CONTROLLING BLACK SCURF OF POTATO TUBERS CAUSED BY RHIZOCTONIA SOLANI

by
D. A. Inglis, W. A. Haglund, and R. E. Thornton
Washington State University

Rhizoctonia solani is a soilborne fungus that negatively impacts potato production in both western and eastern Washington and causes sprout injury, stem and stolon cankers and/or tuber black scurf. Scurf is undesirable on potatoes sold for fresh market because of quality loss--it also is undesirable on seed potatoes because emerging plants can become infected and new fields contaminated with the pathogen.

Black scurf is a mass of fungal survival structures (called sclerotia) that are extremely persistent and difficult to control. Cultural practices such as use of tolerant varieties and crop rotation are recommended but not completely effective. Chemicals like formaldehyde and PCNB are either too dangerous or limited in availability. For these reasons new approaches for controlling potato black scurf need investigation. Control strategies using biological and mechanical vine destruction methods were studied at WSU-NWREU in 1990 experimental field trials.

Biological Trials. Two microorganisms, one isolated from Mount Vernon field soil and tentatively identified as Chaetomium species, and the other isolated from Rhizoctonia tuber sclerotia and tentatively identified as Trichoderma species, were tested. Both trials were hand-planted with Rhizoctonia-infected seedpieces of Red LaSoda cut to approximately 2.5 ounces and placed cut side down in the furrow. A 9 inch seed spacing and 42 inch row spacing was used. The field sites had not been planted previously to potatoes. It has been shown in other work at WSU-NWREU that planting contaminated seed into noncontaminated soil creates desirable disease pressure for Rhizoctonia field experimentation.

In the Chaetomium trial plots treated with this fungus were compared to nontreated plots. Both treatments (check and biological) were tested at three fumigation rates (0, 20 and 40 gallons metham-sodium per acre applied by rotovate-and-roll). The Trichoderma trial compared three treatments to a nontreated check. Those treatments were 1) TBZ 0.25-PCNB 2.5 (1 pound/cwt seed, 2) the biological, and 3) TBZ 0.25-PCNB 2.5 plus the biological. Treatments were tested in fumigated (40 gallons metham-sodium per acre) and nonfumigated soil.

This Presentation is part of the Proceedings of the 1991 Washington State Potato Conference & Trade Fair.

Plots were planted June 19 and 22, respectively. Chaetomium plots were 25 feet long (20 feet used for establishing yield and 5 feet for midseason disease sampling); the Trichoderma plots were 15 feet long (entire length used for yield data). Plots were maintained as a commercial planting insofar as was possible.

Vines in the Chaetomium trial were killed (chopped, then sprayed with Diquat--two applications, 5 days apart using 1 pint/acre in 40 gallons water) September 17 and tubers harvested October 1. Vines in the Trichoderma trial were killed September 21 in the same way, and harvested October 8. A level bed digger was used to lay tubers on the surface of the ground. Following digging, 20 tubers were randomly sampled from the row then later washed, weighed, and rated for black scurf severity (0=healthy; 1=<5%, 2=up to 10%, 3=up to 25%, 4=up to 50%, and 5=>50% of the tuber surface affected with Rhizoctonia sclerotia). The rest of the tubers were taken to the W.S.U. potato facility at Othello where they were machine graded. The weight of the tubers used for the tuber scurf rating was added to the plot weight to determine Total yield.

Comparison of check plot and biological plot means (Table 1) shows that the biological improved stand 14% (67% versus 81%). Yield of U.S. No. 1's increased from 174 to 223 cwt/a, and Total yield from 261 to 311 cwt/a. All yields from this trial are somewhat lower than normal for the area and may be the result of heavy rainfall (4 inches) between the time the ground was worked and fumigated, and when it was planted. When the fumigation and nonfumigated means are compared, stand and U.S. No. 1 yield and Total yield are statistically the same.

Table 1. Percent stand and yield, 1990 Chaetomium trial.

Trt	Percent Stand	Yield (cwt/a) No.1's	No.2's	Total
Check	67 a	174 a	32	261 a
Bio	81 b	223 b	27	311 b
LSD=	6	37		28
0 gpa	76 a	218 a	23	298 a
20 gpa	75 a	200 a	31	286 a
40 gpa	71 a	177 a	34	269 a
LSD=	8	44		44

Total yield = yield U.S. No.1's + No.2's + scurf sample yield

Table 2. Disease data, 1990 Chaetomium plot.

Trt	PPG	T.C.	% S.C.	Scurf
Check	483 a	4.8 a	36	2.88 a
Bio	8193 b	4.3 a	35	2.54 b
LSD=	1744	1.4	10	0.33
0 gpa	4000 a	2.1 a	24	2.10 a
20 gpa	4068 a	5.6 b	44	3.22 b
40 gpa	4482 a	6.0 b	38	2.84 b
LSD=	2123	1.8		0.72

PPG = number Chaetomium propagules per gram recovered from midseason soil plot samples
TC = number of hills with stems infected with Thannatephorus cucumeris
% S.C. = percent underground stems with Rhizoctonia cankers (5 plants sampled/plot)
Scurf: 0=healthy, 5=50% tuber surface with Rhizoctonia sclerotia

Chaetomium was recovered from plot soil samples by dilution planting to determine whether the fungus was surviving in soil. The number of surviving Chaetomium propagules is considerably higher in plots incoulated with the fungus. (Table 2). Fumigation did not seem to influence the introduction or persistence of Chaetomium in soil, since populations are virtually the same when the 20 and 40 gpa fumigation means are compared to the nonfumigated mean.

The number of hills with stems having Thannatephorus cucumeris infection (Rhizoctonia solani perfect stage) is similar, comparing the check and biological treatment means (Table 2). But fumigation at either 20 or 40 gpa increased TC infection compared to the nonfumigated check. The same is true for percentage of underground stems having Rhizoctonia cankers. The mean tuber scurf rating is significantly lower for the biological treatment compared to the check, and also is significantly lower for the nonfumigated treatment compared to the 20 and 40 gpa fumigation treatments.

In the Trichoderma trial yield of U.S. No. 1's and Total yield is highest for the treatment having fungicide-treated seedpieces, followed by the treatment having the fungicide plus biological (Table 3).

Scurf levels are lowest where the seedpiece fungicide and the biological were used together--but that value is significantly different only from the check. No yield resulted from fumigating plots as noted in the Chaetomium trial. Mean scurf ratings, however, are significantly higher when the 40 gpa fumigation treatment is compared to the nonfumigated check.

Table 3. Scurf ratings and yield, 1990 Trichoderma plot.

		Yield (cwt/a)		
Treatment	Scurf	No.1's	No.2's	Total
Check	2.08 a	335 b	12 b	412 b
TBZ-PCNB	1.31 b	418 a	15 a	475 a
Biological	1.08 b	353 b	12 b	410 b
TBZ-PCNB+Bio	0.86 b	379 ab	13 ab	434 ab
	LSD=0.62	53	2	58
0 gpa	1.43 a	356	13	413
40 gpa	1.77 b	364	13	420
	LSD=0.31	28	1	29

For all above tables means in the same group followed by the same letter are not statistically significant (p=.05).

The conclusions from the biological experiments done thus far are that the benefit from Chaetomium is general and not necessarily directed specifically against Rhizoctonia. The opposite seems to be true for Trichoderma, however. Since Chaetomium is a relatively common and widely occurring soil microorganism and the Trichoderma isolate was a sclerotial parasite, it is not surprising that this was observed. First year results with the biologicals are promising enough to continue investigations. Also it is apparent that planting Rhizoctonia-contaminated seed into fumigated soil is similar to planting Rhizoctonia-contaminated seed into new potato ground in that disease (as reflected by Thannatephorus, stem cankers and/or scurf) can be more severe. Possibly, the pathogen gains a competitive advantage because soil microorganisms antagonistic to Rhizoctonia are absent or inhibited in virgin or fumigated ground. Planting contaminated seed into fumigated ground is a farming practice that should be avoided.

Vine Destruction Tests. Recent reports from the Netherlands indicate that haulm pulling or chemical vine killing followed by root cutting may limit the ability of Rhizoctonia to form sclerotia on potato tubers. In western Washington growers commonly chop or flail potato vines then spray them one or more times with vine destroying chemicals. Sometimes vines are burned. Currently there is interest in vine pulling as a vine removal alternative. (The Oldenhuis haulm puller, manufactured in the Netherlands is now available for purchase in western Washington).

This experiment was similar to the biological field trials except two-row plots, 20-feet long were planted June 10, killed September 18, and harvested 2 and 3 weeks following vine kill. Four vine killing treatments were employed. These included natural senescence, burning with a hand-held propane burner, cutting just below soil line with a pruning shears, and chopping with a rotary mower mounted on a tractor followed by two applications of Diquat (same kill procedure used in biological trials).

Table 4. Yield data and scurf ratings, 1990 vine kill plot.

	Yield No.1's			Yield No.2's			Total	
Treatment	>10oz	4-10oz	<4oz	>10oz	4-10oz	<4oz	Yield	Scurf
Nat'l	28 ab	118	65 a	10	15 a	6	285	1.380 b
Burn	34 a	104	47 b	6	12 ab	5	252	2.475 a
Cut	21 b	124	68 a	6	15 a	7	281	1.706 b
Chem	22 ab	121	77 a	6	9 b	5	281	1.525 b
LSD=	12	33	18	8	5	2	46	0.643
2 wk	23	117	66	7	14 a	7 a	278	1.625 a
3 wk	29	116	63	7	10 b	5 b	272	1.918 a
LSD=	9	23	13	6	4	2	40	0.454

For the vine kill trial there is no significant difference in Total yield either among treatment means, or harvest date means (Table 4). However, scurf ratings of tubers are significantly higher for burning. Dutch workers have postulated that volatile compounds exuded by potato tubers trigger scurf formation. Increased stimulatory compounds and decreased inhibitory compounds from tubers at the end of the season may be a response to:

1) stress factors from the dying mother plant,
2) how quickly the tubers separated from the stolons,
3) the amount and proximity of decomposing roots and stems,
4) the position of the tubers in the hill relative to oxygen and available soil moisture.

Burning could have favored the formation of compounds stimulatory to Rhizoctonia by severely stressing aboveground plant parts, causing slow separation of tubers from stolons, allowing belowground plant parts to remain and slowly decompose, not altering the position of tubers in the hill, or some or all of these possibilities. We are anxious to continue this work and study other strategies such as haulm pulling, soil loosening and/or root severing to determine whether a mechanical method for controlling black scurf can be unveiled.