Developing prediction and management systems for the control of Rhizoctonia diseases in potato based on varietal susceptibility and soil temperature.

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Results

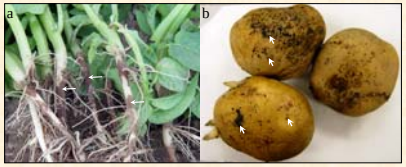


Figure 1. Disease symptoms of Rhizoctonia on potato. (a) Brown sunken lesions form on potato shoots, stolons and roots (arrows). Severe lesions may girdle the affected organ resulting in delayed emergence, poor stands, or weakened plants. (b) Black sclerotia (arrows) on the surface of potato tubers resemble soil that will not wash off.

Table 1. Effect of planting time (soil temperature) on overall incidence and severity of sclerotia on potato tubers of different varieties caused by *Rhizoctonia solani*.

	Black scurf incidence (%)		Black scurf severity (%)	
Timing (°C)	2004	2005	2004	2005
8	85.6 a	10.8 a	43.6 a	11.5 a
14	25.4 b	12.3 a	14.3 b	11.8 a
20	14.4 b	9.0 a	10.0 b	11.5 a

Table 2. Effect of soil temperature at planting time on incidence and severity of black scurf on tubers of different varieties of potato in 2004.

	8 °C				20 °C[x]			
Variety	Incidence[z]		Severity[y]		Incidence		Severity	
FL 1867	91.2	a	42.7	abc[w]	7.6	bc	4.0	ab
FL 1879	69.8	a	29.0	c	2.4	c	1.0	b
Jacqueline Lee	95.8	a	65.3	ab	28.4	ab	27.3	a
MI Purple	93.9	a	38.3	abc	0.0	c	0.0	b
Pike	82.8	a	31.0	bc	9.0	bc	3.0	b
Russet Norkota	90.8	a	30.7	bc	5.7	bc	1.0	b
Snowden	80.3	a	46.0	abc	37.0	a	27.3	a

Table 3. Effect of soil temperature at planting time on incidence and severity of black scurf on tubers of different varieties of potato in 2005.

	8 °C				20 °C[x]			
Variety	Incidence[z]		Severity[y]		Incidence		Severity	
FL 1867	16.7	a	13.0	a[w]	3.3	b	10.3	b
FL 1879	18.3	a	12.3	a	5.0	ab	11.0	ab
Jacqueline Lee	13.3	a	11.8	a	0.0	b	10.0	b
MI Purple	3.3	a	10.3	a	0.0	b	10.0	b
Pike	1.7	a	10.2	a	20.0	ab	12.3	ab
Russet Norkota	13.3	a	11.7	a	26.7	a	15.8	a
Snowden	15.0	a	11.8	a	*		*	

Footnote for Tables 2,3.
[z] Percent incidence of tubers with *Rhizoctonia solani* sclerotia from a sample of 20 tubers per rep.
[y] Severity of black scurf. Index calculated by counting the tuber number (n = 20 per rep) falling into class 0 = 0, 1 = 1-5, 2 = 6-10, 3 = 11-15, and 4 => 16% surface area. Indices of 0 to 25 cover the range 0-5, 25-50 cover the range 6-10, 51-75 cover the range 11-15, and 75-100 cover the range >15% surface area of the tuber with sclerotia.
[x] Data for the 14 °C planting time was not significantly different from the 20 °C timing and is therefore not shown.
[w] Mean values of diseased tubers followed by the same letter (within a column) are not significantly different at $p = 0.05$ (Tukey's HSD Comparison).

Conclusions

Planting based upon soil temperature experiment

In 2004, later plantings, based upon soil temperatures at 14 and 20°C, had significantly less incidence and severity of black scurf on progeny tubers compared to the early planting 8°C. However, the later planted treatments were not significantly different in terms of incidence or severity of black scurf. These results suggest that cold temperature enhances the development of *Rhizoctonia* disease symptoms and perhaps retards plant development and growth. In 2005, there were no significant differences between plantings at 8, 14 and 20°C, this may have been due to a lower incidence of *Rhizoctonia*.

Introduction

Rhizoctonia solani, anastomosis group (AG) 3 causes stem and stolon canker and black scurf on potato tubers, reducing plant health, yield quality and quantity. Soil temperature is a critical factor in the initiation of disease with disease severity being positively correlated with the soil temperature that is most favorable for pathogen growth. Thus, planting decisions based upon soil temperature may reduce the severity of disease symptoms lower the need for fungicide applications. A two year study was conducted in 2004 and 2005 to look at the effect of planting time (based on soil temperatures of 8, 14, and 20°C) on disease incidence and severity. Concurrently, lab experiments were carried out to assess the effects of a range of fungicides at 0.1, 1 and 10 ppm, on the growth of Rhizoctonia isolates *in vitro* at different temperatures (5, 10, 15, 20 , 25 and 30°C).

Materials and Methods

Planting based upon soil temperature experiment

- Tubers were planted when the average soil temperature over a five day period reached 8, 14, and 20°C for control of Rhizoctonia diseases.
- Commonly grown potato varieties (ten in 2004, and 8 in 2005) were tested at each temperature.
- Seed was planted in hills (9 potatoes x 4 rows per variety). Three reps were used per variety per planting time using a randomized complete block design. Data was analyzed in JMP using Students T-test.
- No seed treatments or fungicides with known activity against *R. solani* were applied during the growing season.

Temperature x Fungicide experiments

- Cultures of *R. solani* (AG2-2, AG 3 and AG 4) isolated from Michigan soils were maintained on PDA.
- To study the effect of temperature x fungicide interactions, 5 mm plugs were transferred to PDA plates amended with 0, 0.1, 1 and 10 ppm concentrations of the target fungicides and incubated at 5, 10, 15, 20, 25 and 30°C.
- The target fungicides used were Maxim (fludioxonil), Amistar (azoxystrobin), Headline (pyraclostrobin), and Moncut (flutolonil). The active ingredients in these fungicides are all commonly used for the control of *R. solani*.
- Five plates were used per treatment and radial growth of the pathogen was measured after 3 days by calculating the area of growth on the plates using the image analysis program SigmaScan Pro™.

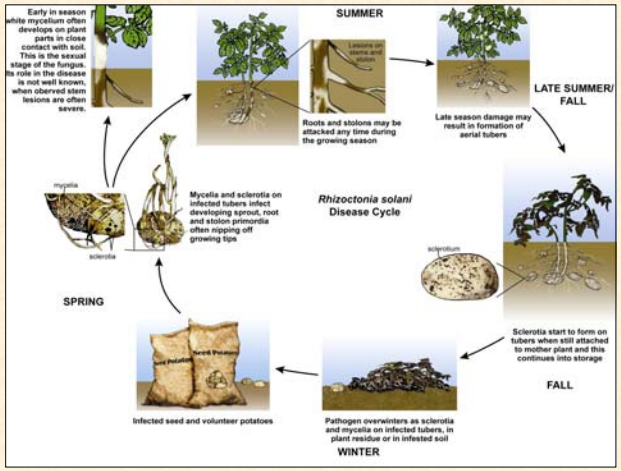


Figure 2. The disease cycle of the stem canker and black scurf pathogen *Rhizoctonia solani*.

Results

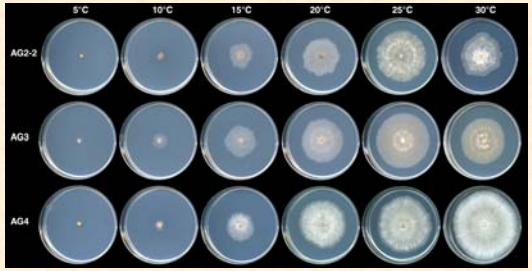
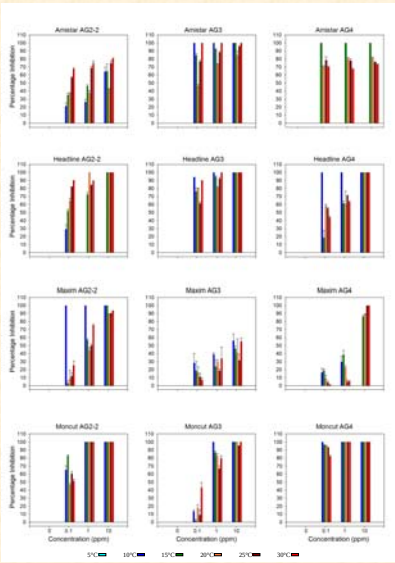


Figure 3. Radial growth patterns of Rhizoctonia solani anastomosis groups (AG) 2-2, 3 and 4 on PDA at different temperatures.

Table 4. The concentration of the target fungicide at which a 50% reduction of the growth (EC_{50}) in colony area (AG 3) was observed at each temperature.

	Fungicide			
Temp. (°C)	amistar	headline	maxim	moncut
5	no growth[z]	0.706 a	1.167 a	no growth[z]
10	no growth[y]	0.772 a	1.138 a	0.796 a
15	1.195 a	0.754 a	1.698 a	0.511 a
20	5.595 b	0.911 a	1.692 a	0.626 a
25	1.549 a	0.702 a	1.765 a	0.599 a
30	no growth[y]	1.128 b	3.228 b	3.036 b

[z] lack of growth was related to temperature as no growth was seen on the untreated control (PDA without fungicide).
[y] lack of growth was related to fungicide concentration as growth was seen on the untreated control but not on any of the fungicide amended plates.



Figures 4. The effect of four fungicides at 0, 0.1, 1 and 10ppm concentrations, on the growth of *Rhizoctonia solani* AG2-2, AG3 and AG4 at six different temperatures 5, 10, 15, 20, 25, and 30°C.

Conclusions

Temperature x Fungicide experiments

The optimal growth temperature for all three AG groups was between 25 and 30°C (Fig. 3). Increasing temperature did not affect the EC_{50} except at 30°C (Table 4). Temperature x fungicide results suggest that applying fungicides at high temperatures (25-30°C) may be less effective than applying them at lower temperatures (15-20°C). In most cases the lowest concentration of fungicide (0.1ppm) was just as effective in preventing fungal growth as the highest (10ppm).

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