Foliar fungicide alternatives in spinach

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ABSTRACT

Spinach (*Spinacia oleraceae*) is a valuable leafy vegetable crop in the United States. Foliar diseases, particularly downy mildew caused by the pathogen *Peronospora farinosa* f. sp. *spinaciae,* can cause significant reductions both in yield and quality. Although fungicides are an effective management tool for many foliar diseases of spinach, concerns over fungicide resistance, residues, and cost have increased interest in fungicide alternatives. In addition, large increases in organic spinach production have provided further impetus to find fungicide alternatives for downy mildew control on spinach. Several materials were evaluated as fungicide alternatives for downy mildew control on spinach. The materials examined have included several surfactants, a commercial food-grade garlic extract, and yucca and chili pepper plant extracts.

INTRODUCTION

Spinach, *Spinacia oleraceae*, is an important vegetable crop grown on more than 18,000 hectares in the United States and is valued at approximately 187 million dollars annually (Lucier, 2000). Major areas of production include California, Colorado, Texas, Arkansas, Oklahoma and parts of the east coast (Correll et al., 1994). Downy mildew, or blue mold, caused by *Peronospora farinosa* (Fr.) Fr. f. sp. *spinacia* Byford (Brandenberger et al., 1991a), is an economically important pathogen on spinach in most regions were the crop is grown (Figs. 1, 2).

To date seven physiological races of the downy mildew pathogen have been described (Irish, et al., 2000; Brandenberger et al., 1994). Both major and minor gene resistance are used to help manage the described races (Irish, et al., 2000; Brandenberger et al., 1991b; Correll et al., 1994; Jones and Dainello et al., 1982).

Loss of registration, fungicide resistance, fungicide residue coupled with the continued opposition to the use of pesticides in fresh market products, alternatives continued to be sought.

Several products were screened for their efficacy in reducing the amount of downy mildew disease incidence and severity in greenhouse experiments. Preliminary results indicate that several products have show potential as fungicide alternatives in downy mildew disease control and that if pursued more indebt could possibly be used in organic production of spinach.

MATERIAL AND METHODS

In greenhouse studies, approximately 10 seed of the downy mildew susceptible cultivar 'Viroflay' were sown in 10 cm square plastic pots with Redi-Earth potting mix (Scott-Sierra, Marysville, OH) and grown with temperatures ranging from 15-25°C. Plants were watered daily and fertilized once a week 7 or 8 days after planting with an all-purpose fertilizer (Peters 13/13/13).

Two weeks after sowing plants were thinned to 5 plants per pot and grown to the 4 true leaf stage. Once plants reached the 4 true leaf stage, five pots with five plants per pot were treated with one of several different materials at varying concentrations. In all experiments both water and fungicide controls were included. Following treatment, plants were inoculated with a downy mildew sporangial suspension (>250,000 spores/ml). Immediately following inoculation plants were incubated in a upright dew chamber maintained at 18°C ambient air temperature and 100% relative humidity for 24 hrs. After the 24 hr infection period, plants were incubated in a temperature controlled growth chamber maintained at 20°C with a 12 hr light/dark cycle for six days. On the sixth day, plants were returned to the dew chamber and maintained at 18°C and 100% RH for a 24-hour period to induce sporulation. On the seventh day, the first four true leaves were rated using a 0-4 scale where 0 = no signs or symptoms of infection; 1 = 1-25% of the leaf area with sporulation and symptoms; 2 = 26-50%; 3 = 51-75%; and 4 = >75% (Fig. 1).

Sporangial germination was also evaluated by counting percent germination of sporangia on water agar plates amended with two surfactants (Naiad and SDS).

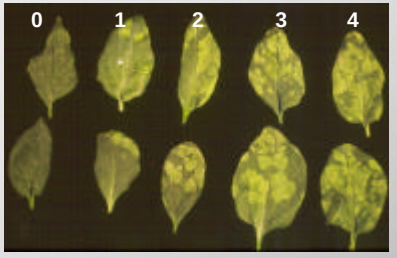

Figure 1. Disease rating scale 0-4

Figure 2. Characteristic disease symptoms

RESULTS AND DISCUSSION

In two out of the three experiments conducted mean disease severity for the water controls was high (>3.0) (Table 1). All materials evaluated significantly reduced the disease severity. Several of the products were used at varying rates and in general, the higher the concentration of product the more effective it was at reducing disease severity. Two surfactants (Naiad and SDS) were the most effective in reducing disease severity and were not significantly different when compared to the fungicide controls. Two strobilurin fungicides (one experimental and another labeled) from BASF were included in the experiments and both were effective at reducing disease (Table 2).

Both Naiad and SDS surfactants significantly reduced the frequency of sporangial germination when compared to the untreated water control and neither surfactant was significantly different when compared to the fungicide control.

At the higher concentration, all of the products significantly reduced the amount of disease severity without causing any apparent phytotoxicity. Although promising, further research to determine most effective rates and evaluations under field conditions are needed to assess these materials as viable management tools.

Table 1. Effect of several materials on downy mildew severity on spinach in greenhouse tests

	Disease Severity[1]		
Treatments[2]	Test 1	Test 2	Test 3
Water	3.1 a[3]	1.9 a	3.4
Garlic (02%)	-	-	3.1
Garlic (05%)	-	-	2.1
Yucca (02%)	2.0 b	0.5 b	-
Pepper (50%)	1.4 c	1.4 a	-
Yucca (10%)	0.9 cd	0.1 bc	-
Pepper (100%)	0.9 de	0.5 b	-
Garlic (10%)	-	-	0.8
Exp. (BASF)	0.7 def	0.0 c	-
SDS (10%)	0.5 defg	0.0 bc	-
Quadris	0.4 efg	0.0 c	0.0
Naiad	0.3 fg	0.0 bc	-
Cabrio (BASF)	0.1 f	0.0 c	-

[1]The first 4 true leaves from each experimental unit (replication) for each treatment were scored for disease severity using the 0-4 scale previously described.
[2]Naiad and SDS are surfactants; Quadris, Exp. (BASF), Cabrio (BASF) are all strobilurin fungicides.
[3]Means followed by the same letter within a column are not significantly different (P = 0.05) using ANOVA and a LSD means separation test.

Table 2. Effect of two surfactants on percent germination of downy mildew sporangia.

	Percent sporangial germination[1]		
Treatment[2]	Test 1	Test 2	Test 3
Water	23.44 a[3]	65.01 a	30.46 a
Naiad	3.67 b	4.27 b	0.00 b
10% SDS	0.91 b	2.10 b	0.37 b
Quadris	0.00 b	0.70 b	0.38 b

[1]Sporangial germination derived from a total of 100 sporangia counted per Petri dish (5 replications) for each treatment.
[2]Naiad and SDS are surfactants; Quadris, is a strobilurin fungicide.
[3]Means followed by the same letter within a column are not significantly different (P = 0.05) using ANOVA and a LSD means separation test.

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