on spray penetration, spur blight severity, and yield of Heritage red raspberry, 1981

Row width (cm)	Treatment[v]	Permethrin deposited in center of row[w] ($\mu g/cm^2$)	Canker length per cane[x] (cm)	Number of cankers per cane[x]	Total yield per 2.75 m of row[y] (kg)
46	Sprayed	0.611 a[z]	8.57 a	1.52 a	6.1 a
	Unsprayed	0 d	14.53 b	2.36 b	4.9 b
91	Sprayed	0.325 b	14.36 b	2.38 b	6.5 a
	Unsprayed	0 d	19.69 c	2.42 b	5.2 b
137	Sprayed	0.098 c	19.87 c	2.40 b	8.2 c
	Unsprayed	0 d	20.12 c	2.44 b	7.6 c

[v] Plastic strips (1.5 mil) were placed over half of each 5.5 m of row per replicate and row width prior to application. This resulted in 2.75 m of row sprayed and unsprayed per replicate and row width.
[w] Based on permethrin (pyrethroid insecticide) deposited on six microscope slides per each of three replicates per row width. Permethrin was applied to one side of each row with an air-blast sprayer at a pressure of 21 kg/cm^2 (300 psi) and a tractor speed of 3.2 kg/hr (2 mph).
[x] Means of 50 randomly selected canes from each of three replicates per row width.
[y] Mean of all fruit from 2.75 m of row from each replicate and row width.
[z] Numbers followed by the same letter within columns are not significantly different at $P = 0.05$ according to Duncan's new multiple range test.

slides were collected from the center of the adjacent row to determine spray penetration using the alternate-row-middle technique of spray application. All three slides from each row width and sample height per replicate were washed with acetone into a glass jar. Acetone solutions were standardized to a volume of 30 ml and analyzed for the presence of permethrin by gas chromatography. Peak heights were measured for each sample and compared with those of known concentrations of analytical grade permethrin. The gas chromatograph was a Bendix Model 2500 (Process Instruments Div., P.O. Box 477, Ronceverte, WV 24970) equipped with an Mi^{63}-electron-capture detector. The column was a glass U-tube measuring 1.0 m × 4 nm i.d., packed with 1% SE 30 on 100–120 mesh Gas-Chrom Q, and operated at 220 C. The flow rate of N_2 carrier gas was 100 ml/min. Inlet and detector temperatures were 240 and 280 C, respectively.

Incidence of spur blight was evaluated by counting the number of cankers and measuring the length of cankered (discolored) area on 100 randomly selected canes per replicate and row width on 20 October. Total yield was obtained by harvesting all ripe fruit from each replicate and row width. Fruit was harvested every 2 to 3 days from 21 August through 8 October.

The experiment was repeated in 1981 as previously described except for the following changes. Fungicide application dates were 5 and 19 May, 3 and 18 June, 2 and 23 July, 6 and 20 August, and 8 September. Canes from the 1980 growing season were placed at the edges of all rows to ensure primary inoculum and disease pressure. One-half (2.75 m) of each row per width and replicate was covered with plastic (1.5 mil) prior to all spray applications. Plastic was removed immediately after application. Spray deposition in the row center was measured on 16 July. Two poles (1 m between poles) were placed in each section of sprayed and unsprayed (covered) row per width and replicate. Incidence of spur blight was evaluated by counting the number of cankers and measuring the length of cankered area on 50 randomly selected canes from sprayed and unsprayed canes per replicate and row width. Total yield was obtained by harvesting all ripe fruit at 2- to 3-day intervals from 24 August through 6 October.

RESULTS AND DISCUSSION

Spray deposition in the row center significantly decreased ($P = 0.05$) with each increase in row width (Tables 1 and 2). There were no significant differences in spray deposition between different sampling heights. Mean canker length per cane significantly ($P = 0.05$) increased with each increase in row width on sprayed canes during both years of testing. Canker length was significantly less on sprayed canes than on unsprayed canes in 46- and 91-cm rows (Table 2). There were no significant differences in canker length between sprayed and unsprayed canes in 137-cm rows. Spray deposition in row centers was significantly ($P = 0.01$) correlated ($r = 0.98$) with canker length. Row width was significantly ($P = 0.01$) correlated with spray deposition in row centers and canker length ($r = -0.95$ and 0.97, respectively). Number of cankers per cane was significantly ($P = 0.05$) less on sprayed canes in the 46-cm row than any other treatment (Tables 1 and 2). There were no significant differences in number of cankers per cane between any other treatments.

When spraying alternate-row-middle, no spray was deposited in the center of 91- or 137-cm rows. In 46-cm rows, only trace amounts (0.002 $\mu g/cm^2$) were detected in 1980 and none was detected in 1981.

Mean total yield from sprayed canes in 1980 was significantly ($P = 0.05$) higher in the 137-cm row than in any other treatment. There were no significant differences between the 46- and 91-cm rows in total yield (Table 1). In 1981, total yield was significantly greater ($P = 0.05$) from sprayed than from unsprayed canes in the 46- and 91-cm rows (Table 2). There were no significant differences in yield between sprayed and unsprayed canes in the 137-cm row.

Koch (4) reported that "leaves inoculated with ascospores of *D. applanata* developed infections which later resulted in cane infections by the fungus moving down through the petiole." This mode of cane infection was observed in this study. However, the majority of infections appeared to originate where the leaf petiole attaches to the stem. To control spur blight with fungicide, thorough coverage of canes and leaves is essential. As row width increases, spray penetration into the row decreases and there is a corresponding increase in spur blight incidence. Alternate-row-middle spraying appeared to give good coverage of the foliage; however, little or no spray penetrated into the center of the row.

Alternate-row-middle spraying does not appear to be an acceptable method for controlling spur blight. It is not uncommon to find Ohio growers with rows in excess of 1 m. In addition, several growers are using the alternate-row-middle spraying method. This may partially explain why growers are not obtaining adequate control with currently recommended fungicides.

In both years of testing during this study, a 100% increase in row width (46 to 91 cm) resulted in no significant increase in yield, and a 200% increase in width (46 to 137 cm) only resulted in approximately a 25% increase in yield. Whereas yield was not greatly affected by increasing row width, the incidence of spur blight and level of disease control was greatly affected. By maintaining a narrow row width and directly spraying each side of the row, more effective control of spur blight should be obtained. In addition to increasing disease control, narrow rows may further aid in increasing yield through more efficient use of available land.

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