Grower Summary

PE 007

Sweet pepper: aspects of the biology and control of Fusarium fruit rot

Annual 2013

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Further information

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Project Number:	PE 007
Project Title:	Sweet pepper: aspects of the biology and control of Fusarium fruit rot
Project Leader:	Dr Tim O'Neill
Contractor:	ADAS UK Ltd
Industry Representative:	Gill Wardell, Abbey View Nurseries
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Project Cost:	£69,449

Headline

- Two fungicides and a biofungicide applied at flowering reduced Fusarium internal fruit rot.

Background and expected deliverables

Internal fruit rot of sweet pepper grown in glasshouses has been an increasing problem worldwide since around 2000. In the UK a survey in 2007 showed infected fruits were present in many crops at levels from 1 to 37% (PC 260). The disease causes some losses on production nurseries but more importantly Fusarium continues to be a frequent cause of rejection by packers and complaints by supermarkets. Losses vary greatly between crops and seasons, and growers are generally unaware a problem may be present until harvest or postharvest. The fruit rot arises through infection of flowers by spores of *Fusarium*. Several *Fusarium* species have been associated with the disease, notably *F. lactis* and *F. oxysporum*. Observations in commercial crops indicate the disease is favoured by high humidity and fluctuating temperatures. At present there is no effective method of control. This project aims to reduce losses to Fusarium internal fruit rot through increased knowledge of factors associated with a high incidence of the disease and use of biofungicides and fungicides to control flower infection.

Summary of the project and main conclusions

Objectives 1-3 are reported in the Year 1 report (March 2012).

Objective 4 – Relative susceptibility of different varieties

Visibly healthy Class 2 peppers of six varieties collected from glasshouses in the Lee Valley on one day in May 2012 differed in their level of Fusarium internal fruit rot. After holding fruit at ambient temperature for 5 days, internal fruit rot ranged from 0.8% in Ferrari (green fruit) to 14.2% in Pele (yellow). Infection in Fiesta (8.3%), Spider (6.7%) and Boogie (5.8%) was also relatively high compared with Cupra (2.5%) and Ferrari. Two of the varieties that differed (Cupra and Spider) were from the same glasshouse. These results on varietal differences are supported by grower experience.

Class 1 peppers of the same six varieties were examined for their susceptibility to Fusarium fruit rot by inoculation of the inner wall with a standard inoculum of *F. lactis*. The diameter of rot lesions after 10 days was greater in Pele, Spider and Cupra than in Ferrari (green) or Boogie, and was intermediate in Fiesta.

The effect of fruit sugar content (% Brix) on the rate of Fusarium rot development was examined. For 60 fruit (10 fruit x 6 colours), % Brix was determined using one third of the

fruit tissue and rot development following inoculation with *F. lactis* was measured in the other two thirds of each fruit. Sugar content ranged from 4.0% (Ferrari green) to 7.2% (Cupra red). No relationship was found between sugar content and the rate of Fusarium fruit rot development.

Taken together, these results indicate:

- Pepper varieties differ in their susceptibility to Fusarium internal fruit rot, with Pele (yellow) very susceptible and Ferrari (green) less susceptible. The red variety Cupra is less susceptible than red Spider.
- Differences between varieties in the incidence of Fusarium internal fruit rot are not determined simply by fruit sugar content.
- The interval between fruit set and harvest may have some effect on incidence of Fusarium fruit rot, as green fruit, which show least infection, are harvested 10-14 days before coloured fruit. However, Pele showed the highest level of infection and yet is generally harvested 1 week earlier than other coloured fruit.
- Differences in varietal susceptibility are determined by factors other than, or in addition to, those noted above and may include, for example, flower characteristics or fruit chemical constituents.

Objective 5a – Effect of high humidity on flower infection

A replicated experiment was done in a commercial crop of peppers, variety Cupra, to determine the effect of imposing high humidity at flowering on the incidence of Fusarium internal fruit rot. In May 2012, flowers were loosely enclosed in small polythene bags for periods of 3, 6, 15 or 24 h after inoculation with *F. lactis*; moisture droplets on the inside of bags indicated very high humidity conditions were achieved. Only 10-18% of inoculated flowers developed to mature fruit. In this experiment, imposed high humidity for 3-24 h did not significantly increase the incidence of internal fruit rot (43-65%) compared with flowers inoculated and not enclosed in a polythene bag (71% with internal fruit rot).

This lack of an increase in internal fruit rot with high humidity duration is not consistent with grower observations which suggest the disease is worse during periods of high humidity. It is possible that artificial inoculation of flowers with a spray of *F. lactis* spores overrode any humidity influence on infection success, or the experiment was insufficiently sensitive to detect humidity effects due to the relatively small number of fruit that developed to maturity in each treatment. Effect of humidity was further examined in Objective 6.

Objective 5b – Monitoring of condensation humidity and in commercial pepper crops

Air relative humidity (RH) and temperature and stem temperature in a pepper crop canopy were measured at three positions on two nurseries in the Lee Valley from March to October 2012. Potential condensation events were determined by calculation of dew point. The frequency and duration of potential condensation events differed between nurseries and monitoring points. At nursery 1 there were no condensation events longer than 5 minutes at positions 2 and 3; however, position 1 had many long condensation events, the longest over 3 hours. At nursery 2, position 3 had over 100 events of greater than 3 hours and over 500 condensation events of 15 minutes or less. Differences were due in part to differences in vent set points.

At nursery 1, RH rarely went above 85% for prolonged periods (>12h) until 23 September when values above 90% became quite common due to lowering of vent set point temperature to enhance colouring-up. Prolonged periods of high RH (>85%) were more common at nursery 2, occurring on average every other day throughout cropping. RH varied little between the three positions within the house at nursery 1; whereas two positions were similar to each other and the third position recorded a lower RH at nursery 2. Comparing the same variety across sites, Fiesta, incidence of Fusarium rot was greater at nursery 2 than nursery 1, indicating that the disease is favoured by greater occurrence of high humidity and condensation.

Objective 6 – Evaluation of potential control treatments applied to flowers

A replicated experiment was done in a commercial crop of peppers, variety Cupra, to determine the effect of four products approved for use on protected pepper on incidence of Fusarium internal fruit rot. Sprays of Amistar (azoxystrobin), Switch (cyprodinil + fludioxonil), Serenade ASO (*Bacillus subtilis*) and Prestop (*Gliocladium catenulatum*) were applied to flowers in July and August 2012 one day before inoculation with *F. lactis*. Treated flowers were tagged and fruit that developed to maturity were assessed for internal fruit rot at the normal harvest stage. The incidence of Fusarium internal fruit rot was significantly reduced by Switch, Amistar and Serenade ASO (Figure 1).

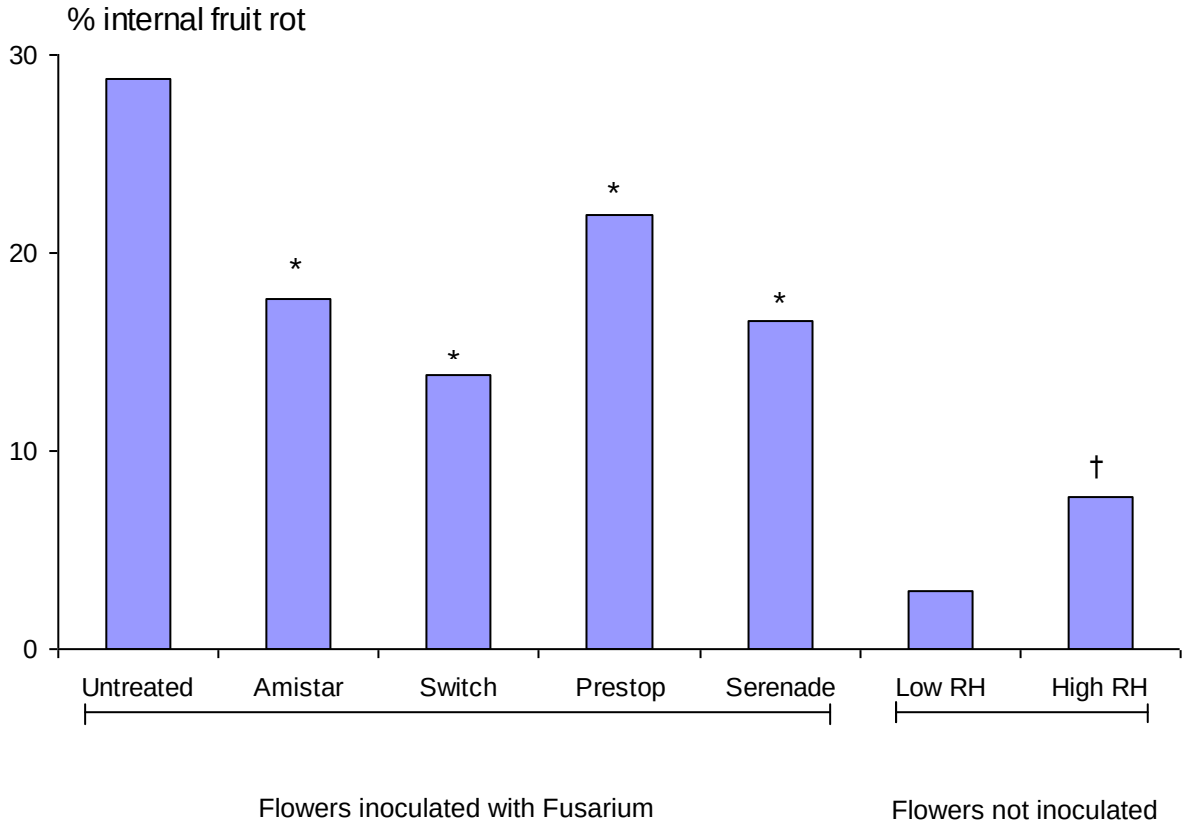

Figure 1. Effect of fungicides, biofungicides and imposed high humidity around flowers on Fusarium internal fruit rot of pepper, cv. Cupra – Lee Valley, 2012. * Significantly different from the untreated (water only) control; † significantly different from the low RH treatment.

An extra treatment was included in this experiment to further investigate the effect of high humidity on occurrence of Fusarium internal fruit rot (see Objective 5a). High humidity was created by loosely enclosing flowers in a polythene bag. In contrast to the previous work, no *Fusarium* inoculum was applied. This treatment significantly increased the level of Fusarium internal fruit rot, from 2.9% to 7.7%, supporting the hypothesis that Fusarium development is favoured by high humidity.

Objective 7 – Effect of season and fruit size on Fusarium species in pepper fruit

The identity of *Fusarium* species associated with pepper fruit at different times of the year and in fruit of different sizes was examined. This was to test the hypothesis that the incidence and range of *Fusarium* species in a pepper crop vary with time of year; and that the species associated with aborted fruit may differ from those found in mature fruit.

Small brown fallen aborted fruit and mature Class 2 fruit with symptoms of Fusarium fruit rot were collected from a commercial crop of variety Cupra at intervals between April and November 2012. The incidence of *Fusarium* was determined in 50 aborted fruit by culture on agar; identity of *Fusarium* species was determined by molecular tests (see Year 1 report) in 10-20 aborted and mature fruit.

The incidence of aborted fruit containing *Fusarium* spp. was 48%, 88%, 84% and 100% in April, June, August and November respectively. *Fusarium lactis* was the predominant species in all samples; *F. oxysporum* and *F. proliferatum* were each detected at a low incidence in both aborted fruit and mature fruit over most of the season.

The high incidence of *Fusarium* species capable of causing internal fruit rot found in aborted fruit from early in the year was surprising. The possible role of *Fusarium* spp. in causing fruit abortion may warrant investigation.

Financial benefits

Fusarium internal fruit rot of sweet pepper occurs in many UK sweet pepper crops, the severity varying with variety, nursery, glasshouse and time of year. The disease is more common in the spring and autumn when fruit take longer to ripen. Growers have reported that up to 20% of a day's pick may be affected. Assuming a farm-gate-value of 50p per fruit and a harvest of 1,000 fruit/ha on a single day, this represents a loss of £100/ha/day. Additional losses arise when infected fruits are not detected at harvest or in the packhouse, but the rot develops subsequently causing supermarket rejection or customer complaint to the supermarket, both of which incur a cost for the grower. The potential financial benefits of this work are an increased proportion of harvested fruit free from *Fusarium* internal infection and reduced risks of packhouse rejection, supermarket complaints and disruption to the supply chain.

Action points for growers

- Note that varieties differ in susceptibility to Fusarium internal fruit rot. Red Cupra is generally less susceptible than red Spider; yellow Fiesta is generally less susceptible than yellow Pele; green fruit (e.g. Ferrari) are less susceptible than the above named coloured fruit. The actual level of Fusarium internal fruit rot in a particular variety will also be affected by glasshouse humidity and condensation and the level of inoculum in a house.
- Remove fallen aborted fruit trapped in the canopy and from the floor as much as reasonably practical in order to reduce inoculum levels of *Fusarium*.

- Grower experience, nursery monitoring and some experimental evidence indicate that Fusarium internal fruit rot is favoured by high humidity; control the glasshouse environment to minimise prolonged periods above 85% RH and the risk of condensation events.
- In houses and varieties where there is a history of Fusarium internal fruit rot, consider application of preventative sprays to flowers of Amistar, Switch or Serenade ASO. The efficacy of such treatments will be further examined in Year 3 of this project.