

A new aggressive strain of *Verticillium albo-atrum* in *Verticillium* resistant cultivars of tomato in the Netherlands

S.J. PATERNOTTE¹ and H.A. VAN KESTEREN²

¹ Glasshouse Crops Research Station, P.O. Box 8, 2670 AA Naaldwijk, the Netherlands

² Plant Protection Service, P.O. Box 9102, 6700 HC Wageningen, the Netherlands

Accepted 19 January 1993

Abstract

In 1991 serious losses caused by *Verticillium* wilt were found on two holdings in the Westland glasshouse district in the Netherlands in which the *Verticillium* resistant tomato cultivars Calypso and Criterium were grown in soilless systems. Isolates from diseased plants were identified as *Verticillium albo-atrum*.

In inoculation experiments *Verticillium* resistant tomato cultivars were seriously affected by the new isolates but not by a control isolate. Moneydor, a susceptible cultivar without the Ve gene, was the most seriously diseased by all isolates.

The isolates from the *Verticillium* resistant tomato cultivars were less virulent on the susceptible cultivar than the control isolate.

Additional keywords: *Lycopersicon esculentum*, resistance.

Verticillium wilt in glasshouse tomatoes, caused by *Verticillium albo-atrum* Reinke & Berth. and *V. dahliae* Kleb., was a common disease in the Netherlands till *Verticillium* resistant cultivars were introduced in 1975.

Losses caused by *V. albo-atrum* in resistant cultivars have been reported in Ohio (Alexander, 1962). By inoculation experiments Pegg and Dixon were able to demonstrate resistance to *V. albo-atrum*, although it varied with inoculum level and pathogen isolate from different hosts: tomato and hop (Pegg and Dixon, 1969).

In 1991 serious losses caused by *V. albo-atrum* were found on two holdings in the Westland glasshouse district where the *Verticillium* resistant cultivars Calypso and Criterium were grown. Isolates obtained from diseased plants were identified as *V. albo-atrum* Reinke & Berth. by the Centraal Bureau voor Schimmelcultures in Baarn, the Netherlands.

In inoculation experiments one isolate from each of these holdings was compared with an isolate that only affects cultivars without the *Verticillium* resistance Ve gene.

The root systems of 14-day-old seedlings were dipped in a spore suspension with 10^6 – 10^7 spores per ml, obtained from a filtered, 1-week-old culture of the isolates in liquid Czapek Dox medium. Seedlings were planted in a commercial potting mix. The *Verticillium* resistant cultivars Criterium, Liberto and Vanessa and the susceptible cultivar Moneydor were used. The temperature in the glasshouse was 20–24 °C.

Symptoms were visible 14 days after inoculation. Leaves of the plants cv. Moneydor were deformed and chlorotic, and the young leaves were a darker green. The most obvious symptom on the resistant cultivars inoculated with the isolates from resistant cultivars was that the plants were stunted in comparison with the control plants.

The number of plants with symptoms of *Verticillium* wilt, the length of the plants and the extent of the vascular discoloration from the cotyledons upwards were measured 3–6 weeks after inoculation. Representative data out of several experiments are given in Tables 1 and 2. The interaction between cultivars and isolates was significant for height but not for vascular browning ($P < 0.05$).

V. albo-atrum was reisolated from inoculated plants and the same disease symptoms reproduced by further inoculation. The *Verticillium* resistant tomato cultivars were more severely affected by the isolates from resistant cultivars than by the control isolate. Cv. Moneydor was seriously affected by all isolates. The control isolate was more aggressive on cv. Moneydor than the new isolates.

Verticillium wilt in *Verticillium* resistant tomato cultivars is very rare and, in 1991, was found on only two holdings in the Netherlands. No spread of the disease to other holdings was observed. Most tomatoes are grown on rockwool slabs free from soil. Mostly used rockwool is steamed or new rockwool is used each year. In spite of this and rigorous hygiene measures the disease recurred in the winter and spring of 1992 on the same holdings.

This is the first report of an aggressive strain of *V. albo-atrum* affecting Ve gene resistant cultivars of tomato outside the U.S.A. These observations with *V. albo-atrum* reflect those with *V. dahliae*. Two races of *V. dahliae* are recognized worldwide. Both races have been recorded in Crete (Ligoxigakis and Vakalounakis, 1992), France (Laterrot and Pecaut, 1966), Italy (Cirulli, 1969; Matta and Garibaldi, 1984), Greece (Tjamos, 1981), Israel (Nachmias et al., 1987), Romania (Costache and Tomescu, 1987), Morocco (Besri

Table 1. Percentage tomato plants with symptoms of *Verticillium* wilt, 3 weeks after inoculation with *Verticillium albo-atrum* (20 plants per treatment, 2 replicates).

Host cultivar	Ve gene	Untreated control	Control isolate	New isolate from cv. Calypso
Moneydor	–	0	98	85
Criterium	+	0	5	80
Liberto	+	0	10	63

Table 2. Height of tomato plants and lenght of vascular browning (in mm) 6 weeks after inoculation with *Verticillium albo-atrum* (20 plants per treatment, 2 replicates).

Host cultivar	Ve gene	Plant length			Length of vascular browning		
		Un-treated control	Control isolate	Isolate from cv. Criterium	Un-treated	Control isolate	Isolate from cv. Criterium
Moneydor	–	211	52	118	0	25	22
Criterium	+	221	186	149	0	0	4
Liberto	+	225	182	178	0	0	1
Vanessa	+	124	119	80	0	1	5

et al., 1984; Rouamba et al., 1988), Australia (O'Brien and Hutton, 1981), Japan (Kobayashi et al., 1990), U.S.A. (Grogan et al., 1979; Bender and Shoemaker, 1984; Berry and Oakes, 1987; Baergen and Hewitt, 1988) and South Africa (Ferreira et al., 1990). Also race 1 of *V. dahliae* is reported to be more aggressive on tomato than race 2 (Grogan et al., 1979; Bender and Shoemaker, 1984). The degree of colonization of susceptible plants by race 1 is greater than by race 2 (Armen and Shoemaker, 1985).

Acknowledgments

Correction of the English text by W.A. van Winden and critical reading of the manuscript by Dr J.T. Fletcher (ADAS-MAFF, Wye) is gratefully acknowledged.

References

- Alexander, L.J., 1962. Susceptibility of certain *Verticillium* resistant tomato varieties to an Ohio isolate of the pathogen. *Phytopathology* 52: 998–1000.
- Armen, J. & Shoemaker, P.B., 1985. Histopathology of resistant and susceptible tomato cultivars inoculated with *Verticillium dahliae* races 1 and 2. *Phytopathology* 75: 1361–1362.
- Baergen, K.D. & Hewitt, J.D., 1988. Evaluation of tomato genotypes for resistance to six isolates of *Verticillium dahliae* race 2. *HortScience* 23 (section 2): 767.
- Bender, C.K. & Shoemaker, P.B., 1984. Prevalence of *Verticillium* wilt of tomato and virulence of *Verticillium dahliae* race 1 and 2 isolates in western North Carolina. *Plant Disease* 68: 305–309.
- Berry, S.Z. & Oakes, G.L., 1987. Ohio 11 and 12, *Verticillium*-wilt-race-2-resistant greenhouse tomato breeding lines. *HortScience* 22: 167.
- Besri, M., Zrouri, M. & Beye, I., 1984. Pathogenicity and race classification of some isolates of *Verticillium dahliae* from resistant tomato in Morocco. *Phytopathologische Zeitschrift* 109: 289–294.
- Cirulli, M., 1969. Un isolato di *Verticillium dahliae* Kleb. virulento verso varietà resistenti di pomodoro. *Phytopathologia Mediterranea* 8: 132–136.
- Costache, M. & Tomescu, A., 1987. Research on the cucumber wilt produced by *Fusarium oxysporum* (Schlecht.) Snyder et Hansen and *Verticillium dahliae* Kleb. II. Specialization of the pathogens. *Bulletin de l'Académie des Sciences Agricoles et Forestières, Roumanie* 15: 199–204.
- Ferreira, J.F., Van der Merwe, P.C. & Naude, S.P., 1990. First report of race 2 of *Verticillium dahliae* on tomatoes in South Africa. *Plant Disease* 74: 530.
- Grogan, R.G., Ioannou, N., Schneider, R.W., Sall, M.A. & Kimble, K.A., 1979. *Verticillium* wilt on resistant tomato cultivars in California: Virulence of isolates from plants and soil and relationship of inoculum density to disease incidence. *Phytopathology* 69: 1176–1180.
- Kobayashi, M., Komoto, Y., Hagiwara, H., Yabuki, S.I. & Kuniyasu, K., 1990. Virulence of one isolate of *Verticillium dahliae* on resistant tomato cultivars. *Bulletin of the Agricultural Research Institute of Kanagawa Prefecture* 132: 35–42.
- Laterrot, H. & Pecaut, P., 1966. Proceedings of the First Congress of the Mediterranean Phytopathological Union. p. 431–433.
- Ligoxigakis, E.K. & Vakalounakis, D.J., 1992. Occurrence of race 2 of *Verticillium dahliae* on tomatoes in Crete. *Plant Pathology* 41: 774–776.
- Matta, A. & Garibaldi, A., 1984. Strains of *Verticillium dahliae* virulent on tomato hybrids with the Ve gene for resistance to race 1 in Italy. Proceedings of the 6th Congress of the Mediterranean Phytopathological Union, Cairo, Egypt. p. 283–285.
- Nachmias, A., Buchner, V., Tsror, L., Burstein, Y. & Keen, N., 1987. Differential phytotoxicity of peptides from culture fluids of *Verticillium dahliae* races 1 and 2 and their relationship to pathogenicity of the fungi on tomato. *Phytopathology* 77: 506–510.
- O'Brien, R.G. & Hutton, D.G., 1981. Identification of race 2 of *Verticillium* in tomatoes in Southeast Queensland. *Australasian Plant Pathology* 10: 56–58.
- Pegg, G.F. & Dixon, G.B., 1969. The reactions of susceptible and resistant tomato cultivars to strains of *Verticillium albo-atrum*. *Annals of Applied Biology* 63: 389–400.

- Rouamba, A., Laterrot, H. & Moretti, A., 1988. Interactions between tomato lines and *Verticillium* strains of pathotype 2. Report of the Tomato Genetics Corporation 38: 42–43.
- Tjamos, E.C., 1981. Virulence of *Verticillium dahliae* and *Verticillium albo-atrum* isolates in tomato seedlings in relation to their host of origin and applied cropping system. Phytopathology 71: 98–100.