

Severe Outbreaks of *Verticillium* Wilt on *Cichorium intybus* and *Brassica rapa* and Pathogenic Variations Among Isolates of *Verticillium dahliae*

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ABSTRACT

Cicarese, F., Frisullo, S., and Cirulli, M. 1987. Severe outbreaks of *Verticillium* wilt on *Cichorium intybus* and *Brassica rapa* and pathogenic variations among isolates of *Verticillium dahliae*. *Plant Disease* 71:1144-1145.

Severe attacks on chicory (*Cichorium intybus*) and broccoli raab (*Brassica rapa*) caused by *Verticillium dahliae* have been observed in southern Italy. The symptomatology of diseased plants of both vegetable species have many traits in common. Infected plants showed stunted growth as well as yellowing and drying of lower leaves. Pathogenicity tests were carried out on various herbaceous plants with isolates of *V. dahliae* from chicory (Vd-CL and Vd-CT). Broccoli raab was susceptible to all isolates of *V. dahliae* tested, whereas Italian cultivars of chicory were susceptible to their homologous isolates of *V. dahliae* but immune to other isolates of the fungus. Florida Market eggplant and Hale's Best melon were susceptible to all isolates, whereas Quadrato d'Asti pepper and Marketer cucumber proved to be immune to all isolates of *V. dahliae*.

The cultivation of chicory (*Cichorium intybus* L.) and broccoli raab (*Brassica rapa* L.) is prominent in many horticultural districts of southern Italy, particularly in Apulia, where in 1983, chicory was cultivated on about 5,000 ha and provided 85% of the nation's production. In this region in 1984, the production of broccoli raab reached 50% of the nation's production and included 4,400 ha.

In Apulia, crops of chicory and broccoli raab benefit from favorable climatic conditions throughout most of the year. In addition, ecotypes with diversified biological cycles, which are suited to different climatic conditions all year, have been developed by recurrent selection by local seed distributors.

During recent years, widespread alterations in cropping systems have been observed for chicory and broccoli raab in the districts of Bari and Lecce.

The symptomatology of diseased plants is similar in both vegetable species. In nature, the disease occurs as enlarging areas. Plants show stunted growth as well as a diffuse yellowing and drying of the lower leaves. On chicory, the leaves often grow asymmetrically, tending to bend toward the yellowed side. On the other hand, the deformation of leaves is less frequent and pronounced on broccoli raab; the yellowing and withering extend over most the leaf up to the margin and

precede defoliation, which usually begins with the basal leaves. Cross sections of the stems near the crowns of the two vegetable species always show a darkening of the vascular system. Laboratory isolations from the stems of diseased plants have always produced colonies of *Verticillium dahliae* Kleb.

This paper reports on the role of *V. dahliae* in the disease and the results of pathogenicity tests with isolates from

chicory and broccoli raab. We also compared the disease reactions of different vegetable species susceptible to *V. dahliae* that are used commonly in local rotations with chicory and broccoli raab.

MATERIALS AND METHODS

Pathogenicity tests were carried out in a greenhouse at 24 ± 2 C. The following isolates of *V. dahliae* were used: Vd-CL and Vd-CT from naturally infected chicory plants, Vd-RA from infected broccoli raab, and Vd-41 from diseased tomato.

These isolates of *V. dahliae* were tested on three local broccoli raab cultivars (di Marzo, di Aprile, and Fasano), on two local chicory cultivars (Galatina and Catalogna), on Hale's Best melon (*Cucumis melo* L.), on Quadrato d'Asti pepper (*Capsicum annum* L.), on Marketer cucumber (*C. sativus* L.), and on Robusta (Ve) and Super Marmande tomatoes (*Lycopersicon esculentum* Mill.).

Table 1. Results of pathogenicity tests with isolates of *Verticillium dahliae* from chicory, broccoli raab, and tomato

Tested plants	Disease index and symptoms ^a caused by <i>V. dahliae</i> isolates							
	Vd-CL (from chicory)		Vd-CT (from chicory)		Vd-RA (from broccoli)		Vd-41 (from tomato)	
	Ext. ^b	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.
Chicory								
Galatina	73	60	82	82	0	0	0	0
Catalogna	47	37	90	87	0	0	0	0
Broccoli raab								
di Marzo	35	30	22	23	68	63	65	60
di Aprile	33	33	18	18	75	70	75	72
Fasano	58	55	40	37	85	78	60	60
Eggplant								
Florida Market	87	93	90	98	85	82	97	90
Pepper								
Quadrato d'Asti	0	0	0	0	0	0	0	0
Melon								
Hale's Best	58	37	47	40	22	20	100	100
Cucumber								
Marketer	0	0	0	0	0	0	0	0
Tomato								
Robusta (Ve)	0	0	0	0	0	0	0	0
Super Marmande	0	0	0	0	23	18	97	97
Control (uninoculated plants)	0	0	0	0	0	0	0	0

Research work supported by C.N.R., Italy. Special grant I.P.R.A. Sub-project 1. Paper N. 969.

Part of this work was presented at the Fourth International Verticillium Symposium, Guelph, Canada, in 1986.

Accepted for publication 1 June 1987.

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^aThe formula used to calculate the disease indexes is $\Sigma(fv)/n \times 100$, where Σ = summation, f = frequency of a numerical rating, v = numerical rating, n = total number of tested plants, and x = maximal value of the evaluation scale (0-4, where 0 = no disease symptoms and 4 = plant with more than 75% of leaves showing symptoms or discoloration extending over 50% of vascular crown).

^bExt. = external symptoms and Int. = internal symptoms.

Test plants were inoculated at the four-leaf stage by dipping the roots in a conidial suspension 1×10^6 /ml of 10-day-old cultures of the test fungi in tap water.

Severity indices of external symptoms were calculated on a scale of 0-4, where 0 = no disease symptoms and 4 = plant with more than 75% of leaves showing symptoms. Stem discoloration indices were based on a scale of 0-4, where 0 = no stem browning and 4 = discoloration extending over 50% of the vascular crown.

RESULTS AND DISCUSSION

Results of the pathogenicity tests with isolates of *V. dahliae* from chicory, broccoli raab, and tomato are reported in Table 1.

On chicory, the two isolates of *V. dahliae* from chicory (Vd-CL and Vd-CT) reproduced the same symptoms as observed in the field. Isolates Vd-CL caused lower disease indices than isolate Vd-CT, 73 and 47% vs. 82 and 90% for external symptoms on Galatina and Catalogna chicory, respectively. Also, isolates Vd-CL and Vd-CT were highly aggressive on Florida Market eggplant, on di Marzo, di Aprile, and Fasano populations of broccoli raab, and on Hale's Best melon. The disease severity indices of external symptoms on the aforementioned vegetables ranged from

18 to 58%. The two isolates did not induce any disease symptoms on Robusta (Ve-resistant) and Super Marmande (susceptible) tomatoes, on Quadrato d'Asti pepper, and on Marketer cucumber.

The isolate Vd-RA from broccoli raab caused severe symptoms on homologous hosts (external disease indices of 68, 75, and 85% on di Marzo, di Aprile, and Fasano broccoli raab, respectively), and on the cultivar Florida Market eggplant; it was slightly pathogenic on Hale's Best melon and on Super Marmande tomato. On the other hosts, it did not produce any disease symptoms.

Isolate Vd-41 from tomato was highly pathogenic on Super Marmande tomato, Hale's Best melon, and Florida Market eggplant; it was less aggressive on broccoli raab, whereas it did not produce any symptoms on chicory, Quadrato d'Asti pepper, Robusta tomato, and Marketer cucumber.

This is the first report concerning economic losses caused by *Verticillium* wilt in fields of broccoli raab. A general brief mention of plants of the genus *Brassica* infected by *Verticillium* spp. was made in Sweden (1). Natural infections by *Verticillium* spp. on *C. intybus* were reported to cause appreciable damage in Belgium (3).

The cultivars of broccoli raab and chicory used in these tests did not show

any substantial variations against their homologous isolates of *V. dahliae* because all of them were highly susceptible. In contrast, although the cultivars of broccoli raab were susceptible to all isolates tested, the chicory cultivars showed differential reactions, i.e., immune to isolates from broccoli raab and tomato but susceptible to their homologous isolates.

In other pathogenicity tests, the isolates of *V. dahliae* were highly pathogenic on melon and eggplant, whereas they caused no disease on pepper and cucumber. This further confirms that isolates of *V. dahliae* pathogenic to pepper and to a lesser extent, cucumber, occur less frequently in nature (2).

ACKNOWLEDGMENTS

The technical collaboration of M. Bottalico and N. Contursi is gratefully acknowledged. Appreciation is expressed to V. V. Bianco for providing information about the botanical nomenclature of chicory and broccoli raab and the significance of their cultivation in Italy.

LITERATURE CITED

1. Kroeker, G. 1976. *Verticillium dahliae* on *Brassica* oil seed crops in Sweden. Pages 28 and 29 in: Int. *Verticillium* Symp. 2nd. Univ. Calif. Berkeley.
2. Matta, A., Cirulli, M., D'Ercole, N., and Ciccarese, F. 1980. Indagini sulla specializzazione fisiologica di *Verticillium dahliae* Kleb. in Italia. Inf. Fitopatol. 11-12:5-11.
3. Vandervalle, R., and Parmeter, G. 1951. Una malattia de la Chicory (*Cichorium intybus* L.) caused by *Verticillium dahliae* Kleb. Parasitica 7:69-76.