Effect of polythene Tunnels and Cultivars on Grey Mould Caused by *Botrytis cinerea* in Organically Grown Strawberries

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Summary

The effect of covering the crop with polythene tunnels on *Botrytis* fruit rot was investigated. Two cultivars were grown organically in three field experiments during 2001-2003.

Botrytis cinerea is a major threat to strawberry cultivation in the field, especially when the crop is grown organically. Control of the disease in organic strawberry crops depends merely on prevention. *Botrytis* infection risk depends on humidity and temperature. Under optimal temperature conditions leaf wetness period necessary for infection of strawberry flowers decreases (Bulger *et al*., 1997). Prevention or shortening of the leaf wetness period might help to reduce infection risk of strawberries.

Cv. Elsanta proved less susceptible to *B. cinerea* than cv. Darselect, thus choosing an appropriate cultivar is a helpful means to control grey mould. Covering the crop with polythene tunnels effectively reduced the infection risk of *B. cinerea* on strawberry flowers. Mechanisms to regulate the temperature in the tunnel are necessary to ensure fruit quality and should be investigated further.

Key words

Fragaria x ananassa Duch., cultural control, infection risk

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Introduction

A majority of strawberries grown in the Netherlands are June bearing and grown annually. Usually cold stored waiting bed plants are planted in spring, sometimes runner plants are planted in August. Production period varies from May to August.

Grey mould caused by *Botrytis cinerea* is a major threat to strawberry cultivation in the field. No control of grey mould is necessary in strawberry cultivation in glasshouses. In conventional strawberry growing, under field conditions several spray applications with fungicides are necessary. Possibilities to control grey mould in organically grown strawberries are limited to cultural control measures aiming at reducing inoculum production and decreasing infection risks. Fruit sanitation had no effect on grey mould incidence (Mertely *et al*., 2000). Leaf sanitation had a slight effect on *Botrytis* fruit rot in a perennial growing system (Mertely *et al*., 2000) but not in an annual growing system (Boff *et al*., 2001). The risk of infection of the flowers by *B. cinerea* depends on temperature and humidity (Bulger *et al*., 1997). At the optimum temperature short periods of leaf wetness are enough for the fungus to infect flowers. At sub-optimal temperatures prolonged leaf wetness periods are necessary for the fungus to infect strawberries. Xiao *et al*. (2001) showed that large polythene tunnels effectively controlled *Botrytis* fruit rot in strawberries.

The aim of our research was to decrease the infection chance by *B. cinerea*, by limiting the leaf wetness period and thus lowering the infection risk. It was assumed that covering the crop with small polythene tunnels would lessen fruit rot incidence under Netherlands circumstances. The susceptibility of two cultivars, Elsanta and Darselect, to *Botrytis* fruit rot was assessed.

Materials and methods

Crop cultivation

Three field experiments were carried out at Horst-Meterik in the southeast of the Netherlands. The experimental site was situated on a sandy soil with 2% organic matter. Strawberry runners were planted on August 22nd 2001 and August 7th 2002. Cold stored waiting bed plants were planted on May 7th 2003. The field was divided into eight plots in each experiment. Four plots were planted with cultivar Elsanta and the other four with cultivar Darselect. Organically raised runner plants of both cultivars were provided by Murray Ltd in 2001. Runner plants used in 2002 and cold stored waiting bed plants were produced organically by Applied Plant Research at Horst Meterik.

Each plot consisted of 20 strawberry plants, in a slightly elevated bed 150 cm wide with two rows 55 cm apart. Strawberry plants were planted 33 cm apart within rows. Strawberries were grown organically, according to good agricultural practise. At truss elongation straw was put in the field at a rate of 10 t per ha.

In each experiment four polythene tunnels (4.0 x 1.50 x 0.50 m) were placed over the beds to a length of 4 meters covering a plot completely. The tunnels were placed in spring on April 24th 2002, May 7th 2003 and at the end of May 2003. Two plots of both cultivars were protected from rainfall using these small tunnels. A small opening at the side of the tunnel was left open to facilitate air movement and pollinator access. At picking the plastic was moved manually to the top of the bows. To control temperature the gap could be adjusted manually.

Crop assessments

The fruits of all 20 plants per plot were handpicked twice a week. Fruits were rated class 1, small (< 28 mm), class 2 or rotten and fruits of each quality rating were weighed. Class 1 strawberries were counted when the yield did not exceed 500 g per plot, otherwise a representative sample of 500 g was counted. Mean fruit weight of class 1 strawberries was calculated as a weighed average during the harvest period.

Statistical analyses

Data were analysed using Genstat 8.0 (Rothampstead Experimental Station, Rothampstead, United Kingdom). Analysis of variance was applied to the cumulative incidence of *Botrytis* fruit rot, total and marketable yield. Arithmetic means are presented with Least Significant Differences (LSD) calculated with Student`s t-distribution at the 95 % confidence level. Logarithmic transformations were used to stabilise variances of percentage grey mould. The experiments were designed in a randomised block design with two replicates each year. Three experiments were carried out using two cultivars. Least significant differences were calculated.

Results

Percentage fruit rot caused by *Botrytis cinerea* was lower when small polythene tunnels were used (Table 1). The mean incidence of fruit rot was 47% and 37% lower in small tunnels than in the field observed in cultivars Elsanta and Darselect, respectively.

Placing tunnels had no effect on strawberry yield. By placing tunnels the percentage fruit rot decreased in all experiments and in both cultivars tested. Because of the small number of replicates this decrease was not significant in each year. Significantly more fruit rot was ob-

Table 1.
The effect of cultivars and polythene tunnels on strawberry yield and *Botrytis* fruit rot.

Treatment		Yield (t ha^{-1})		*Botrytis* fruit rot (%)
Cultivar	Small tunnels	Total	Class 1	
Darselect	Yes & no	14.7 a[1]	11.1 a	8.9 a
Elsanta	Yes & no	22.1 b	16.6 b	4.0 b
Both	Yes	19.0	13.9	7.8 a
Both	No	17.8	13.7	5.0 b

[1] Means followed by different characters indicate significant differences between the treatments

served in cultivar Darselect compared to cultivar Elsanta. No cultivar x tunnel interaction was observed in the experiments, indicating that the use of tunnels would be beneficial when either of both cultivars were grown.

Discussion

Darselect was more susceptible to grey mould than cv. Elsanta in our experiment. This indicates that choosing an appropriate cultivar based on susceptibility to *B. cinerea* should be considered in organic farming.

A significant decrease in *Botrytis* fruit rot was observed in both cultivars when polythene tunnels were placed over the crop. The mean incidence of *Botrytis* fruit rot was 42% lower in small tunnels than in the field. This is in concordance with Xiao *et al.* (2001) who found a decrease of fruit rot of 88-94% using large plastic tunnels compared to the field situation. They showed that shorter periods of leaf wetness were associated consistently with tunnels compared with the field. Whereas, the infection of flowers is favoured by extended periods of leaf wetness (Bulger, *et al.*, 1997). Legard *et al.* (2000) showed that widening plants spacing lowered *Botrytis* incidence. They assumed that amongst other factors also the changes in micro climate could contribute to a decrease in disease incidence. This observations supports the assumption that grey mould incidence can be partially controlled by manipulating leaf wetness periods.

Another explanation for the decrease of fruit rot incidence in tunnels compared to the field is the lack of precipitation under polythene cover. Sporulation and subsequent dispersal of *B. cinerea* conidia is enhanced by rain fall (Sutton, 1990) and total wetness duration (Sosa-Alvarez *et al.*, 1995). Thus inoculum production of *B. cinerea* is possibly hampered within polythene tunnels. Since inoculum production is positively correlated with flower infection of strawberries (Xu *et al.*, 2000) a reduction of inoculum potential results in less *Botrytis* rot.

Strawberry necrotic leaves are not significant sources of *B. cinerea* inoculum especially in annual waiting bed production (Boff *et al.*, 2001). Thus inoculum must be mainly produced outside the field and possibly the influx of inoculum is hampered by using tunnels. Subsequently infection risk might be reduced.

The effect on fruit rot of using tunnels was less pronounced in our experiment than that of Xiao *et a.l* (2001). Possibly the size of the tunnel has an effect on microclimate and thus on disease incidence. For instance temperature fluctuations were large in small tunnels compared to the field situation (Jordan & Hunter, 1972), whereas temperature fluctuations were much smaller in larger tunnels (Xiao *et al.*, 2001). *Botrytis* infection risk increases with higher temperature especially at night time (Xu *et al.*, 2000), which might be an explanation of the less prominent effect on fruit rot with small tunnels compared to the use of large tunnels.

Preharvest *Botrytis* fruit rot is caused by infection of flowers primarily (Jarvis & Borecka, 1968; Pappas & Jordan, 1997; Mertely *et al.*, 2002). After bloom, environmental factors showed considerably less association with disease incidence than during blooming (Wilcox & Seem, 1994). Emphasis on control should focus on peak bloom (Mertely *et al.*, 2002). These observations suggest that lowering the infection risk during flowering by using tunnels is most effective. Less efficacy might be expected from placing tunnels before flowering or during harvest. Although after bloom rain fall had some effect on *Botrytis* fruit rot (Wilcox & Seem, 1994).

Placing tunnels had no significant effect on the amount of class 1 fruit harvested, although the percentage of class 1 fruit picked increased from 74 to 77 %. This was a direct result of the decrease of grey mould when polythene tunnels were used. Earliness of the crop might be enhanced by using polythene tunnels, since the average temperature is higher in tunnels than in the field (Jordan & Hunter, 1972; Xiao *et al.*, 2001). However fruit quality might decrease when strawberries are grown at higher day temperatures (Wang & Camp, 2000).

Conclusions

Cultivars used differed in susceptibility to *B. cinerea*, therefore choosing an appropriate cultivar is a mean to control grey mould. The infection risk of *B. cinerea* on flowers can effectively be reduced by using plastic tunnels in organically grown strawberries, irrespective of the cultivar used. The results of Xiao *et al* (2001) suggest that possibly better results can be obtained when large tunnels are used. Mechanisms to control the temperature in the tunnel are necessary to ensure fruit quality and should be investigated further.

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