CONTROL OF AUGUSTA DISEASE CAUSED BY TOBACCO NECROSIS VIRUS IN TULIP AFFECTED BY CULTURE CONDITIONS AND SOIL DISINFESTATION

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Summary

The control of Augusta disease caused by the fungus *Olpidium brassicae* and tobacco necrosis virus (TNV) in tulip was studied. In early October-planted bulbs in the field high infection rates were obtained contrary to those planted at Occtober 28 or later. High rates were obtained in boxes under favourable moisture conditions kept in a store room for 14 days at 5, 9, 13 and 17°C in November and December. The mostly variable rates during forcing were considerably decreased in two treatments after late planting. Very substantial differences between cultivars were found in the recurrence of symptoms in replanted bulbs which were not evident in the primary infection. The spread of infectivity on to a field by soil remains and tunics and roots appeared in the second year after application. The soil disinfestation by cyprofuran, dazomet, etridiazool, and metalaxyl proved ineffective, or even was stimulatory on the infection. Tolclofosmethyl was considerably effective. The impact of the various factors involved in the control was discussed.

Introduction

The incidence of Augusta disease was at high rate in the late 1980s. Especially in one region on heavy soil types, whereas in the 1990s the occasional occurrence was prevalent (Asjes, 1993). The soil infectivity in its persistence and spread of the fungus/virus complex was described elsewhere (Asjes and Blom-Barnhoorn, 1997). In this paper data about control by the effect of culture conditions and soil disinfestation will be presented.

Material and methods

Trial fields. Fields previously grown with severely primarily infected tulips were used, viz., 1990-1995 on heavy soil (16.5-25.5 % lutum; indicated as 'loam'), 1990-1992: on sand (3 % lutum; 'sand'), and a second on sand in 1992-1993. The plots (1x2 m; 100-120 bulbs (10-11 cm) in 10 rows) in triplicate were flanked by paths (0.5 m).The test cultivars in loam and sand were in 1990: Don Quichotte, in 1991: Angelique, in 1992 on sand: Leen van de Mark , and in 1993 and 1994 on loam: Apeldoorn. A thermograph registered temperatures in loam and sand at 15 and 35 cm depth in 1990.

Soil infestation. In 1993 an amount of moist soil remains from severely infected forced tulips was mixed in loam at 0-15 cm and 0-30 cm depth before planting. Previously the plots were practically free from Augusta disease (0-1 %) in 1991 and 1992.

Soil disinfestation. The chemicals were 1. cyprofuran in Tubosan (20% powder) at normal dosis of 30 g/m^2; 2. dazomet in Basamid (100% powder; normal dosis 20 g/m^2); 3. etridiazool in AAterra (liquid; 700 g/l; normal dosis 4 ml/m^2), 4. metalaxyl in Ridomil (5G; powder; normal dosis 20 g/m^2), and 5. tolcolfosmethyl in Rizolex (powder 50%; normal dosis 10 g/m^2). The amounts were either spread with sand, or with water (2 l) and mixed through the soil at 0-15 and 0-30 cm depth before planting.

Box trials. PVC-like boxes described elsewhere (Asjes and Blom-Barnhoorn, 1997) were filled with infested field sand stored before at 5°C in plastic bags and planted with bulbs (2 x 20), furtherly kept at, 5, 9, 13 and 17°C for 14 days with sprinkling and then brought to the field. Forcing trials were also done in these boxes.

Results

Planting date in the field

In 1990 tulips planted on different dates in loam and sand were infected, respectively, in cv. Angelique (Oct. 7): 35 and 68%, (Oct.31): 0.3 and 3 %, and (Nov.21): 0 and 0%; in cv. Christmas Marvel (Oct. 7): 42 and 46%, (Oct.31): 0.7 and 0.5% and (Nov.21): 0 and 0 %; and in cv. Don Quichotte (Oct.7): 0.3 and 4%, (Oct.31): 0.7 and 0.5% and (Nov.21): 1.3 and 0%. Symptoms mostly in dwarfed plants were most severe after the October 7 planting. The data indicated that planting dates strongly affected the infection rates in cvs. Angelique and Christmas Marvel. Soil temperatures with daily fluctuations were in October ca. 15°C at 15 cm and ca. 13°C at 35 cm depth. In November and December temperatures went down to ca. 9-7°C and 8-1°C at 15 cm, and 10-8°C and 8-3°C at 35 cm, respectively.

Planting in boxes in storage rooms

In 1990 trials with cv. Angelique started on October 24 rated 85, 100, 100, and 100% infection, if the boxes were kept at 5, 9, 13, and 17°C, respectively. In cv. Christmas Marvel started on November 20 these rates were 85, 95, 95, and 90%. In 1991 in cv. Angelique in a trial at 5, 9, and 17°C started on December 15 the rates were on soil 1: 11, 16, and 54%, on soil 2: 0, 25, and 11%, and on soil 3: 17, 12, and 93%, respectively. The data indicate that tulips were infected under favourable moisture conditions at different temperatures late in November and December.

Forcing to flower in the greenhouse in winter

In 1990 81 secondarily infected lots of 23 cultivars showed symptoms rather more affected by the sensitivity of cultivars than by the treatments subjected to bulbs to induce flowering in late January and March (Asjes 1993). In 1991 47 and 14% infection was observed after the forcing (20°C till planting in boxes followed by 17 weeks at 9°C) of secondarily infected cv. Angelique planted on October 7 and November 4, respectively. In the growers' forcing primary infection more often occur in early October-plantings than later on. Severe infection may occur in some series of forced tulips and not in others, notwithstanding the planting in similarly infested soil (Asjes and Blom-Barnhoorn, 1997).

Primary susceptibility and recurrence of secondary symptoms

In box trials four of 35 cultivars, viz., Arma, Lustige Witwe, Prinses Irene and Roccoco, did not become infected. In samples from field lots (50-90% infection) nine cultivars, e.g., Angelique, Apricot Beauty, Arie Alkemade's Memory, etc., proved most sensitive during the forcing and culture on sand by the recurrence of symptoms up to one third of the primary rates, whereas on loam this was near to the previous field rate. In little sensitive cultivars these rates were 0-5% and 10-25%, respectively. The sensitive cultivars rated in between. The data indicate that primary high rates were not similar to those found in the forcing and culture in sand, and in loam more proportionate in the most sensitive cultivars.

Spread of infectivity by soil and tunics and roots debris

The infectivity of soil from the rinsing of bulbs after lifting, especially from heavy soil, and of debris of soil, tunics and roots from the cleaning of bulbs, and of soil remains from the forcing of bulbs was earlier indicated (Asjes and Blom-Barnhoorn, 1997).

In 1994 humid soil remains was spread over the soil surface and mixed with the loam at different depths. In 1995 in cv. Apeldoorn no symptoms of infection were observed. In box trials with soil sampled from these three plots per treatment in July 1995 rates of infection obtained in 1996 in cv. Apeldoorn were: 0-3 cm: 25% (12-40%), 0-15 cm: 71% (52-82%), and 0-30 cm: 48% (25-78%). In 16 samples from plots with high infection rates in 1991 and 1992 the average rate in 1996 was 9% (0-38%). So the effect of soil infestation in 1994 was indicated in 1996, while the original infestivity of soil observed in 1991 and 1992 had been decreased considerably.

Soil disinfestation

Soil disinfestation was done in loam with cyprofuran, dazomet, etridiazool and tolclofos-methyl with the following results: 1990 (October 7); 1. dazomet; 0-15 cm depth: 0 g/m^2: 14; 10 g/m^2: 45, 20 g/m^2: 18, and 30 g/m^2: 1%; 0-30 cm: 10 g/m^2: 53, 20 g/m^2: 52, and 30 g/m^2: 1%; 2. cyprofuran; 0-15 cm depth; 30 g/m^2: 35%; 3. metalaxyl; 0-15 cm depth; 10 g/m^2: 17%. The data indicate that dazomet gave control in two and the infection was increased in three treatments. Cyprofuran gave an increased rate of infection.

1991 (October 7); dazomet; 0-15 and 0-30 cm depth; 0 g/m^2: 20 and 15%; 20 g/m^2: 36 and 31%; 40 g/m^2: 46 and 28%; 60 g/m^2: 22 and 31%, and 80 g/m^2: 36 and 9%. The October 28-treatments rated 1% (0-2%). The October 7-treatments indicated the increased incidence after the use of dazomet.

1991 (October 7); etridiazool; 0-15 and 0-30 depth; 0 ml/m^2: 6 and 25%; 4 ml/m^2: 16 and 1%; 8 ml/m^2: 11 and 4%; 16 ml/m^2: 6 and 11%. The data indicate variable control.

1991 (October 7); tolcofosmethyl; 0-15 and 0-30 cm depth; 0 g/m^2: 15 and 13%; 10 g/m^2: 5 and 1%; 20 g/m^2: 2 and 5%; 40 g/m^2: 5 and 2%. The data indicate considerable control. The October 28-treatments of both compounds rated 0 and 0% (0-1%).

In sandy soil treatments were applied in 1992 as follows:

1. etridiazool; October 7; 0-15 and 0-30 cm depth; 4 ml/m^2: 9 and 12%; 8 ml/m^2: 6 and 11%, and 16 ml/m^2: 1 and 3%. The treatments with four times the normal dosis of 4 ml/m^2 was effective and comparable with other non-treated parts of the field. October 28-treatments gave average infection of 0 and 0.3%;
2. metalaxyl; October 7; 0-15 and 0-30 cm depth; 10 g/m^2: 8 and 28%; and 20 g/m^2: 18 and 13%; October 28: average 1.1% (0-2%). The data indicate increase of infection if applied on October 7;
3. tolclofosmethyl; October 7; 0-15 and 0-30 cm depth; 10 g/m^2: 1 and 4%; and 20 g/m^2: 0 and 1%; October 28: 0, 2, 1 and 0%. The data indicate very substantial control of Augusta disease.

The data of all years indicate that the control by tolclofosmethyl was effective, whereas dazomet, cyprofuran, etridiazool, and metalaxyl mostly were not, or even stimulated the infection. The planting at October 28 proved the most effective in the control.

Discussion

The very low rate of infection after late planting at the end of October confirmed earlier data (Van Slogteren, 1963). This may be due to the prevalent soil temperature near to 15°C in October at which the optimal release of fungal zoospores of *Olpidium brassicae* occurs (Nahata et al., 1988). However, the increase of inoculum potential from infested soil by favourable moisture conditions largely overcame the control by late planting. Symptomless plants, possibly because of underdeveloped infection throughout the whole plants, especially after late planting, may show up in the next season in replanted progeny bulbs in heavy soil, particularly if the most sensitve cultivars are grown (Asjes, 1993; Nahata et al., 1988).

The spread of infectivity in remnants with the disease complex obtained from water mixed with hightly infestive loam or debris of soil, tunics and roots, which was stuck to healthy bulbs of four susceptible cultivars failed to infect any bulb grown in loam afterwards. The soil infectivity apparently decreased in 1993 when the trial field laid fallow. The infectivity introduced into the soil did not become evident in the following season, which may be due to the incomprehensible build-up of inoculum potential. Activities of loosening the soil, the depth of planting except shallow (5-10 cm), the relative compaction, the excessive wetting of soil, or the prevention of water influx on top of the soil for weeks, were not in any way indicative in this process (Asjes, unpublished results).

Soil disinfestation treatments may be subject to the more or less prominent patchy occurrence of variable infestive soil. Nevertheless most chemicals showed no control, or rather stimulation of infection, which is contrary to earlier reports on substantial control by dazomet (Van Slogteren, 1970) and metalaxyl (Nahata et al., 1988). So far the most effective control in the field will be by late planting, while tolclofosmethyl is applicable if it is necessary to plant early, and in pot soil used for forcing, especially if the most sensitive cultivars are grown.

References

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