A Surveillance of Horseradish Diseases in Illinois in 2000

M. Babadoost [1]
Department of Crop Sciences, University of Illinois, Urbana, IL 61801
Email: babadoos@uiuc.edu

Introduction

Illinois ranks first in horseradish production among the states. Approximately 50% of total commercial horseradish in the Unites States is produced in Illinois. In September 2002, a survey was conducted to assess the incidence and severity of diseases in horseradish fields in the Mississippi River valley in southwest Illinois, the major horseradish producing area in the state.

Materials and Methods

In September 2000, nine horseradish fields in the Mississippi River valley area were surveyed for the incidence and severity of diseases (Table 1). The fields were selected based on the location, crop history, and crop variety. In each field, 10 locations were selected by walking across the longest diagonal of the field. At each location, the incidence and severity of diseases on the foliage and roots were assessed in an area approximately 36 sq ft. Foliage diseases were identified based on the disease symptoms, which turnip mosaic, Alternaria leaf spot, Cercospora leaf spot, leaf blight, and brittle root blight. The incidence of diseases was determined as percent of the plants or leaves with disease symptoms and severity of disease was assessed as percent leaf area affected. Severity of disease was rated using a scale of 0-3, where 0=no symptoms, 1=1-10, 2=11-50, and 3=more than 50% of leaf area diseased. Also, at each location, five plants were dug up and the incidence of brittle root and discoloration in various parts of the root was determined. Leaves and roots were collected for examination in the laboratory. The samples were kept in a cooler during transportation. The collected leaves were examined in the laboratory for symptoms of the diseases and signs of the pathogens, using a dissecting scope and a compound microscope. The roots were washed under tap water, blotted dry, and sectioned for observation of discoloration symptoms. The sections were surface-sterilized by soaking in 5.25% NaClO (100% commercial bleach) solution for 1 min, followed by soaking in 70% ethanol for 1 min. Each surface-sterilized section was then rinsed in sterile-distilled water three times. The section was blotted with sterilized paper and cut in a sterile plate into pieces, each approximately 3-5 mm thick. The pieces were placed on acidified potato dextrose agar (PDA-LA) in Petri plates and incubated at 18-20°C in darkness. The plates were examined after 2, 3, and 4 weeks and growing microorganisms were identified. The growing fungal and bacterial colonies were transferred onto PDA-LA and nutrient agar (NA), respectively, for further studies. The culture plates were incubated at 18-20°C.

Results

Turnip mosaic (TM), caused by turnip mosaic virus, Alternaria leaf spot, caused by *Alternaria brassicae*, Cercospora leaf spot, caused by a *Cercospora armoraciae*, brittle root, caused by *Spiroplasma citri*, leaf blight, root rot, and root discoloration were observed in all of the nine fields surveyed (Table 1). The rates of disease severity of TM on the leaves ranged from 8.5 to 24.5% (aver. 16.4%). Severity of Alternaria and Cercospora leaf spots was evaluated together because it was difficult to accurately identify these diseases from each other in the field. The rates of severity of these diseases ranged from 3 to 18.5% (aver. 9.6%). Leaf blight, which occurred mostly in older leaves, was caused by TM, Alternaria leaf spot, Cercospora leaf spot, and/or leaf senescence. The incidence of leaf blight ranged from 3 to 27.5% (aver. 11.9%). Brittle root was observed in seven out of nine fields. This disease caused complete foliage blight of the infected plants. The incidence of brittle root averaged 8%.

Root rot was observed in five of the fields surveyed. The incidence of root rot in these fields ranged from 4 to 40%. Root discoloration was observed in all parts of the roots (Table 2). However, discoloration was the most common in vascular bundles, as peppered discoloration, and in the core area. Discoloration was also observed in the cortex area, which was mostly accompanied with rot from the root surface inward. The incidence of root discoloration ranged from 0 to 52% (aver. 24%) for peppered roots, and from 0 to 14% (aver. 4.4%) for core discoloration (Table 3). The incidence of cortex discoloration ranged from 2 to 28% (aver. 11.6%).

Verticillium dahliae, *V. longisporum*, *Fusarium* species, unknown non-sporulating fungi, and bacteria were isolated from the discolored roots, as well as from the roots with no obvious symptoms (Table 3 and Fig. 1). *Verticillium* species and bacteria were isolated from the samples collected from all of the fields surveyed. *V. dahliae* was isolated from 15, 41, 33, and 7% of the roots with no discoloration, peppered discoloration, core discoloration, and cortex rot, respectively. Likewise, *V. longisporum* was isolated from 11, 32, 28, and 10% of the roots with no discoloration, peppered discoloration, core discoloration, and cortex rot, respectively. *Fusarium* species were identified in 7, 18, 22, and 28% of roots with no symptoms, peppered discoloration, core discoloration, and cortex discoloration, respectively. Bacteria (of unknown species) were present in most of the culture plates.

Table 1. Occurrence of disease in horseradish fields in Illinois in 2000[1].

Field	Variety	Soil fumi-gation	Crop rotation[2]				Disease incidence and severity (%)[3]									
			1997	1998	1999	2000	Turnip mosaic (sev.)	Alternaria leaf spot (sev.)	Cercospora leaf spot (sev.)	Leaf blight (inc.)	Brittle blight (inc.)	Brittle root (inc.)	Root rot (inc.)	Peppered root (inc.)	Core discolor (inc.)	Cortex discolor (inc.)
2000-1	1069	N	FC	SB	FC	HR	26.0	18.5	18.5	27.5	40.0	10.0	32.0	8.0	14.0	8.0
2000-2	1069	N	HR	SB	FC	HR	15.0	10.0	10.0	10.0	4.0	4.0	6.0	52.0	10.0	28.0
2000-3	1573	Y	HR	FC	FC	HR	17.5	6.0	6.0	8.0	6.0	12.0	4.0	12.0	6.0	14.0
2000-4[4]	1573	N	FC	FC	SB	HR	12.5	13.5	13.5	11.5	10.0	10.0	0.0	24.0	0.0	2.0
2000-5[4]	1573	N	SB	FC	FC	HR	19.5	14.5	14.5	9.0	8.0	8.0	0.0	8.0	2.0	22.0
2000-6	Jersey	N	HR	HR	FC	HR	8.5	5.5	5.5	15.5	8.0	14.0	10.0	28.0	0.0	14.0
2000-7	1590	N	HR	FC	SB	HR	24.5	4.5	4.5	12.5	0.0	0.0	40.0	34.0	4.0	8.0
2000-8	Eastern	N	SB	FC	SB	HR	10.5	10.5	10.5	10.5	14.0	14.0	0.0	0.0	4.0	2.0
2000-9[5]	647	N	HR	SC	MP	HR	13.5	3.0	3.0	3.0	0.0	0.0	0.0	50.0	0.0	6.0
Average							16.4	9.6	9.6	11.9	10.0	8.0	10.2	24.0	4.4	11.6

[1] Results of a field survey conducted in September 2000.
[2] FC=field corn, SC=sweet corn, SB=soybean, HR=horseradish, MP=melon and pepper.
[3] Inc.=incidence, percent plants affected; Sev.=severity, percent leaf or root area affected.
[4] Never previously planted to horseradish.
[5] Gypsum applied in fall 1999.

Table 2: Microorganisms isolated from horseradish roots collected from fields in September 2000.

Field	Root symptom	Roots tested (no)	Microorganisms isolated*					
			Verticillium dahliae	*Verticillium longisporum*	*Fusarium* species	Other fungi	Bacteria	None
2000-1	No symptoms	2	2	1	0	0	1	0
	Peppered discoloration	5	2	2	0	0	5	0
	Core discoloration	2	0	1	1	0	1	0
	Cortex rot	2	0	0	1	0	1	0
2000-2	No symptoms	4	0	0	1	0	2	1
	Peppered discoloration	5	5	1	2	0	2	0
	Core discoloration	5	4	0	1	0	4	0
	Cortex rot	5	2	0	3	2	3	0
2000-3	Peppered discoloration	2	0	0	0	0	2	0
	Cortex rot	4	0	0	1	1	4	0
2000-4	No symptoms	5	1	1	0	0	2	2
	Peppered discoloration	2	0	1	1	0	0	0
	Cortex rot	3	0	2	1	0	1	0
2000-5	No symptoms	5	0	1	0	1	5	0
	Peppered discoloration	5	3	1	1	1	5	0
	Core discoloration	3	2	0	0	1	3	0
	Cortex rot	2	0	0	1	0	2	0
	Brittle root	3	2	0	3	3	3	0
2000-6	No symptoms	3	0	0	0	0	2	1
	Peppered discoloration	6	1	5	0	0	2	0
	Core discoloration	3	0	2	0	2	1	0
	Cortex rot	1	0	0	0	0	0	1
2000-7	No symptoms	2	0	0	0	0	2	0
	Peppered discoloration	4	0	1	0	0	3	0
	Cortex rot	5	0	0	1	1	3	1
2000-8	No symptoms	1	0	0	0	0	1	0
	Core discoloration	2	0	0	0	0	0	2
	Cortex rot	5	0	1	0	0	3	2
2000-9	No symptoms	5	1	0	1	1	3	0
	Peppered discoloration	5	3	0	2	3	4	0
	Core discoloration	3	0	2	2	1	0	0
	Cortex rot	2	0	0	0	1	1	0

* Two or more organisms were isolated from some samples.

Table 3: Relationship between microorganisms isolated from horseradish roots and root symptoms.

Root symptom	Roots tested (no.)	Microorganisms isolated*					
		Verticillium dahliae	*Verticillium longisporum*	*Fusarium* species	Other fungi	Bacteria	None
No symptoms	27	4	3	2	2	18	4
Peppered discoloration	34	14	11	6	4	23	0
Core discoloration	18	6	5	4	4	9	2
Cortex rot	29	2	3	8	5	18	0
Brittle root	3	2	0	3	3	3	0

* Two or more organisms were isolated from some samples.

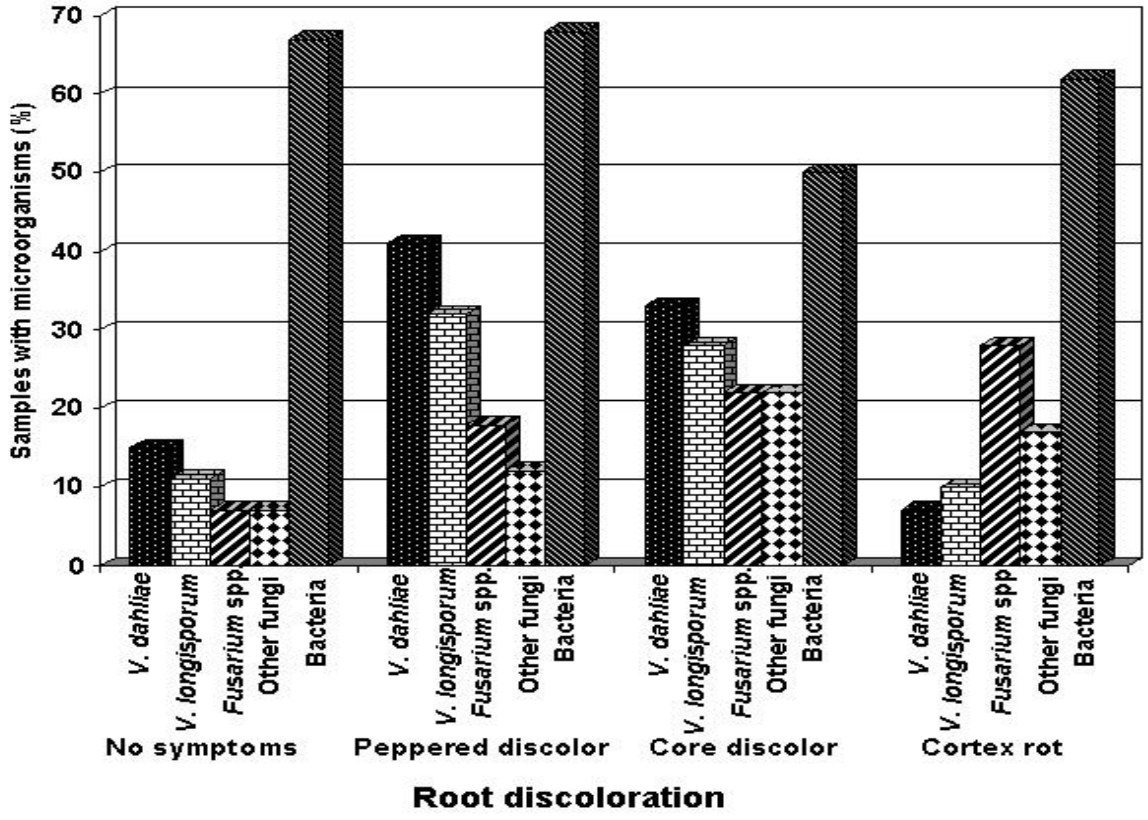

Figure 1. Microorganisms isolated from horseradish roots in 2000.

Conclusions

1. This is the first report of isolation of *V. longisporum* from horseradish roots. This fungus has already been found pathogenic in some other cruciferous plants (e.g., cabbage and cauliflower). We believe that *V. longisporum* has long been associated with horseradish roots, but has until now gone unnoticed.

2. Peppered discoloration, core discoloration, and cortex discoloration with rot were the most common forms of discolorations in the roots.

3. *V. dahliae* and/or *V. longisporum* were isolated from most of the roots with peppered discoloration and those with a discolored core.

4. *V. dahliae* has already been reported to cause root discoloration in horseradish. Involvement of other isolated microorganisms (*V. longisporum*, *Fusarium* species, non-sporulating fungi, and bacteria) in causing root discoloration can only be determined by conducting the appropriate pathogenicity tests.

5. Root discoloration was observed in the fumigated field, as well as in the field treated with gypsum. Thus, it appears that soil fumigation or application of gypsum into the soil are not effective treatments to prevent occurrence of root discoloration.

6. *V. dahliae*, *V. longisporum*, *Fusarium* species, non-sporulating fungi, and bacteria were found in 15, 11, 7, 7, and 67%, respectively, of the roots which exhibited no visible discoloration. Also, root discoloration was observed in the field with no horseradish history and where horseradish sets with no visible discoloration had been planted. These findings indicate that apparently healthy-looking roots may not be pathogen-free sets for planting.

7. Turnip mosaic, Alternaria leaf spot, Cercospora leaf spot, and leaf blight were observed in all of the fields surveyed. These diseases may significantly reduce yield and quality of the crop. Additional studies are needed to ascertain the impact of these foliar diseases, and if the control measures are economically warranted.

8. Further studies on etiology and epidemiology of horseradish root discoloration are needed. Development of resistant horseradish cultivars to the root discoloration should be emphasized. In the meantime, other approaches (such as use of chemicals and heat-treatment) for developing effective methods for control of the disease should be studied. Reliable methods for evaluation of resistance of horseradishes to the various root discolorations are needed. Annual field surveys, for at least three years, to assess the incidence and severity of diseases in the fields would provide valuable information for disease management strategies.

Acknowledgements

This study was partially funded by the Association of Horseradish Growers of Illinois and the University of Illinois at Urbana-Champaign. The authors thank the horseradish growers of Illinois for their participation in the field surveys and providing the field information.