

Studies on Discoloration of Horseradish Roots of 1999

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Introduction

Over the past 20 years, the horseradish growers in Illinois have experienced internal discoloration in horseradish roots and a significant reduction in the marketable yields. Based on previous studies, *Verticillium dahliae* is considered to be the main causal agent of the horseradish root discoloration in Illinois. However, other investigators reported that horseradish root discoloration is a complex problem and, in addition to *V. dahliae*, other microorganisms may be involved in this complex. The main objective of this study was to determine the microorganisms associated with discolored roots of horseradishes in Illinois.

Materials and Methods

During March 2000, root samples of nine different horseradish cultivars, grown in 31 fields in the Mississippi River valley near East St. Louis and Decatur in 1999, were collected and evaluated for root discoloration (Table 1). The roots were kept at 4° C during the processing. Three to six roots (each root representing one plant) from each field were evaluated for the incidence and severity of discoloration. The roots were washed under tap water, blotted dry, and sectioned at five different places and rated for severity of symptoms. The main root symptoms observed were peppered discoloration, hollow root, and rot. Peppered discoloration was rated as slight = 1-10, moderate = 11-50, and severe = more than 50% of the root in cross section with peppered discoloration.

Root sections, 5 cm long, were cut and peeled. 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 and Discussions

Roots from 14 fields had no obvious symptoms while roots from 17 fields were found with symptoms. Peppered discoloration, hollow, and rot symptoms were observed in the roots from 13, 11, and 4 fields, respectively. Of 133 roots examined, 89 (67%) roots had no obvious symptoms. With the rest (33%) exhibiting peppered discoloration, with or without, hollow (21%) and rot (6%) symptoms (Table 1). *Verticillium* and *Fusarium* species were isolated from

the roots from 55 and 52% of the fields, respectively (Table 2). Other fungi and bacteria growing on the root pieces were also subcultured onto PDA-LA and NA. Overall, *Verticillium* species, *Fusarium* species, all non-sporulating fungi combined, and bacteria were present in 30, 23, 38, and 82% of the roots studied, respectively (Table 3). *Verticillium*, *Fusarium*, non-sporulating fungi, and bacteria were found in the roots with symptoms, as well as in the roots without obvious symptoms (Table 4).

The results of the examination of the roots indicated that root discoloration can occur in any part of the root (e.g., the core section, vascular bundles, or cortex). Although *V. dahliae* has been reported to be one of the major causal agents of peppered discoloration in horseradish root, there is no established definite relationship between root symptoms and the pathogen(s) involved. Since *Verticillium* species, *Fusarium* species, non-sporulating fungi, and bacteria were found prevalent in horseradish roots, more than one pathogen may be involved in causing the root discoloration. Involvement of any of these organisms on causing the root discoloration can only be determined by conducting the appropriate pathogenicity tests.

Table 1. Symptoms observed on horseradish roots collected from storages in 1999*.

Variety	Fields (no)	Roots tested (no)	Symptoms					Hollow root	Rot
			None	Peppered discoloration**					
				Slight	Moderate	Severe			
1573	13	58	36	9	9	4	6	1	
1590	6	30	24	5	0	1	12	3	
1038	4	13	12	1	0	0	0	0	
1722	2	13	3	6	2	2	5	1	
647	2	7	4	3	0	0	0	3	
1635	1	3	2	0	0	1	3	0	
1069	1	3	2	1	0	0	0	0	
1005	1	3	3	0	0	0	1	0	
Poag	1	3	3	0	0	0	1	0	
Total	31	133	89	25	11	8	28	8	

* Some roots had more than one kind of symptom.

** Slight=1-10, moderate=11-50, and severe=more than 50% root with peppered discoloration.

Table 2. Microorganisms isolated from horseradish roots grown in different fields in 1999.

Variety	Fields (no)	Microorganisms isolated*				
		<i>Verticillium</i> species	<i>Fusarium</i> species	Other fungi	Bacteria	None
1573	13	6	6	10	13	0
1590	6	2	1	4	5	3
1038	4	2	1	4	4	0
1722	2	2	2	2	2	0
647	2	2	2	2	2	0
1635	1	1	1	1	1	0
1069	1	1	1	0	1	0
1005	1	1	1	1	1	0
Poag	1	1	1	1	1	0
Total	31	17	16	25	30	3

* Two or more organisms were isolated from some samples.

Table 3. Microorganisms isolated from roots of different horseradish varieties grown in 1999.

Variety	Roots tested (no)	Microorganisms isolated*				
		<i>Verticillium</i> species	<i>Fusarium</i> species	Other fungi	Bacteria	None
1573	58	11	9	17	46	0
1590	30	3	2	8	21	10
1038	13	2	2	4	10	0
1722	13	11	4	12	13	0
647	7	2	4	2	7	0
1635	3	3	3	2	3	0
1069	3	2	2	0	3	0
1005	3	3	2	3	3	0
Poag	3	3	2	3	3	0
Total	133	40	30	51	109	10

* Two or more organisms were isolated from some samples.

Table 4. Microorganisms isolated from horseradish roots with various symptoms in 1999.

Root Symptoms	Roots tested (no)	Microorganisms isolated*				
		<i>Verticillium</i> species	<i>Fusarium</i> species	Other fungi	Bacteria	None
None	89	14	13	33	66	12
Peppered discoloration	44	21	14	15	40	0
Hollow root	28	13	9	14	26	0
Rotted root	8	4	5	3	8	0

* Two or more organisms were isolated from some samples.

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 providing the horseradish roots and the field information.