Chemical Control of Cotton Root Rot (Phymatotrichum Root Rot) in Drip Irrigated Cotton

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Abstract

The objective of this study was to evaluate fungicides for control of root rot (PRR), caused by the fungus *Phymatotrichopsis omnivora*. The experiments were done in two production areas of Texas (San Patricio and Tom Green Counties) using drip-irrigated fields with a history of severe root rot. In separate experiments, the fungicides were applied to the lower stems of plants or were injected into drip irrigation tape when plants were flowering. Also, two seed treatment fungicides (consisting of combinations of fungicides) were compared with a stem application of propiconazaole when plants were flowering. With stem applications, disease incidence two months after application was 29% with propiconazole at 2 lb a.i./A, as compared with 49% for the control, and 45 to 59% for the other fungicides. There was no evident root rot control when fungicides were injected through the drip tape.

Introduction

Phymatotrichum root rot (PRR), caused by a persistent soilborne fungus, *Phymatotrichopsis omnivora* (synonym: *Phymatotrichum omnivorum*), is a widespread disease in much of the cotton production areas of Arizona, New Mexico and Texas. Symptoms are usually visible when cotton plants have extensive vegetative growth and may be flowering. Infected plants wilt and quickly die. There may be large areas of dead plants within a field and there can be a significant yield loss if plants die before boll maturation. The fungus survives as sturdy, seed-like structures known as sclerotia, which can be found at different depths in soil. The disease cycle starts when sclerotia germinate and the fungus grows as a mycelial strand through the soil to infect plants, especially when soil moisture is high, for example, following a rain or an irrigation. Control measures for this disease have been reviewed by Streets and Bloss (1973) and more recently, by Lyda and Kenerley (1993).

There is currently no long-term, effective, economical control of this disease. Host plant resistance has not been identified in cotton. Crop rotation is not effective because the fungus has a wide host range of dicotyledonous plants and cropping to resistant monocots such as corn or sorghum does not eliminate inoculum from the soil. Organic amendments such as manures can alleviate disease severity, but the effect is limited to that growing season. Additionally, the availability and expense of application limits the utility of organic amendments. Deep tillage can be effective in removing much of the inoculum from the root zone, but is generally not practical. Altering planting dates, usually to a later date, so that plants mature in the early fall, as soil temperatures decline, is practiced with some success by some growers (Fernandez *et al*., 2005), but is generally not practical.

Early 20th century research on chemicals for control of PRR has been reviewed by Streets and Bloss (1973). This early research was unsuccessful at identifying economical, effective chemicals. In 1967, Lyda *et al*. reported excellent control of PRR following fumigation with 75 gal/A 1,3-dichloropropene (available currently as Telone II). However, this rate of treatment is not economically feasible. The introduction of new classes of systemic fungicides during the 1960s and 1970s offered some promising possibilities. Lyda and Burnett (1970) found that two benzimidazole fungicides, thiabendazole and benlate, applied as stem drenches to 1-month-old plants at rates of 2 lb. in 15 gal water/A controlled PRR in greenhouse experiments. Most of the published research has focused on evaluation of triazole fungicides. Whitson and Hine (1986) found that 1 to 2 lb/A (active ingredient, a.i.) propiconazole, applied as a granular side-dress 6 to 9 weeks after planting, controlled PRR. Other research has focused on improvement of efficacy of propiconazole through the use of slow-release formulations (Lyda and Riggs, 1986, 1987; Matocha and Vacek, 1997; Small and Lyda, 1984). Olsen and George (1987) reported that 0.75 lb/A (a.i.) propiconazole applied through a drip irrigation system reduced PRR mortality. To date, this is the only report of effective control of PRR with a fungicide delivered via drip irrigation. Additionally, there have been no reports of screening of fungicide classes developed since the 1980s, such as the strobilurins.

The objective of this study was to evaluate new fungicides for control of PRR. The fungicides were applied as seed treatments, stem drenches, and via drip irrigation.

Materials and Methods

The experiments were done in five drip-irrigated fields in Texas, located in San Patricio County (SPC) near Tynan, and near Wall, San Angelo (east and south), and Mereta in Tom Green County. The Wall and San Angelo fields are Angelo clay loams, the Mereta field is a Mereta clay loam, and the SPC field is a Raymondville clay loam. All fields had PRR present and plots were located in areas with a history of severe, uniform infection.

Drip Irrigation Application

The experiment was done at the east San Angelo location. Rows were on 40 in centers and drip tape was 12 in deep, under the row, with emitters every 24 in. The emitter output was 0.2 gal/hr. The fungicides were injected in a volume of 1.3 gal at a T-connection using a Precision Control Products Pulsafeeder 9711-11 operating at approx. 125 psi with an output of 2.8 gal/hr. The fungicides were applied once, on 8/14/06. The onset of PRR in the field was before first full bloom, approx. 7/1/06. A treatment consisted of a 770 ft row, which was replicated three times in a randomized complete block design. Disease was assessed in two, 200-ft long marked portions of the row, near the front and the rear of the plot.

Stem Drench Application

The experiments were done at SPC, Wall, and south San Angelo locations. Fungicides were applied using a hollow cone nozzle directed toward the lower stem in a volume of 20 gal/A at 20 psi. Plots consisted of four, 17-ft rows and were arranged in a randomized complete block design with four replications. Fungicides were applied either before or during flowering. Plants were evaluated periodically during the growing season for above-ground PRR symptoms. Additionally, flupicolide, V-10116, V-10178, metconazole, fluoxastrobin, pyrimethanil, flusilazole, DPX-LEM 17, prothioconazole, and a combination of boscalid and pyraclostrobin were compared with propiconazole, in a smaller test at the south San Angelo location, using two, 17-ft rows and four replications.

Seed Treatment

The experiments were planted 5/25/06 at the Wall and Mereta locations. Two seed treatments applied to DP488 BG/RR were compared with non-treated seed and a stem application of propiconazole (2 lb a.i./A), applied at 5 NAWF on 7/24/06 on plants originating from non-treated seed. The two treatments were (chemicals with lb a.i./ cwt following in parentheses): (a) trifloxystrobin (0.01) + triadimenol (0.015) + ipconazole (0.01); (b) trifloxystrobin (0.01) +

triadimenol (0.016) + TCMBT [2-(thiocyanomethylthio)benzothiazole] (0.02). Plots were four, 50-ft rows replicated four times in a randomized complete block design.

Results and Discussion

None of the fungicide treatments applied via drip irrigation adequately reduced the incidence of PRR (Table 1). Although there was no positive response from any of the drip-applied fungicides tested, such applications may yet hold promise. Further experiments are necessary to determine if an earlier application (i.e. prior to symptom appearance in the field) or a higher dose would suppress disease.

Table 1. Effect of fungicides applied via drip irrigation on 8/14/06 on PRR in an east San Angelo field.

Fungicide	lb a.i./A	# Diseased*
None	-	125
Azoxystrobin	0.17	221
Propiconazole	0.75	118
Thiophanate-methyl	0.35	189
Prothioconazole	0.75	167
Metconazole	0.13	176

*Diseased plants/200 row ft, mean of 4 replicates. Evaluated 9/12/06. Differences are not statistically significant.

None of the fungicides applied as a stem drench reduced PRR at any of the three locations. In the south San Angelo field, a propiconazole stem drench gave the greatest PRR reduction (Table 2).

Table 2. Effect of fungicides applied as a stem drench on 7/27/06 on PRR on two dates in a south San Angelo Field.

Fungicide	lb a.i./A	% Diseased*	
		8/22	9/26
None	-	12	46
Propiconazole	2	21	27
Thiophanate-methyl	2	14	48
Boscalid	0.44	14	52
Pyraclostrobin	0.2	20	41
DPX-LEM 17	0.27	22	49
V-10178	1.5	14	58

*Mean of 4 replicates for each date. Differences are not statistically significant.

The Wall location had 22% to 28% PRR incidence with the fungicides, in comparison with 28% for the control, as evaluated one month after treatment, on 8/22/06 (Table 3).

Table 3. Effect of fungicides applied as a stem drench on 7/24/06 on PRR (evaluated 8/22/06) in Wall, TX.

Fungicide	lb a.i./A	% Diseased*
None	-	28
Propiconazole	2	22
Thiophanate-methyl	2	28
Boscalid	0.44	26
Pyraclostrobin	0.2	22
DPX-LEM 17	0.27	24
V-10178	1.5	27

*Mean of 4 replicates. Differences are not statistically significant.

The SPC field had >95% mortality in all treatments, as evaluated on 8/1/06 (Table 4).

Table 4. Effect of fungicides applied as a stem drench on 7/24/06 on PRR (evaluated 8/1/06) in SPC.

Fungicide	lb a.i./A	# Living plants/68 row ft*
None	-	5
Propiconazole	2	6
Thiophanate-methyl	2	4
Boscalid	0.44	5
Pyraclostrobin	0.2	2
DPX-LEM 17	0.27	3

*Mean of 4 replicates. Differences are not statistically significant.

A reduction in PRR was also seen with a propiconazole stem drench in separate experiment in the south San Angelo field (Table 5). In that experiment, the fungicides were applied 8/3/06, during the first week of flowering. On 9/26/06, the incidence of PRR with the propiconazole treatment was 22%, which was significantly less (*P*=0.05) than the control, which was 56%. PRR with the other fungicide treatments ranged from 37% to 67% and were not significantly different from the control.

Table 5. Effect of fungicides applied as a stem drench on 8/3/06 on PRR on two dates in a south San Angelo Field.

Fungicide	lb a.i./A	% Diseased*	
		8/22	9/26
None	-	24	56
Propiconazole	2	22	22
DPX-LEM 17	0.27	17	59
Flupicolide	1.1	20	67
V-10116	0.46	22	54
V-10178	0.76	26	39
Metconazole	0.2	19	51
Fluoxastrobin	1	31	47
Boscalid + pyraclostrobin	0.67 +0.34	25	39
Prothioconazole	1	23	37
Pyrimethanil	1.27	26	48
Flusilazole	0.84	13	50

*Mean of 4 replicates for each date. Treatments are not significantly different (*P*=0.05) from the control, except propiconazole on 9/26.

Stem drench applications of fungicides had shown activity in experiments conducted in 2005, but those experiments were done with higher fungicide rates (3.4 to 33.9 lb a.i./A) and a higher volume of water (41 GPA) (T. Isakeit *et al*., 2006). In this work, a lower water volume and lower chemical rates were tested to make the treatments economical. With the fungicides tested to date, stem drench applications are not viable for controlling PRR.

The fungicide seed treatments and the stem drench application of propiconazole did not reduce PRR in the experiment at the Wall location, as assessed on 7/27/07 and 8/22/07 (Table 6).

Table 6. Effect of fungicides applied as a stem drench on 8/3/06 on PRR on two dates in a south San Angelo Field.

Fungicide	Rate (a.i./unit)	Applied to:	# Dead / 200 row ft.*		
			7/27	8/22	Total
None	-	-	104	105	209
Trifloxystrobin + triadimenol + ipconazole	0.01 + 0.015 + 0.01 lb/cwt	Seed	116	104	220
Trifloxystrobin + triadimenol + TCMBT	0.01 + 0.016 + 0.02 lb/cwt	Seed	95	95	190
Propiconazole	2 lb / A	Stem	83	92	175

*Mean of 4 replicates. Differences are not statistically significant.

There was insufficient PRR development at the Mereta location during this time to make any meaningful treatment comparison (data not shown).

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