Recent Developments in Garlic and Onion White Rot Management

Tom Turini, University of California Coop. Ext.

White rot is a potentially devastating disease of garlic, onions and related crops that is caused by the fungus *Sclerotium cepivorum.* This fungus only affects plants related to garlic and onions, but survives in the soil for decades without a host in a durable resting structure called a sclerotium, Sclerotia of *S. cepivorum* resemble poppy seeds and are formed on infected roots and bulbs. Planting susceptible crops in soil with few as 2 sclerotia per liter of soil can result in economic loss. Commonly, the commercial practice in the Central San Joaquin Valley is to avoid planting onions or garlic in an infested field. However, there are now over 13,000 acres known to be infested with this pathogen and the infested areas are some of the most desirable fields for production of these crops. Some growers have recently made plans to again use these infested fields for garlic and onion production.

There are several means of reducing levels of sclorotia in the soil, but frequently the reduction is not sufficient to avoid economic damage and these materials can be prohibitively expensive if used field wide. A material that can be applied to stimulate germination in the absence of a host so that the fungus starves has reduced levels by more than 90% but a reduction of that magnitude still may leave enough inoculum to cause damage.

There are several fungicides with different modes of action that are now registered for use against white rot. They are Cannonball WG (fludioxonil), Endura (boscalid) and tebuconizole, which is marketed as Orius or Tebuzole and the common name was Folicur until recently. These materials have all shown activity against white rot when applied prior to seed placement in the planting furrow.

There have been numerous studies in which these materials have performed well against white rot. In Fresno County, field experiments were conducted in a naturally infested commercial field. In these studies, the fungicide activity against *S. cepivorum* was assessed when either applied in the planting furrow or through the drip irrigation system during the growing season.

During the 2007-08 and 2008-09 growing seasons, fungicides applied to the planting furrow were compared. Garlic seed were planted On 21 Nov 07 with CA Late and on 23 Oct 08 with CA Early. See Tables 1 and 2 for treatment lists. All at-planting treatments were applied with a CO^2-pressurized back pack sprayer in the equivalent of 25 gal/A in water except for *G. intrardices*, which was applied as a granular material into the planting furrow. The spray was applied in a 4 to in. band directly into the 2-3 in.-deep trench 5 to 30 min before the garlic cloves were placed in the trench. The remainder of the season, the garlic was irrigated with buried drip. Above ground symptoms were rated after they became obvious. In late summer 50 ft of bed were harvested and yield per acre was calculated. Data was subjected to analysis of variance and mean separation was accomplished with Least Significant Difference (p=0.05).

In addition, at-planting applications in combination with fungicide injections into drip irrigation systems were evaluated during the 2007-08, 2008-09 and 2009-10 seasons. The planting dates and seed was the same as for the at-planting comparisons and in 2009, CA Late garlic seed was planted on 13 Nov. The experimental design of this trial was a five replication split block: Drip application programs were the main plot treatments and the at-planting applications were the sub plot treatments. All at-planting treatments were applied as detailed above. Within 24 following planting, the field was sprinkler irrigated. After establishment, the field was irrigated with drip tape placed at the center of each bed at a depth of 2 in, except in 2009 when depths varied. All drip applied materials were pump injected over a 45 to 60 min period. In Feb, 50 cloves were collected from untreated buffers, surface sterilized in 10% household bleach for 1 to 2 min and placed on a wire mesh over water in plastic containers and

incubated at 72^{o}F. After 3 wk of incubation, *S. cepivorum* was present on less than 4% of the cloves. After above ground symptoms were apparent, each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale: In plots that received a 0 rating, there were no symptomatic plants observed and all plants were dead in plots rated 10. Data was subjected to a factorial analysis of variance for the split plot design. Least significant difference (P=0.05) was used for mean separation.

RESULTS and DISCUSSION

In 2007-08, the experiment for evaluation of the at-planting/drip applications, all at-planting applications reduced disease as compared to the untreated control except for Contans WG. However, none of the drip application programs reduced disease severity, which may be attributable to infection that occurred prior to the first application through the drip. In the experiment for evaluation of at-planting applications, only Folicur 3.6F with or without Watermaxx II, Endura 70WG, and Cannonball 50WP 8 oz with or without the Watermaxx II had lower disease ratings and higher yields than the untreated control. No evidence of phytotoxicity was observed in any treatments in either experiment.

TABLE 1. Efficacy of materials applied at planting on white rot symptom severity and yield in 2007-08.

Treatment (rate of formulated product per acre, applied in planting furrow)	Severity (0-10)[z]		Weights (tons/acre)	
	23 Apr	14 May	Fresh wt[y]	Dry wt[x]
Endura 70WG 6.8 oz	1.60 f[w]	4.20 ab	4.58 a	4.30 a
Folicur 3.6F 20.5 fl oz	2.40 cdef	4.60 ab	3.92 ab	3.70 a
Cannonball 50WP 8.0 oz + WatermaxxII 2 qt	2.00 def	4.20 ab	3.54 abc	3.50 ab
Folicur 3.6F 20.5 fl oz + WatermaxxII 2 qt	1.60 f	3.00 b	3.43 abcd	3.24 abc
Cannonball 50WP 8.0 oz	1.80 ef	5.00 a	3.32 bcde	3.13 abc
Cannonball 50WP 4.0 oz	3.20 abcd	4.40 ab	2.82 bcdef	2.42 bcd
Moncut 70DF 2.86 lb	3.00 bcde	5.20 a	2.56 cdef	2.38 cd
Glomes intrardices 30 lb	3.60 abc	5.00 a	2.34 def	2.20 cd
Contans WG 4 lb	3.40 abc	5.80 a	2.15 ef	2.09 cd
Contans WG 2 lb	3.80 ab	5.40 a	2.04 f	1.89 d
Contans WG 8 lbs	3.80 ab	5.20 a	1.91 f	1.89 d
Untreated control	4.40 a	5.40 a	1.76 f	1.73 d

[z] Each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale with a plot receiving a 0 rating having no symptomatic plants and a plot of all dead plants would be rated 10.
[y] Fresh weight was taken on date harvested, 22 Aug.
[x] Dry weight was taken 11 days after harvest, on 3 Sep.
[w] Means followed by the same letter within a column are not significantly different as determined by LSD (P=0.05).

TABLE 2. Influence of materials applied in a concentrated band in the planting trench on above ground symptom development observed on 9 May 2009.

Treatment (rate of product per acre, applied in the planting furrow)	Yield (tons/acre)		Above ground symptoms (0-10)[z]
	19 Aug (at harvest)	26 Aug (dry wt)	
Gem 2.5 oz formulated product/acre (fp/a)	4.70 abc	4.46 abc	1.0 ab
Moncut (flutolanil: Gowan) 2.86 lbs fp/a	4.72 abc	4.50 abc	0.8 abc
Endura 6.8 oz + WatermaxII 64 fl oz	3.77 bcd	3.59 bcd	0.4 bcd
Contans 4 lbs fp/a	4.17 bcd	3.93 bcd	1.2 a
Contans 8 lbs fp/a	3.40 cd	3.19 cd	1.4 a
Endura 6.8 oz fp/a*	2.96 d	2.79 d	0.2 cd
Tebuzol 20.5 fl oz	4.22 bcd	3.97 bcd	0.2 cd
Tebuzole 20.5 fl oz + TopsinM 40 fl oz	5.82 a	5.45 a	0.0 d
Cannonball 50WP 8.0 oz fp/a*	4.98 ab	4.65 ab	0.2 cd
Folicur 20.5 fl oz fp/a*	3.56 cd	3.35 bcd	0.0 d
Folicur 20.5 fl oz+ Botran 102 fl oz	3.52 cd	3.31 bcd	1.0 ab
Untreated control	3.55 cd	3.33 bcd	1.0 ab

[z] Each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale with a plot receiving a 0 rating having no symptomatic plants and a plot of all dead plants would be rated 10.
[y] Fresh weight was taken on date harvested, 22 Aug.
[x] Dry weight was taken 11 days after harvest, on 3 Sep.
[w] Means followed by the same letter within a column are not significantly different as determined by LSD (P=0.05).

TABLE 3. Influence of fungicide programs, which consisted of at-planting and/or drip applications, on white rot severity and yield in 2007-08.

Treatment Material applied at planting	Severity (0-10)[z]		Weights (tons/acre)	
	23 Apr	14 May	Fresh wt[y]	Dry wt[x]
Cannonball 50WP 8.0 oz + Botran 5F 3.2 qt	1.3 c[w]	1.70 b	5.51 a	5.21 a
Folicur 3.6F 20.5 fl oz	2.2 b	2.15 b	5.23 a	4.90 a
Cannonball 50WP 8.0 oz	1.7 bc	2.30 b	5.29 a	4.14 a
Untreated control	3.1 a	4.15 a	3.01 b	2.53 b
Contans WG 4 lbs	3.7 a	4.90 a	2.54 b	2.44 b

Date of drip application and materials applied			Severity (0-10)		Weights (tons/acre)	
15 Feb	7 Mar	27 Mar	23 Apr	14 May	Fresh wt	Dry wt
Cannonball 50WP 8.0 oz	Folicur 3.6F 20.5 fl oz		2.52	3.00	4.63	3.82
Cannonball 50WP 8.0 oz	Folicur 3.6F 20.5 fl oz	Endura 70WG 6.8 oz	2.40	3.28	4.26	3.82
Folicur 3.6F 20.5 fl oz	Cannonball 50WP 8.0 oz	Endura 70WG 6.8 oz	2.24	3.00	4.43	3.91
Untreated control			2.40	3.28	4.07	3.83
Drip application, probability			NS[v]	NS	NS	NS

At planting/drip treatment interaction, probability	NS	NS	NS	NS

[z] Each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale with a plot receiving a 0 rating having no symptomatic plants and a plot of all dead plants would be rated 10.
[y] Fresh weight was taken on date harvested, 22 Aug.
[x] Dry weight was taken 12 days after harvest, on 3 Sep
[w] Means followed by the same letter within a column are not significantly different as determined by LSD (P=0.05)
[v] Means in column above NS are not significantly different (P=0.05)

TABLE 4. Influence of fungicide programs, which consisted of at-planting and/or drip applications, on white rot severity and yield in 2008-09

Treatment	Yield (tons/acre)		Above ground symptoms (0-10)[z]
Material applied at planting	19 Aug (at harvest)	26 Aug (dry wt)	9 May 2009
Folicur 20.5 oz	5.14	4.81	0.10 b
Cannonball 8.0 oz	5.20	4.89	0.25 b
Endura 6.8 oz	5.14	4.86	0.10 b
Contans 4 lbs fp/a	4.62	4.36	0.90 a
Control	4.26	4.03	1.05 a
At planting application, probability	0.112[z]	0.122	0.006

Date of drip application and materials applied				Yield (tons/acre)		Above ground symptoms (0-10)
20 Feb	11 Mar	31 Mar	22 Apr	19 Aug	26 Aug	9 May
Folicur 20.5oz	Cannonball 8.0 oz	Endura 6.8 oz	Botran 3 qt	5.36	5.05	0.44
Cannonball 8.0 oz	Folicur 20.5oz	Endura 6.8 oz	Botran 3 qt	4.87	4.59	0.48
	Cannonball 8.0 oz	Endura 6.8 oz	Botran 3 qt	5.16	4.82	0.56
Untreated control				4.10	3.90	0.44
Drip application, probability				0.073	0.096	0.347
At planting/drip treatment interaction, probability				0.254	0.295	NS

[z] Each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale with a plot receiving a 0 rating having no symptomatic plants and a plot of all dead plants would be rated 10.
[y] Fresh weight was taken on date harvested, 19 Aug.
[x] Dry weight was taken 12 days after harvest, on 26 Aug.
[w] Means followed by the same letter within a column are not significantly different as determined by LSD (P=0.05).
[v] Means in column above NS are not significantly different (P=0.05).

TABLE 5. Influence of fungicide programs, which consisted of at-planting and/or drip applications, on white rot severity and yield in 2009-10.

Treatment	Severity (0-10)[z]	
Material applied at planting	13 Apr	16 May
Orius 3.6F 20.5 fl oz	0.00 b	1.35 b
Cannonball 50WP 8.0 oz	0.05 b	1.53 b
Untreated control	0.08 a	2.05 a

Date of drip application and materials applied				Severity (0-10)	
Tape depth	15 Feb	7 Mar	27 Mar	13 Apr	16 May
3”	Orius 3.6F 20.5 fl oz	Endura 70WG 6.8 oz	Endura 70WG 6.8 oz	0.17 b	1.12
3”	Cannonball 50WP 8.0 oz	Endura 70WG 6.8 oz	Endura 70WG 6.8 oz	0.17 b	1.63
3”	Untreated control			0.75 a	1.92
surface	Orius 3.6F 20.5 fl oz	Endura 70WG 6.8 oz	Endura 70WG 6.8 oz	0.25 b	1.67
10”	Orius 3.6F 20.5 fl oz	Endura 70WG 6.8 oz	Endura 70WG 6.8 oz	0.08 b	1.58
Drip application, probability				0.010	NS[x]
At planting/drip treatment interaction, probability				0.023	NS

[z] Each plot was rated for typical above-ground white rot symptoms including leaf dieback and plant death on a 0-10 scale with a plot receiving a 0 rating having no symptomatic plants and a plot of all dead plants would be rated 10.

[y] Means followed by the same letter within a column are not significantly different as determined by LSD (P=0.05)
[x] Means in column above NS are not significantly different (P=0.05)