Control of Strawberry Red Stele Caused by *Phytophthora fragariae*

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ABSTRACT

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In a 2-yr field trial, spring and fall applications of metalaxyl significantly controlled strawberry red stele caused by *Phytophthora fragariae*. The second year after transplanting, plants treated with metalaxyl produced an average of 161% more total fruit by weight and had 137% more flowers remaining at fruit harvest than untreated plants. Applications of Ortho RE 20615 or propamocarb hydrochloride did not significantly alter disease incidence, total fruit weight, or flower production as compared with untreated plants.

Strawberry red stele caused by *Phytophthora fragariae* (Hickman) occurs in strawberry fields throughout Connecticut. Fumigation is expensive and impractical for red stele control in perennially grown strawberries, and fungicides have not been available for the control of this disease. As a result, growers find it nearly impossible to grow some of the susceptible cultivars that are preferred. For example, 5 of 15 strawberry farms surveyed in Connecticut had this problem; 3 other farms had the problem in the past and avoid it by planting in areas where the pathogen is not present or by using resistant cultivars.

Because of the importance of this disease in Connecticut, we established field trials to test three experimental fungicides reported to have activity against plant-pathogenic phycomycetes (1,2; Experimental Data Sheet, Ortho 20615, Chevron Chemical Co., Richmond, CA). These included metalaxyl, propamocarb hydrochloride, and Ortho RE 20615.

MATERIALS AND METHODS

The plot was located in a low area of a strawberry field where red stele had been a consistent problem. Strawberry cultivar Catskill, which is susceptible to *P. fragariae*, was planted on 11 May 1978. The treatments were applied in a randomized block design using four treatments and three replications of 25 plants per treatment. Plants were placed in three rows 31 m long and 1.0 m apart. Each row contained all four treatments.

The treatments were metalaxyl (Ridomil 2 E, Ciba-Geigy Corp., Greensboro, NC 27409) at 1.1 kg a.i./ha (1 lb a.i./acre); propamocarb hydrochloride (Previcur-N, NOR-AM Agricultural Products, Inc., 350 West Sherman Blvd., Naperville, IL 60540) at 8.9 kg a.i./ha (8 lb a.i./acre); and Ortho RE 20615 50 W (Chevron Chemical Co., 940 Hensley St., Richmond, CA 94804) at 1.1 kg a.i./ha (1 lb a.i./acre).

We applied the fungicides as 225-ml drenches per plant at transplanting, as sprays in the spring soon after budbreak (15 May 1979 and 15 May 1980), and again in the fall before dormancy (11 September 1979). The fourth set of plots was not treated with fungicides.

We rated replicates of each treatment visually for disease severity on 15 May and 11 September 1979 and again on 15 May 1980. Disease severity was rated on a five-point scale at increments of 0.5: 0 = no plants with apparent symptoms; 1, 2, 3, and 4 = 20, 40, 60, and 80%, respectively, of plants in a replicate showing disease symptoms; and 5 = all plants dead. At each spring rating, we observed roots of several plants with or without aboveground symptoms for the stele reddening that is typical of this disease (3). Only plants with aboveground symptoms had roots with red steles, and from these the pathogen could be isolated on cornmeal agar amended with nystatin, vancomycin, and pentachloronitrobenzene.

On 10 June 1980, both green and ripe fruits were harvested from each plot and weighed. We also recorded the number of flowers per plot remaining at this time. All data were analyzed using Duncan's multiple range test.

RESULTS

Regardless of treatment, no plants were lost after transplanting. Also, no fungicidal treatment produced any obvious effects on plant appearance or growth.

Plants treated with metalaxyl were healthier than untreated plants or than those treated with propamocarb hydrochloride or Ortho RE 20615 (Table 1). This was most evident at the 15 May 1980 rating, shortly after the plots had been naturally flooded under 50–75 cm of water for about 7 days. At that time, no plants from plots treated with metalaxyl showed root symptoms of red stele, whereas symptoms were evident in plants from other plots. Further, plants growing in a row adjacent to an experimental plot planted with the resistant cultivar Guardian had red stele symptoms on their leaves and roots. During this study, only plants treated with metalaxyl were significantly protected from red stele (Table 1).

On 10 June 1980, the plants treated with metalaxyl had produced significantly more fruit by fresh weight than the plants in any of the other plots (Table 2). The treatments were not significantly different in the number of flowers remaining on the plants. Plants treated with metalaxyl, however, averaged 46% more flowers than the next best treatment (propamocarb hydrochloride). This lack of significant difference may have been caused by the number of replications (three per

Table 1. Severity of red stele on Catskill strawberry plants treated with experimental fungicides[w]

Fungicide	Disease severity rating[x] 15 May 1979	11 September 1979	15 May 1980	Grand mean[y]
None	3.17 b[z]	2.08 a	3.17 b	2.80 ± 0.30 b
Propamocarb hydrochloride	2.17 ab	2.42 a	2.83 b	2.47 ± 0.43 b
Ortho RE 20615	3.00 ab	2.25 a	3.17 b	2.81 ± 0.30 b
Metalaxyl	1.67 a	1.75 a	0.33 a	1.25 ± 0.28 a

[w] Metalaxyl (1.1 kg a.i./ha), propamocarb hydrochloride (8.9 kg a.i./ha), or Ortho RE 20615 (1.1 kg a.i./ha) were applied as a 225-ml drench per plant at transplanting on 11 May 1978. Plants were sprayed to runoff at the same rates on 15 May and 11 September 1979 and on 15 May 1980.

[x] Average rating of three replications per treatment at each observation time: 0 = no plants with apparent symptoms; 1, 2, 3, and 4 = 20, 40, 60, and 80%, respectively, of plants showing disease symptoms; 5 = all plants dead.

[y] Calculated from the rating of each replicated plot per treatment for all observation periods.

[z] Values followed by the same letter are not significantly different at $P = 0.05$ by Duncan's multiple range test.

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Table 2. Fruit weight and number of flowers on strawberry plants untreated or treated with experimental fungicides for control of red stele[x]

Treatment	Avg. fruit weight/plot (kg)[y]	Avg. no. of flowers/ plot[y]
None	2.31 ± 1.35 a[z]	94.33 ± 46.38 a
Propamocarb hydrochloride	2.25 ± 0.73 a	153.33 ± 52.52 a
Ortho RE 20615	1.91 ± 0.63 a	133.00 ± 41.67 a
Metalaxyl	6.02 ± 0.74 b	224.00 ± 30.20 a

[x] Metalaxyl (1.1 kg a.i./ha), propamocarb hydrochloride (8.9 kg a.i./ha), or Ortho RE 20615 (1.1 kg a.i./ha) were applied as a 225-ml drench per plant at transplanting on 11 May 1978. Plants were sprayed to runoff at the same rates on 15 May and 11 September 1979 and on 15 May 1980.

[y] On 10 June 1980, all fruit (green and ripe) was harvested and weighed, and the remaining flowers were counted. Values represent the average of three replicated plots per treatment.

[z] Values followed by the same letter are not significantly different at $P = 0.05$ by Duncan's multiple range test.

treatment), because the variation between replicates within treatments (see the standard error values in Table 2) was large enough to negate possible differences between treatments.

We used a linear regression analysis to assess disease severity by relating the ratings of 15 May 1980 to either the number of flowers (r = 0.89) or fruit weight (r = 0.95) on 10 June 1980. As expected, these regression values showed that increased disease severity was related to reduced plant productivity. They also demonstrated the usefulness of our rating system for assessing the severity of strawberry red stele in the field.

DISCUSSION

In our field experiments, metalaxyl controlled strawberry red stele by significantly reducing the severity of the disease. Plants treated with metalaxyl also averaged significantly more fruit by weight the second year after transplanting. Plants treated with either propamocarb hydrochloride or Ortho RE 20615 were not better in disease rating or fruit weight than untreated plants.

The use of metalaxyl as a transplant drench, plus spray applications each spring after budbreak and each fall before dormancy, should enable susceptible strawberry cultivars to be grown in fields infested with *P. fragariae*. Because the greatest reduction in disease severity was observed in the spring after a fall application, a fall application of metalaxyl the same year plants are transplanted to the field may be beneficial.

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