Does pollination contribute to June drop in cherry?

Dominic Williams[1], Alison Karley[1], Avril Britten[2], Kay Smith [1], Julie Graham [1]

[1]The James Hutton Institute, Invergowrie, Dundee, UK, DD2 5DA
[2]James Hutton Limited, Invergowrie, Dundee, UK, DD2 5DA
dominic.williams@hutton.ac.uk, ali.karley@hutton.ac.uk

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Introduction

One of the problems faced by cherry growers is yield instability due to varying amounts of fruit loss. 'June drop' is the phenomenon when cherry trees drop green fruit that have gone through the initial fruit swelling but are abscised before ripening. 'June drop' in cherry is one of the contributors to unstable yields each year.

The drivers of June drop are currently unknown and are being investigated in an Innovate UK project (CherryBerry). As part of this research, a study was carried out to understand whether poor pollination levels lead to June drop.

An experiment was carried out in a polytunnel to control pollination and resource supply to developing fruit. In addition, timelapse cameras were set up to record bee behaviour during flowering.

Methods

Cherry trees of two self-sterile varieties and one self-fertile variety were planted in a covered tunnel at James Hutton Institute in Dundee. Five treatments were allocated at random to individual trees, with treatments applied to a single branch (six flower clusters) on each tree. The treatments aimed to control pollination and resource supply to the fruit.

1) Unbagged control – pollinated by insects
2) 'Fake' unbagged control – open pollinated by insects before being covered by mesh bag with large holes
3) Closed unpollinated – enclosed in an insect-proof mesh bag before flowers opened
4) Close hand pollinated – enclosed in an insect-proof mesh bag after hand pollinating flowers
5) Closed hand pollinated and bark ringed - enclosed in an insect-proof mesh bag and photosynthate transport restricted

Flower numbers were counted then fruit numbers were counted at two weekly intervals throughout development.

Timelapse imaging

Timelapse cameras recording photos every 2s were placed in tunnels throughout flowering. These were regularly checked to change memory cards and batteries when needed. Images from these were analysed in a two-step bee detection method. First a motion detector was used to find examples of movement within the images. Secondly a deep learning based classifier was used to determine if the motion was a bee pollinating insect or not. This enabled a record of where bees had been in the images to be generated.

Results

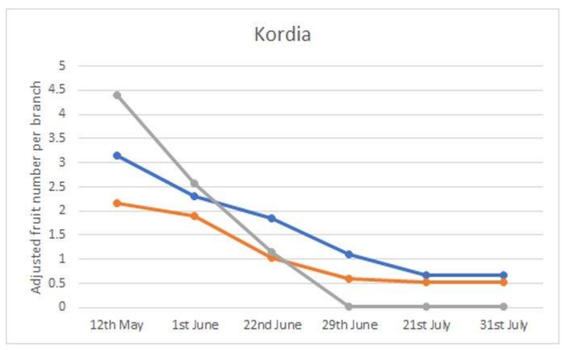

Figure 1 Flower and fruit number (adjusted for initial flower number) between flowering and fruit harvest in self-sterile variety Kordia. Grey = pollinator excluded, blue = open pollinator control, orange = 'Fake' bag control.

Flowers started developing into fruit in late May (**Figure 1**), with a similar pattern seen for all three varieties. Fruit loss occurred throughout June. By the end of June, no fruits remained when pollinators had been excluded, but some fruit remained in the insect-pollinated treatments. This suggests that June Drop is partly affected by pollination and could also partly result from parthenocarpy (fruit development in the absence of pollination).

Flower visits by bees were detected automatically in images within a 2-day window after initial flower opening (**Figure 2**). This allows us to count how many times each flower has been visited.

Figure 2 Image showing locations of bee visits in a 2 day window from initial flower opening. This method only looked at bee visits to visible flowers in the camera.

Comparison of fruit development and fruit set across treatments between late June and July (**Figure 3**) confirmed that fruit set was negligible in the absence of pollination. It showed that fruit retention was low for insect pollinated flowers (treatments 1, 2) and was increased significantly when flowers were hand-pollinated (treatment 4), suggesting that fruit yield is limited by insect pollinators. Surprisingly, fruit retention was highest when photosynthate transport to/from the branch was restricted by bark ringing (treatment 5). This might be because fruit numbers were low overall, and photosynthate production within the branch was sufficient for fruit filling.

The self-fertile variety Sweetheart performed poorly compared with the two self-sterile varieties Kordia and Penny. These results show fruit production could be boosted by choosing certain varieties and with better pollination.

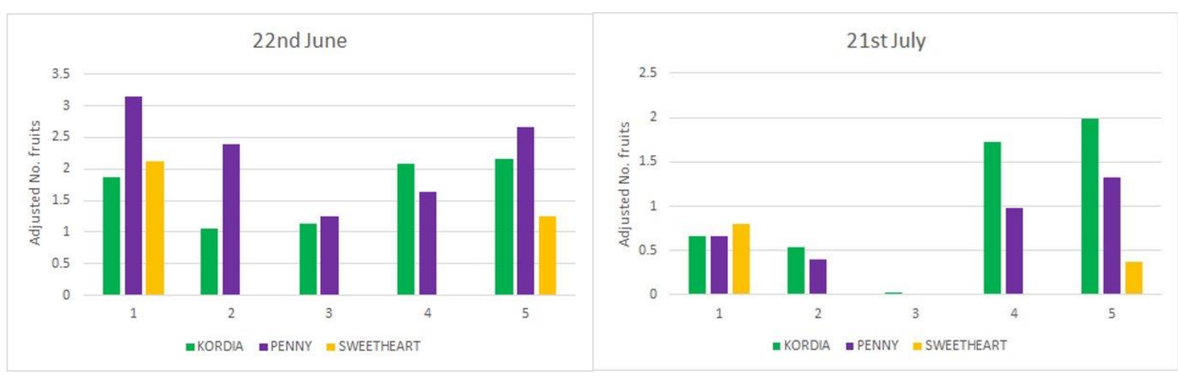

Figure 3 Fruit number (adjusted for initial flower number) on cherry branches on 22nd June and 21st July. Treatment numbers are shown on the x-axis (see Methods). On 22nd June no significant differences were seen between treatments. On 21st July there were significant differences between treatments and cherry varieties.

Conclusions

- Fruit development is initiated in cherry in absence of pollination
- Fruit developing from unpollinated flowers are unlikely to develop into ripe fruit
- Fruit set in self-sterile varieties is improved by hand pollination
- June drop losses can be mitigated partly by variety choice and increased flower pollination
- Timelapse cameras can be used in polytunnels to detect bees in a subset of flowers and could be a useful method to monitor pollination efficiency

Acknowledgements
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