PROGRESS REPORT TO THE OREGON PROCESSED VEGETABLE COMMISSION, 1999

TITLE: Exploring biotic, nutritional, and stress parameters in the root rot syndrome of sweet corn.

PROJECT LEADER: Mary Powelson
Botany and Plant Pathology Department
Oregon State University
Corvallis, OR 97331-2902

GRADUATE STUDENT: Beth Hoinacki
Botany and Plant Pathology Department

COOPERATOR: Neil Christensen, Crop and Soil Science Department

PROJECT FUNDING: $14,000

SUMMARY OF WORK

- Root necrosis at harvest was 86% for plants grown in nonfumigated plots versus 18% for plants in fumigated plots.
- Root rot decreased sweet corn yields 15-33% in nonfumigated versus fumigated plots.
- A biotic agent is the major factor in the sweet corn root rot complex.
- Soil fertility and plant nutrition status of commercial sweet corn fields is still to be determined.
- The rapid increase of root necrosis and leaf firing seen from silking until harvest is not due to increased susceptibility of the corn plant during this period.
- Soil treatments had no effect on root rot development, firing, or yield.
- Ridomil significantly reduced the recovery of *Pythium* spp. from symptomatic corn roots, but did not reduce severity of root rot symptoms.

INTRODUCTION

The cause of sweet corn root rot has been difficult to determine. Extensive sampling and surveying indicate the fungal pathogens *Pythium arrhenomanes* and *Fusarium oxysporum* and *solani* are consistantly associated with diseased roots. In field studies with these fungi we have not been able to reproduce disease symptoms similar to what we see in commercial fields; however greenhouse studies have shown *P. arrhenomanes* to be pathogenic on sweet corn seedlings. These studies suggest neither fungus alone is the cause of this disease. In addition, in a soil treatment study with Ridomil Gold, the

frequency of recovery of *Pythium* was reduced but had no effect on severity of disease. This suggests that *Pythium* is not the primary cause of root rot.

Experiments were conducted during 1999 to determine: 1) if the cause of root rot of sweet corn is biotic, 2) if the disease is associated with plant nutrition, and 3) the potential role of stress in disease development and 4) the effect of soil treatments on reducing severity of root rot symptoms.

MATERIALS AND METHODS

Fumigation study. A fumigation study was conducted to determine if a biological agent is an important factor in root rot development. Fumigation plots were established in early spring, 1999, in two commercial sweet corn fields with a history of root rot. In each field, four plots (30 x 60 ft) were fumigated with methyl bromide (67%) and chloropicrin (33%) at 400 lbs/a and tarped. Adjacent to each fumigated plot a nonfumigated plot was established for comparison. After fumigant dissipation, sweet corn seed, cvs. Golden Jubilee (field 2) or 2684 (field 1), was planted. All plots were treated with standard grower practices. Soil samples were taken in both fields at planting and 1 mo post-planting, and in one field at harvest. At the first sample date soils were analyzed for pH, C, N, P, K, Ca, Mg, nitrate-N and ammonium-N by the Central Analytical Laboratory, Oregon State University. At the second sample date, and at harvest in the one field, soils were analyzed for nitrate-N and ammonium-N only.

Plants were sampled in both fields at 4 and 7-8 wks post-planting and at harvest. At 4 wks, 10 plants were randomly sampled from each plot in both fields. Plants were cut at the soil surface and shoot height was recorded before drying at 60 C for 2 days. Rootballs were washed in tap water and assessed for percent necrosis. Roots were plated on media selective for *Pythium* or *Fusarium*. Plates were incubated, the number of putative colonies of *Pythium* and *Fusarium* formed was recorded, and a subsample was cultured to fresh media and stored for later identification. At 7-8 wks, height was measured in the field for 10 randomly selected plants in each plot. In addition, three plants per plot were randomly sampled and taken back to the lab where rootballs were washed and percent root necrosis was recorded. Symptomatic root pieces were plated and colonies recorded and subcultured as before. At harvest, three plants per plot were randomly sampled and the rootballs washed and percent root necrosis recorded. In addition, five plants per plot were randomly selected, cut at the soil surface, placed in burlap bags, oven dried and weighed. Yield was determined by recording the number of harvestable ears and total ear weight for two 10 ft long rows randomly selected in each plot.

Fertility/nutrition study. Soils and plants from four commercial fields were sampled to examine the possible role of macro- and micronutrients in the disease complex. Nonfumigated plots in the two fields in the fumigation study were used and plots in two other fields, one with a history of root rot and one in which disease was beginning to develop, were established. Composite soil samples were taken at planting; 10 cores, 0-10" deep, were randomly taken from each of the

plots and mixed. Plant tissue was sampled at 1 mo post-planting, at tassel emergence and then at subsequent 1 wk intervals until harvest. At 1 mo post-planting, 10 plants were randomly sampled in each plot, cut at the soil surface, oven-dried, ground, and stored for future analysis. At subsequent sampling dates the leaf opposite the primary ear was sampled from each of 10 randomly selected plants in each plot and treated as before. In addition, at harvest stems were collected from the three plants sampled for disease in each of the plots in all four fields. The 8-14" section above the soil surface was oven dried, ground, and stored for future analysis.

Ear removal study. To determine if the rapid increase in root necrosis and associated leaf firing that occurs from silking to harvest is due to an increase in susceptibility of the plant, an experiment was conducted to assess disease development as a function of plant stress. Two treatments, ear removal vs. no ear removal, were applied to 15 ft long corn rows of cvs. Golden Jubilee or 2684 in three commercial fields. Ear removal consisted of removing all developing ears at the onset of ear emergence.

At harvest, three plants per treatment per plot were randomly sampled, the rootballs washed, and the percent root necrosis recorded. Foliar disease assessment was made by recording the number of leaves fired from the ground up for six randomly selected plants in each plot.

Soil treatment study. A field study was conducted to test soil fungicide treatments for control of root rot. This study was a partial repeat of the soil treatment study conducted during the summer of 1998. Plots (1 row, 20 ft long) were established at planting in three commercial fields with a history of root rot. Treatments were Terrachlor Super X (5.5 l/ha), Ridomil Gold (2 l/ha), Zonix (1% v/v of water), and a nontreated control. Treatments were arranged in a randomized block design and replicated five times. Treatments were applied in 8 L of water with a backpack, CO_2 pressurized sprayer in 1 ft bands down rows. Treatments began at plant emergence and were repeated every 10 days for a total of six applications.

Plants were evaluated for amount of root necrosis at 4, 7, and 10 wks post-planting. On each sampling date one plant per plot (five plants per treatment) was sampled, the rootball washed, and percent necrosis of the rootball recorded. Roots were placed on agar medium selective for *Pythium* or *Fusarium*. Plates were incubated at room temperature and number of colonies formed of each were enumerated.

At harvest foliar disease assessments were made by recording the number of leaves fired on every other plant in each plot for a total of six plants. Yield was evaluated by picking all harvestable ears from plants in a 10 ft row within plots. Ear number and total ear weight was recorded.

Analysis. Treatments were compared with analysis of variance and means were separated by Fischer's protected least significant difference ($p \leq 0.05$).

RESULTS

Fumigation study. At 4 and 7-8 wks post-planting, plants were on average 7.6 and 5.9% taller in the fumigated compared with the nonfumigated plots for the two fields; however this was significant in only one field at 7-8 wks ($p=0.004$). Necrosis of the rootball was significantly reduced in fumigated plots at all three sample dates in both fields (Figure 1).

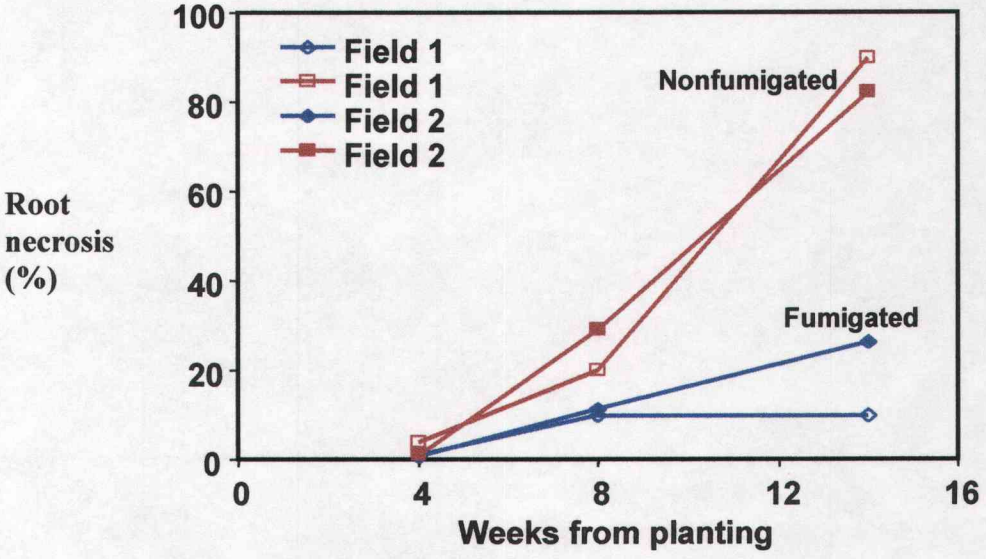

Figure 1. Effect of fumigation on root necrosis of sweet corn.

Rootballs of corn grown in fumigated plots remained white and healthy with numerous fibrous fine roots for most of the growing season. Root browning and isolated lesions did develop during the season but necrosis of whole roots was not observed until harvest, at which point approximately 10% of the rootball was necrotic. In the nonfumigated plots, however, lesions appeared early and disease developed rapidly, with the rootballs becoming more than 80% necrotic in both fields by harvest. While both *Pythium* and *Fusarium* spp. were isolated from roots of both fumigated and nonfumigated plots, recovery rate of both genera was reduced in the fumigated plots, as was expected due to the effect of the fumigation (Table 1).

Table 1. Effect of soil fumigation on the recovery of *Fusarium* and *Pythium* from symptomatic sweet corn roots.

	Percent recovery*			
	Fusarium		*Pythium*	
	Weeks from planting		Weeks from planting	
	4	7-8	4	7-8
Field 1				
Fumigated	58	15	2	8
Nonfumigated	98	35	8	34
	**	ns	ns	ns
Field 2				
Fumigated	87	19	9	6
Nonfumigated	97	34	17	3
	ns	**	ns	**

*Percent of 10 root pieces colonized by fungi.
** Significantly different according to Fischer's Protected LSD ($P \leq 0.05$).

At harvest, foliar symptoms were more severe in nonfumigated plots compared to fumigated in both fields; however this was not significant. Number of ears on plants harvested in fumigated plots was significantly greater than those in nonfumigated plots in both fields. In one field ear number was increased by 31% and in the other, 9%. A corresponding increase in yield/plot was also seen in both fields. In one field, yield was 36% greater and average ear weight was 8% greater in the fumigated plots. In the other field yield was 14% greater and average ear weight 5% greater. Plant biomass was also greater at harvest in fumigated plots compared to nonfumigated (Table 2).

These results indicate that a biotic agent is indeed the major factor in root rot disease of sweet corn.

Table 2. Effects of soil fumigation on sweet corn yield parameters and disease at harvest.

	Ear Number	Plot weight (Kg)	Average ear weight (g)	Plant biomass (Kg)	Leaf firing (#)	Root necrosis (%)
Field 1						
Fumigated	46	15	332	2.2	1.0	10
Nonfumigated	32	10	304	2.0	2.2	90
	**	**	**	ns	ns	**
Field 2						
Fumigated	40	13	316	2.0	1.1	26
Nonfumigated	36	11	301	2.0	1.6	82
	**	ns	ns	ns	ns	**

** Significantly different according to Fischer's Protected LSD ($P \leq 0.05$).

Fertility/Nutrition study. Soils for the four fields were analyzed by the Central Analytical Laboratory at Oregon State University (Table 3). Plant tissue analysis will be completed soon in collaboration with Dr. Neil Christensen, Department of Crop and Soil Science, OSU. More thorough results for this study are expected in mid-winter.

Table 3. Soil analysis of fumigated and nonfumigated plots in two sweet corn fields different sampling dates.

	pH	C (%)	N (%)	P (ppm)	K (ppm)	Ca (meq/100g)	Mg (meq/100g)	NH_4-N (ppm)	NO_3-N (ppm)
Field 1									
Fumigated[a]									
Planting	5.8	3.78	0.33	42	168	4.9	1.1	38.5	79.9
1 mo post-planting								82	28
Harvest								14.3	40.1
Nonfumigated									
Planting	5.4	3.83	0.33	47	242	6.7	1.5	2	45.4
1 mo post-planting								46.6	28.6
Harvest								7.2	15
Field 2									
Fumigated									
Planting	7.1	4.2	0.34	77	101	10.6	0.7	110.3	<0.8
1 mo post-planting								68.6	55.4
Nonfumigated									
Planting	6.8	4	0.32	97	66	9	0.6	25.5	109.6
1 mo post-planting								2.9	108

[a] Plots were fumigated with methyl bromide (67%) and chloropicrin (33%) at 400 lbs/a.

Ear removal study. The removal of ears had no effect on necrosis of the rootball or number of leaves fired at harvest. Ear removal was done to reduce stress to the plant as resources are allocated to ear development and kernal fill rather than growth and host defenses. Our results suggest that the rapid increase in necrosis seen at the end of the season is not because of increased susceptibility of the plant due to stress.

Soil treatment study. Soil fungicide treatments had no effect on percent necrosis of the rootball at any of the three sampling dates, or on leaf firing and yield at harvest. Lesions were seen in all plots in all fields at 4 wks and percent necrosis of the rootball varied from 40-80% across treatments at 10 wks. Recovery of *Fusarium* from corn roots was not effected by any of the soil treatments ($p>0.05$). The recovery of *Pythium* was reduced in all of the Ridomil

Gold treated plots for all three fields (Table 4). This is similar to our results from the 1998 soil treatment study and again suggests that the *Pythia* are not the primary factor in root rot development.

Table 4: Effect of soil treatment on the recovery of *Pythium* over time from sweet corn roots.

	Percent recovery*		
	4 wk	7 wk	10 wk
Field 1			
Control	10	20	12
Ridomil Gold	0	0	0
	ns	ns	**
Field 2			
Control	4	28	54
Ridomil Gold	2	2	20
	ns	**	ns
Field 3			
Control	20	38	14
Ridomil Gold	0	0	4
	**	**	ns

*Percent of 50 root pieces per treatment colonized by *Pythium*

**Significantly different according to Fischer's Protected LSD ($P \leq 0.05$)