Aspects of Applied Biology ***127****, 2014*
Crop Production in Southern Britain: Precision Decisions for Profitable Cropping

Factors contributing to the holistic control of strawberry powdery mildew

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Summary

A holistic approach to the control of strawberry powdery mildew (*Podospheara aphanis*) is important, as the disease is never absent from the crop. Work reported here shows that the disease is present in the crop when new plants are bought in from a propagator and when older plants have been in the growing medium for one or more growing seasons. Control measures used in one growing season reduced the disease carry-over, thus reducing the initial inoculum in the following season. The use of a late autumn fungicide spray or a fungicide spray before fleece use in spring reduced the number and maturity of overwintering chasmothecia, thus also contributing to a reduction in initial inoculum. The role of a silicon nutrient in suppressing powdery mildew development is also reported.

Key words: Strawberry powdery mildew, *Podospheara aphanis*, chasmothecia, fungicide spray

Introduction

Strawberry powdery mildew is caused by *Podosphaera aphanis* (Braun, 1982). The disease affects leaves, flowers and fruits, thus reducing strawberry yield, both in quantity and quality. Strawberry plants are usually in the ground for three winters and four harvests, either in an open field or under a polyethylene tunnel. Some varieties are grown as annuals in UK. When environmental conditions are conducive to disease development, a large number of asexual conidia (Fig. 1) are produced (Glawe, 2008). The strawberry powdery mildew survival structures are chasmothecia, which overwinter on strawberry plants. A mature chasmothecium contains one ascus with eight ascospores (Fig. 1). In the UK, the chasmothcia are formed in August and September as the day-length and temperature decrease. Work reported here followed the development of chasmothecia from April 2011 to March 2012 and quantified the number and maturity of the chasmothecia. Comparison was made between two fields (Ladybird field & Diamante field) receiving routine control measures: one (Ladybird field) received 10 sprays with fungicides (under polyethylene tunnel) and the other (Diamante field) received seven sprays with fungicides (open field). The aims of this research were to record the amount of disease occurring on plants brought into the farm for planting and to follow the development and maturation of the chasmothecia throughout the year under normal farm conditions and to investigate the impact of routine fungicide sprays during the winter to control powdery mildew. In addition the effect of using a silicon nutrient was assessed.

Strawberry growers frequently use sprays of potassium bicarbonate in a silicon nutrient in the period immediately before harvest for controlling development of some diseases. Anecdotal observations suggest that silicon nutrient and potassium bicarbonate act synergistically to reduce disease development. Recent literature (Fatema *et al.*, 2012) also suggests that silicon is accumulated in plants and has a role in reducing disease development. Earlier work by Fatema & Hall (2011) showed that a silicon nutrient reduced *P. aphanis* ascospore germination early in the season. This paper reports a 2013 trial testing the hypothesis that use of silicon nutrient, taken up through the roots from the fertigation tube, delayed the onset of the epidemic of strawberry powdery mildew.

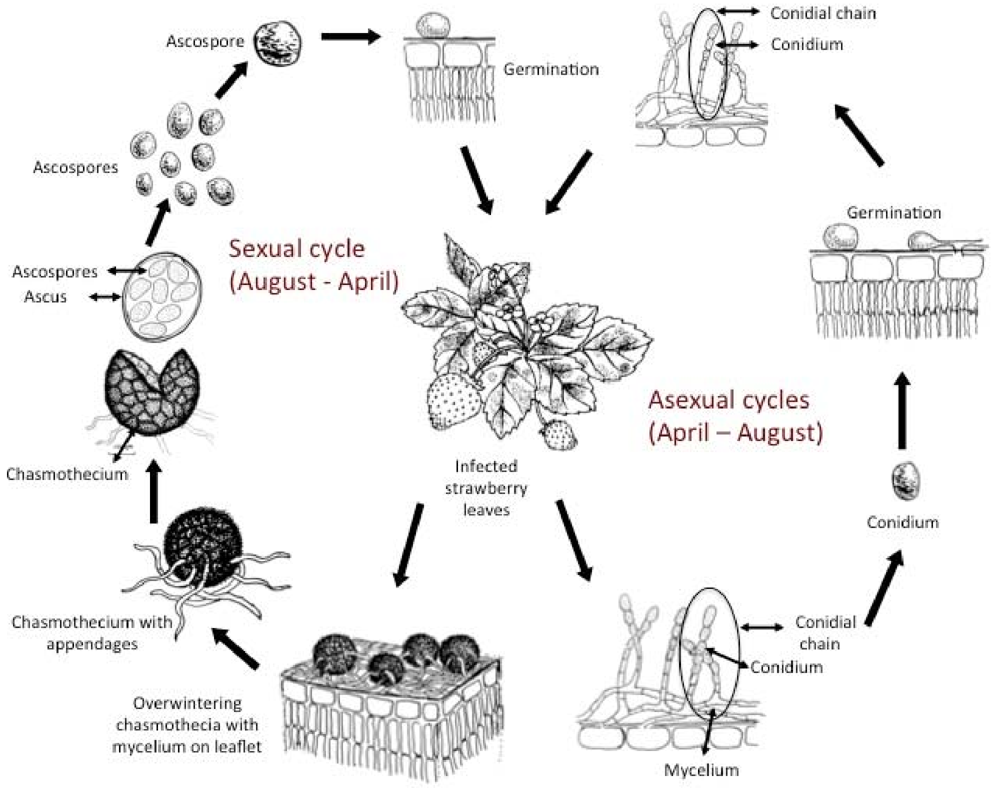

Fig. 1. Life cycle of *Podospheara aphanis* (strawberry powdery mildew). The asexual conidiospores develop and are released from the top of the conidial chain. These germinate and produce the initial infection. Production of conidia is key to creating the secondary cycle of infection and the build up of the epidemic. In the autumn the mycelia begin to produce chasmothecia to survive inclement conditions and begin the cycle again the following spring when disease conducive conditions occur. Chasmothecium contain one ascus and eight ascospores. Germinating ascospores produce germ tubes, which penetrate the epidermis of the leaves where haustoria are formed inside the cells and mycelium starts to grow.
Source from: Xiaolei Jin (author).

Materials and Methods

Development of powdery mildew on strawberry plants from the propagator

The 2013 glasshouse trial was done in the University of Hertfordshire (UH) glasshouse. The strawberry crowns (cv. Elegance) were bought from a propagator to Maltmas Farm and were planted in the glasshouse in February 2013. These plants were monitored weekly for 4 months for powdery mildew development. The runners were potted on and disconnected from the parent plants. All plants were observed for powdery mildew weekly. The plants for the fertigation trial were assessed for strawberry powdery mildew on arrival at the growers.

Effects of different fertigation treatments on development of strawberry powdery mildew, 2013

The 2013 fertigation trial was done in commercially operated polyethylene tunnels using 10 beds in each of two tunnels with four treatments; untreated, silicon nutrient alone, fungicide alone and silicon nutrient plus fungicide. The silicon nutrient was applied as a nutrient (15 mL per 200 L, i.e. a rate of 0.0017%) and added to the fertigation system twice a week for 4 months. The strawberry cultivar UH5 planted as an annual crop and 10 old leaves and 10 fully expanded new leaves were randomly sampled from 2m lengths of each plot each week for 13 weeks. All samples were assessed for amount of disease per leaf; a pre-assessment was done before the first application of the silicon nutrient.

Effects of different fungicide treatments on development of Podospheara aphanis chasmothecia

In the 2011–2012 field trial, strawberry leaves were collected from two fields; Ladybird field under polyethylene tunnel received more than 10 sprays with fungicides and Diamante field open field received seven sprays with fungicides at Maltmas Farm near Wisbech in Cambridgeshire. Ten leaves (cv. Elegance) were randomly sampled from each 30 m length of a 150m strawberry bed (50 leaves per assessment) and taken to the laboratory for assessment of chasmothecia maturation. All samples were placed in sample bags and kept in a cold room (4°C) until they were assessed. Five chasmothecia were selected from each leaflet with chasmothecia, then placed on a slide with one drop of fungal mounting fluid (lactic acid plus glycerol) and covered by a cover slip. Five chasmothecia per leaflet were observed under ×100 or ×400 magnification for maturity, number of ascospores in the ascus and colour.

Results

Development of powdery mildew on strawberry plants from the propagator

The results of the 2013 UH glasshouse trial shows that strawberry mother plants had been infected 14% by *Podospheara aphanis* naturally in July 2013. The runner plants had been replanted in March 2014. A month later, 13% of runner plants showed symptoms of powdery mildew. The pre-assessment of plants for the 2013 fertigation trial carried out in March 2013, showed that 4% of the strawberry plants showed symptoms of powdery mildew, which indicated that those strawberry crowns delivered by the propagator were not disease-free.

Effects of different fertigation treatments on development of strawberry powdery mildew, 2013

The results of the 2013 fertigation trial indicated that the untreated control showed the epidemic build up from 24 April to 31 July 2013 (Fig. 2). The silicon nutrient alone gave some suppression of *P. aphanis* ($P>0.05$) (Fig. 2) and it appeared to delay the onset of the epidemic by 9 to10 days when compared to the untreated plots. The silicon nutrient and commercial fungicide applications together gave the good control of the epidemic. There is an indication that, at the end of the trial the silicon and fungicide treatment gave slightly better control than the fungicide alone.

Effects of different fungicide treatments on development of Podospheara aphanis chasmothecia

The results showed that there were greater numbers of mature chasmothecia in September 2011 and March 2012 in Diamante field, which had received seven fungicide sprays, compared with Ladybird field, which had received 10 fungicide sprays (Fig. 3). This result indicated that fewer chasmothecia developed when there was more frequent spraying. This is linked to the results shown in Fig. 4, which shows that smaller colonies of *P. aphanis* result in fewer chasmothcia being formed. Other work (not shown) also indicates that a late autumn fungicide spray results in fewer chasmothecia being formed, thus also contributing to a reduction in initial inoculum the following spring. There was a good correlation between the amount of mycelium on a leaflet and the number of chasmothecia (Fig. 4).

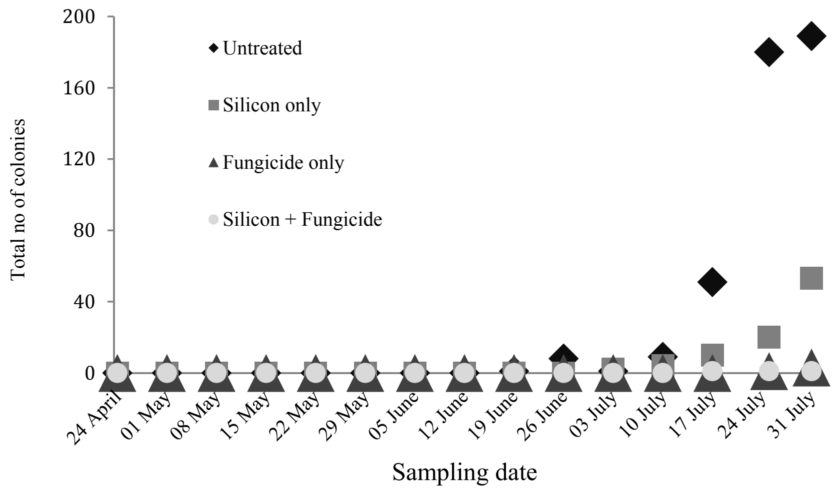

Fig. 2. Graph of epidemic buildup on the four treatments showing number of powdery mildew colonies on the leaves of strawberry plant during the period 24 April to 31 July in the 2013 polyethylene tunnel silicon nutrient fertigation trial.

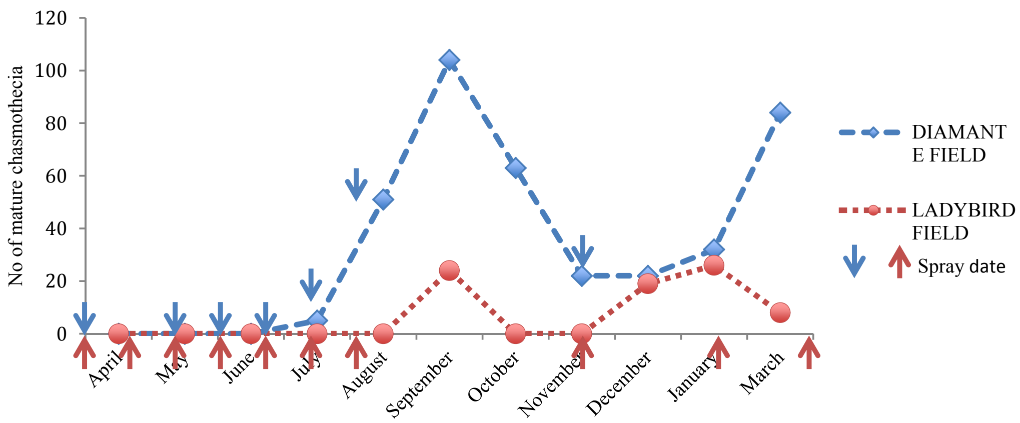

Fig. 3. The number of mature *P.aphanis* chasmothecia on 50 strawberry leaves sampled each month from Diamante field open field (seven sprays with fungicide) and Ladybird field polyethylene tunnel (10 sprays with fungicide) from April 2011 to August 2012 at Maltmas Farm near Wisbech in Cambridgeshire.

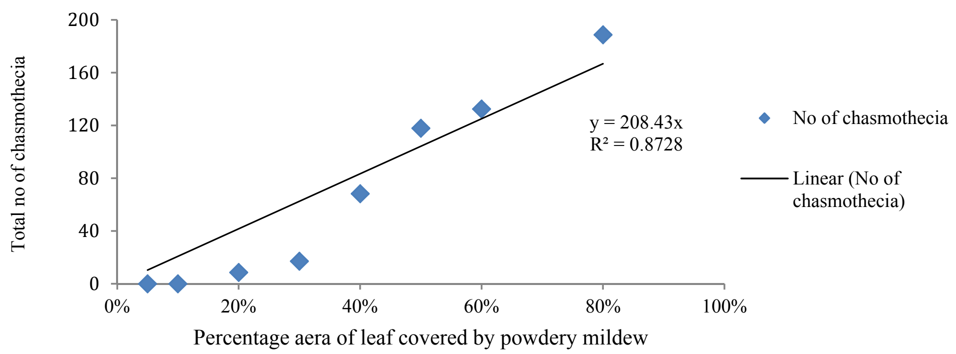

Fig. 4. The number of chasmothecia (immature and mature) on 50 leaves in Sep 2011 correlated with colony size. Percentage area covered with mycelium in Diamante field. $R^2 = 0.872$ which indicated that there was a good correlation between the amount of mycelium on a leaflet and the number of chasmothecia.

Discussion

This study demonstrated that *Podospheara aphanis* is present in a crop when they come from the propagator, which shows there are no disease-free. Chasmothecia are generally present in overwintering crops. In both cases the use of fungicides can reduce the initial inoculum from these sources (Fig 3). The 2013 silicon trial in the tunnel demonstrates that silicon nutrient, as a nutrient feed in fertigation appears enhance the plant defence mechanisms and reduces the build up of the epidemic of powdery mildew. The silicon nutrient alone gave some disease reduction when compared with the untreated control (Fig. 2). By the end of the trial the silicon and fungicide treatment gave slightly better control than the fungicide alone but the effect is small.

Fig. 4 shows that chasmothecia production is linked to colony size and so suggests that any control method, which reduces colony size, will have a knock on effect on disease carryover. This demonstrates that using fungicides in the autumn and spring is effective in reducing chasmothecia numbers and maturity thereby reducing the initial inoculum. Hoffmann *et al.* (2012) indicated that applications of fungicides from the start of the growing season to the beginning of the fruit ripening period did not only affect the disease level but also determined the incidence of the autumn leaf infection. Fig. 4 demonstrates that the more mycelium on a leaf, the greater the number of chasmothiecia. Hoffmann *et al.* (2012) also stated that the level of leaf disease affected the number of chasmothecia formed on the leaves. Hence, this work suggests that spraying in autumn could decrease the spread of the disease. The use of the silicon nutrient is also valuable in reducing epidemic build-up.

Acknowledgments

The authors thank Harriet & Henry Duncalfe, Maltmas Farm for providing the field trials. We thank Gidon Bahiri (OrionFT) for the supply of the silicon nutrient.

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