Control of Spread of Augusta Disease Caused by Tobacco Necrosis Virus in Tulip by Composting Residual Waste of Small Bulbs, Tunics, Roots and Soil Debris

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Abstract

In this study the elimination of the infectious virus/fungus complex of tobacco necrosis virus (TNV; cause of Augusta disease in tulip) and *Olpidium brassicae* in different soil types and residual waste material of soil debris, small tulip bulbs, roots and tunics by temperature treatments of different duration is described. The infectious capacity was eliminated by a 40°C temperature treatment for eight or more weeks and at 50°C for two weeks. The incidence of 50°C in composting heaps of waste material of soil debris, tunics and roots and other bulbous remnants for at least 50 days during summer months enabled the ultimate control of spread of the disease complex if the distribution of compost over the fields is intended.

INTRODUCTION

Tobacco necrosis virus (TNV) as cause of the 'Augusta disease' named by its occurrence in cv. Queen Augusta in 1928 (De Bruyn Ouboter and van Slogteren, 1949) and spread by the soil-borne fungus *Olpidium brassicae* (Kassanis, 1979) occurs worldwide in tulips, e.g., Britain (Mowat, 1970), Denmark (Lange, 1976) and Japan (Nahata et al., 1988). In the Netherlands in the late 1980s high virus rates were frequently observed in cultivars mainly grown in heavy soil types in some regions (Asjes, 1993). In the 1990-1999 period the incidence was only occasional.

Cultivars showed little difference in susceptibility to primary infection. The recurrence of symptoms in secondarily infected cultivars differed greatly due to sensitivity and soil type of cultivation (Asjes, 1993; 1997). Late planting of bulbs in autumn applied at October 28 or later largely prevented infestation of crops (Asjes and Blom-Barnhoorn, 1996a).

In experiments the persistence in soil of the virus/fungus-disease complex covered 3-8 years so far (Asjes and Blom-Barnhoorn, 1996b). The spread of the disease complex to other fields may be caused by the distribution of residual waste of small bulbs, tunics, roots and soil debris obtained by cleaning bulbs after harvest (Asjes, 1997). In this paper data on the control of spread by composting this waste material and heat treatment of different types of soil is presented.

MATERIALS AND METHODS

Material

Virus/fungus-infested field soil and soil in wooden trays in which tulip bulbs were planted to produce cut flowers under greenhouse conditions in winter, was used as well as residual soil, soil debris, small bulbs, roots and tunics obtained by cleaning tulip bulbs after harvest. The infested material was stored in plastic bags at 5°C till experimentation. The material was obtained from different origin: 1. 'Potting soil' with a high organic matter content collected in 1993 from sets of forced tulips infested with Augusta disease (90-100 %); 2. 'Sand' with low organic matter content (*c.* 1 %) collected in 1997 from forced tulips similarly infested with Augusta disease as 1.; 3. 'Heavy loam' collected in

September 1992 from a field infested with TNV; 4. Infested waste material, mainly roots and tunics ('waste tunics') collected from two different holdings in 1997 and 1998; 5. Infested 'waste soil', mainly sand and small bulbs obtained by superficial cleaning of tulip bulbs by machine directly after harvest from one holding.

Test units of material from different origin were submitted to the different temperature treatments.

Experimentation

Different temperature regimes were applied to eliminate the infectious capacity in residual waste material and in soil. The regimes were applied in storage cells at Lisse in which temperatures were maintained at the same level from July till October. In 1997 on two experimental farms material was also stored in composting heaps from the end of August onwards.

Test units in open-framed plastic trays were planted in the first week of October with tulip bulbs of cv. Angelique (n = 20). This cultivar is highly susceptible to Augusta disease. Material of roots and tunics were mixed with sand from a TNV-free location. The trays were dug into sandy soil of a field. Trays with this field sand were also planted with tulip bulbs of 'Angelique' to check that the field was Augusta disease-free. TNV-symptoms were observed from March till June of next year.

The test units in which plants did not show TNV symptoms in 1998 were replanted with tulip bulbs in early October. This was done to determine that the elimination of infectious capacity by the treatments applied in 1997 persisted as indicated by the absence of disease symptoms after two years of cultivation of different sets of tulips.

RESULTS

Tests in Storage Cells in 1997

Table 1 shows results of temperature regimes at 20, 30 and 53°C of different duration submitted to test units in storage cells in the period July-September in 1997. Test units of source material (1-5 in Table 1) stored at 5°C till experimentation yielded 85, 95, 45, 70 and 100 % Augusta disease, respectively.

The infectious capacity was maintained at 5, 20 and 30°C. This was lost in the material stored at 53°C for 3-9 weeks. The healthy tulip bulbs in 53°C-units planted in 1998 in these trays treated in 1997 did not show symptoms of TNV in 1999.

Treatment in Composting Heaps in 1997

Infested source material of 'potting soil' (1), 'sand' (2), 'heavy loam' (3) and 'waste material of small bulbs, tunics and roots'(4) and 'soil debris' (5) in plastic trays put in the centre of composting heaps were submitted for 50 days to temperatures generally above 50°C (temperature data kindly supplied by M. Wondergem). Tulip bulbs planted in these test units in 1997 did not show symptoms of TNV in 1998 and healthy tulips planted in these units in October 1998 did not show symptoms of Augusta disease in 1999.

Tests in Storage Cells in 1998

Table 2 shows data on the effect of temperature regimes at 30, 40 and 50°C of different duration submitted to test units in storage cells in the period July-September in 1998. Test units of source material (1, 2, 4, 5 in Table 2) stored at 5°C till experimentation yielded 85, 75, 75 and 40 % Augusta disease, respectively.

The efficacy to eliminate infectious capacity was affected by temperature levels and duration of treatment. The elimination was complete by 40°C-temperature treatment for 8-10 weeks. No infectivity was observed after two weeks at 50°C.

DISCUSSION

The elimination of the infectious capacity in infested source material of different origin was attained by temperature treatment at 50°C for a short period. Under the experimental conditions the material in storage cells dried out and it was in fairly wet condition after treatment in composting heaps. The composting of waste material of bulbs, tunics, roots, and soil debris in heaps in which temperatures may vary in the centre and at the edges, will benefit during composting from the generally routinely applied removal of the material up and downwards to enhance overall temperature levels above 50°C. In this way the distribution of the remnant compost will not infest soils in fields in which the virus/fungus complex was not prevalent so far. It must be furtherly investigated whether infested soil continuously used to force tulip bulbs into flowering in the greenhouse can be disinfested by steam sterilization.

Literature Cited

Asjes, C.J. 1993. Occurrence and recurrence of symptoms of Augusta disease caused by tobacco necrosis virus in tulip. Proceedings 2nd Symposium International Working Group on Plant Viruses with Fungal Vectors, Montreal, Canada. Ed.: Dr. C. Hiruki, pp. 141-144.

Asjes, C.J. 1997. Virus in bloembollen in kaart gebracht. Bloembollencultuur 108 (4):1-50.

Asjes, C.J. and Blom-Barnhoorn, G.J. 1996a. Soil infectivity and occurrence of Augusta disease caused by Tobacco necrosis virus in tulip. Proceedings 3rd Symposium International Working Group on Plant Viruses with Fungal Vectors. Eds.: Sherwood, J.I. and Rush, C.M., Dundee, Scotland, pp. 129-132.

Asjes, C.J. and Blom-Barnhoorn, G.J. 1996b. Control of Augusta disease caused by Tobacco necrosis virus in tulip affected by culture conditions and soil disinfestation. Proceedings 3rd Symposium International Working Group on Plant Viruses with Fungal Vectors. Eds.: Sherwood, J.I. and Rush, C.M., Dundee, Scotland, pp. 125-128.

Bruyn Ouboter, M.P. de and Slogteren, E. van. 1949. Augustaziek der tulpen, een virusziekte van het tabaksnecrosetype. Tijdschrift Planteziekten 55:262-267.

Kassanis, B. 1979. Tobacco necrosis virus. CMI/AAB Descriptions Plant Viruses nr. 14:4 pp.

Lange, L. 1976. Augusta disease in tulips. Field experiments concerning tobacco necrosis virus and its vector *Olpidium brassicae*. Tidskrift Planteavl 80:153-169.

Mowat, W.P. 1970. Augusta disease in tulip – a reassessment. Annals of Applied Biology 66:17-28.

Nahata, K., Kusaba, T. and Mukobata, H. 1988. Studies on the ecology and control by tulip virus diseases. Bulletin Toyama Agricultural Research Centre 2:1/132.

Tables

Table 1. Infection of Augusta disease (TNV) in tulip cv. Angelique in 1998 treatment of source material of soils, residual waste material of small bulbs, tunics and roots, and soil debris by temperature regimes submitted in July-September 1997.

Source material	% Augusta disease storage temperature and duration in weeks								
	20°C			30°0C			53°C		
	9	6	3	9	6	3	9	6	3
1. Potting soil	80	65	85	55	70	100	0	0	0
2. Sand	100	70	70	90	85	95	0	0	0
3. Heavy loam	0	0	0	10	10	5	0	0	0
4. Waste tunics	35	30	30	40	70	10	0	0	0
5. Waste soil	80	- ')	-	95	-	-	0	-	-

') - = material for test unit was not available.

Table 2. Infection of Augusta disease (TNV) in tulip cv. Angelique in 1999 after treatment of source material of soils, residual waste material of small bulbs, tunics, roots, and soil debris by temperature regimes submitted in July-September 1998.

Source material	% Augusta disease storage temperature and duration in weeks					
	30°C					
	13	10	8	5	4	2 weeks
1. Potting soil	50	- ')	30	-	45	30
2. Sand	-	0	0	-	35	0
4. Waste tunics	35	-	5	0	35	40
5. Waste soil	45	0	0	25	-	35
	40°C					
1. Potting soil	-	0	-	15	-	-
2. Sand	0	0	-	-	40	30
4. Waste tunics	0	0	0	0	0	20
5. Waste soil	0	0	0	5	-	10
	50°C					
1. Potting soil	0	-	-	-	-	-
2. Sand	0	0	0	0	-	0
4. Waste tunics	-	0	0	0	0	0
5. Waste soil	0	0	-	0	0	0

') - = material for test unit was not available.