Impact of Local and Landscape Factors on Spotted Wing Drosophila Epidemiology

Summary report of work conducted in 2023-2024.

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Summary

- Monitoring of Spotted Wing Drosophila (SWD) abundance at the James Hutton Institute over an eleven-year period (2013-2023) has shown that insect numbers were low until 2021, when numbers started to increase, and this increase was sustained in 2022 and 2023. In most cases, the numbers caught per trap per week were 10-100 fold lower than those reported for other areas of the UK, however, some commercial sites are now recording similar abundance to other UK areas and growers are reporting visible signs of SWD reproduction in crop fruit.
- Six summer raspberry varieties were tested for differences in SWD susceptibility in no-choice laboratory assays using field-collected berries. These assays revealed significant differences between varieties in total SWD emergence, but no differences in the timing of adult fly emergence.

Spotted Wing Drosophila monitoring in Scotland

The Spotted Wing Drosophila (SWD), *Drosophila suzukii,* is an invasive fruit fly which originated in Japan and has since spread across the world, first being detected in the UK in 2012. In the UK, SWD is a pest of soft and stone fruit, laying eggs in ripening and ripe fruit of many plant species. If left uncontrolled, SWD infestation can result in extensive financial losses for the grower.

SWD monitoring at the James Hutton Institute

SWD has been monitored in Scotland for eleven years (2013-2023) at the James Hutton Institute in Dundee, following an established protocol (AHDB, 2022). Modified Droso traps with Cha-Landolt bait were positioned in and around fruit crops and checked for SWD every 1-2 weeks in the summer and every 2-4 weeks in the winter months. Ten traps were used during 2013-2021, and five traps in 2022 and 2023. The number of female and male SWD adults was recorded in each sample and expressed as an average number per trap per week by averaging the trap catch over the preceding sampling period (i.e. between 1 and 4 weeks). No data are shown for 2013 as no SWD were detected in the traps.

In all years, the number of SWD caught at JHI (**Fig. 1**) remained very low until week 29 when an increase in numbers was observed. During the years 2014-2020, the numbers remained low (<5 individuals per trap per week) for the rest of the year. In 2021, 2022 and 2023 there was a sharp uptick in the number of SWD caught from week 33 onwards and numbers remained high until week 47. This is demonstrated in the largest recorded peak weekly value of SWD per trap caught at JHI (**Fig. 2a**), which was low throughout 2014-2020, but has shown an increase in the last three years.

It was not possible to compare overall abundance (total SWD catch) at this site for each of the eleven monitoring years, because the number of traps used in the monitoring varies between the different years. However, it is possible to compare the total catch for weeks 25-52 in 2022 and 2023 when same 5 traps were used over the same monitoring period (**Fig. 2b**). The results show that, whilst the total catch is much lower than those recorded in southern UK, the total catch in 2023 at JHI was more than double that in 2022 suggesting that the SWD population is continuing to increase and establish at this site.

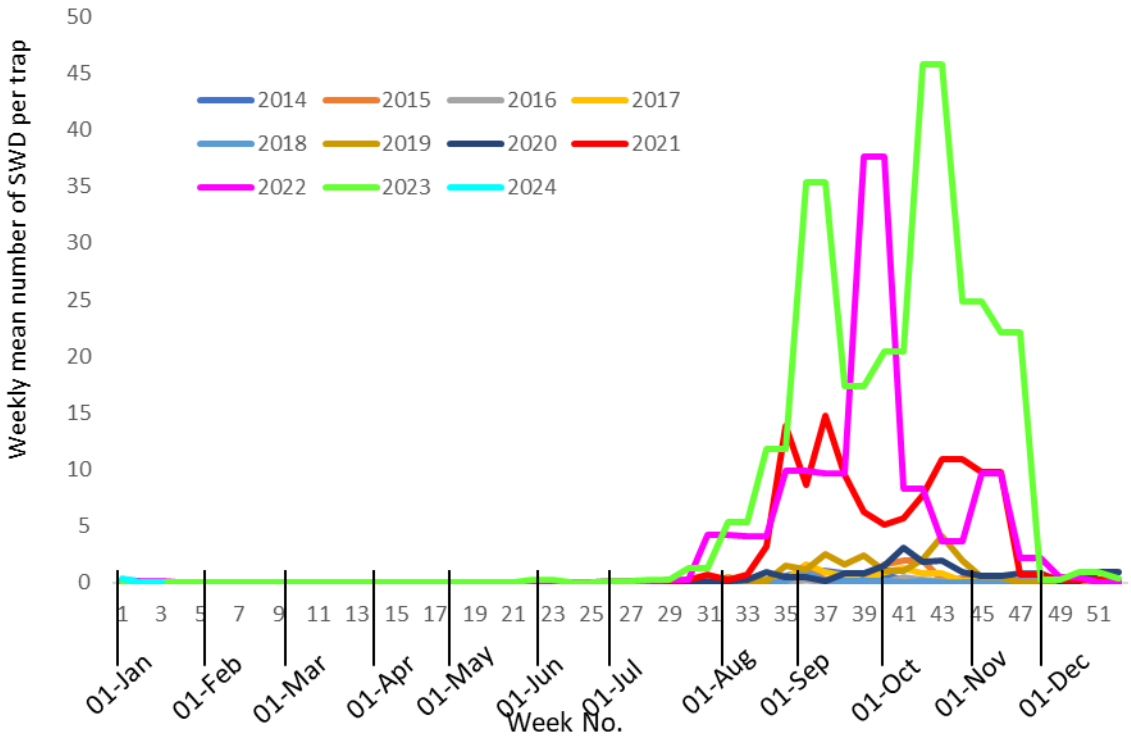

Fig 1. The mean number of SWD per trap per week detected at JHI. Values for 2014 – 2021 are means of 10 traps, while values for 2022 are the mean of 5 traps.

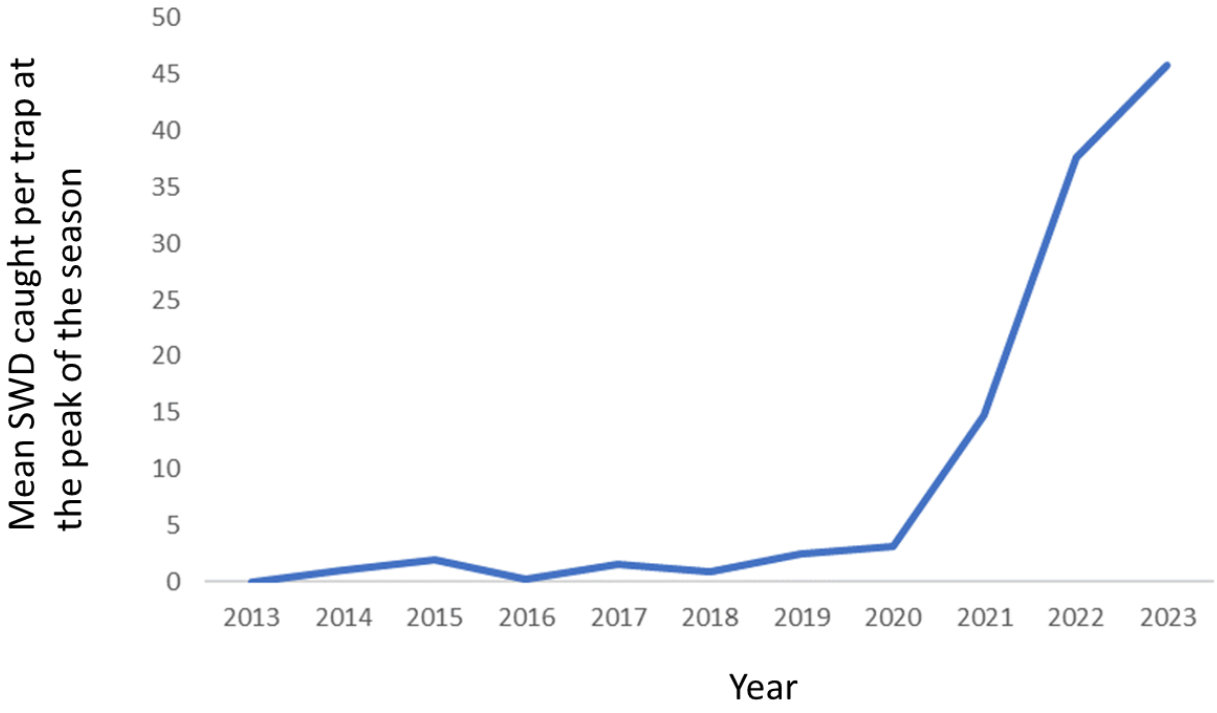

Fig 2a. The peak value of the mean number of SWD per trap per week caught at JHI in the period 2014 – 2023.

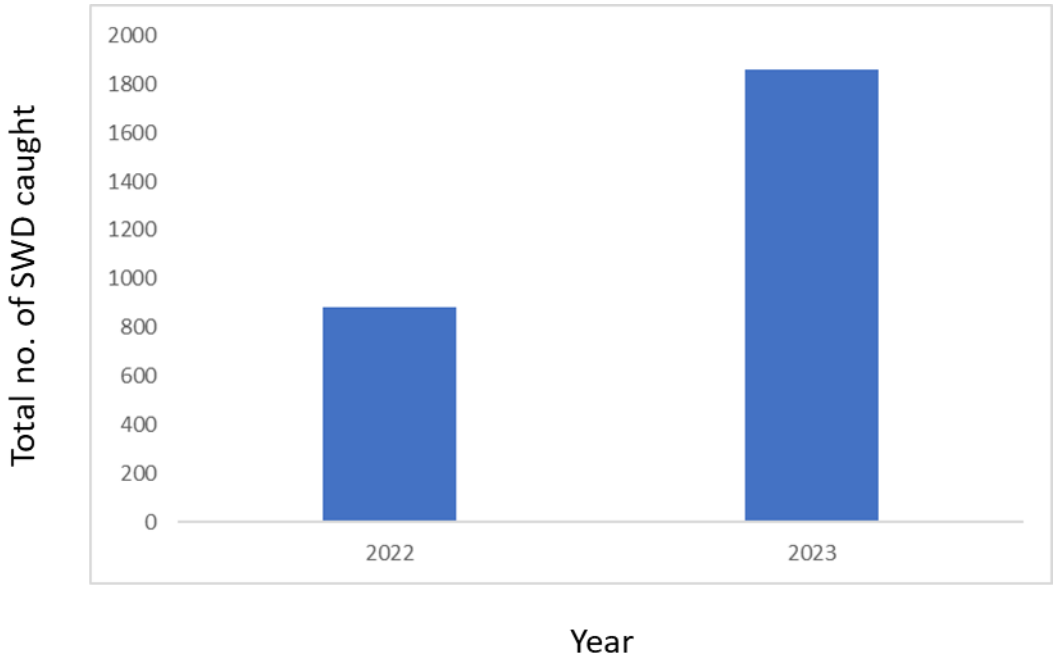

Fig 2b. The total number of SWD caught in 5 traps weeks 25 to 52 at JHI in 2022 and 2023

Fruit varietal differences in SWD susceptibility

The susceptibility of six summer fruiting raspberry varieties was tested using no-choice assays where two mated adult females were allowed to lay eggs for 24 hours.

Methods. Two locations were used to collect berries for the tests: the demo plot which had ten plant plots and M13 which had two replicate plots each with three plants. Both sets of plants were grown in a tunnel. The following genotypes were tested in the demo plot: Glen Fyne, Glen Ample, Glen Dee and RBC2OP33. The following genotypes were tested in M13 plot: Paris and 1623H-6.

The berries were collected by covering fruiting branches with mesh sleeves (**Fig. 6**) and picking the fruit when ripe. Each mesh bag contained approximately ten berries and ten bags were used for each genotype. These bags were removed as soon as the desired weight of berries had been collected.

Figure 6. Mesh sleeves protecting the berries

Two or three day old mated female SWD adults were used for the assays. The SWD lab culture tubes were placed in ice to chill the SWD and then two females were removed and placed into an Eppendorf. These females were left to warm up so that normal behaviour was observed before they were added to the tubs containing the berries.

Assays were set up in clear plastic tubs covered with muslin and secured with a rubber band. Approximately 25 g of berries were used in each assay. Three treatments (each with three replicates) were tested. For treatments (1) and (2) the two mated female SWD were allowed to lay eggs for 24 hours before being removed from the assays. (1) The berries were dissected after 5 days and the

number of larvae was counted; (2) The berries were left for three weeks and the number of emerging adults was counted; and (3) control tubs that had no SWD added and were used to confirm that no wild SWD had gained access to the berries within the mesh sleeves. As the berries were not all ripe at the same time, replicate treatments for each genotype were done on different dates. See **Table 1** for dates that the assays were started, and the weight and number of berries used in each assay.

Table 1. The start date of each assay with the weight and number of berries used in each assay

		5 days			3 weeks			control 3 weeks		
		rep 1	**rep 2**	**rep 3**	**rep 1**	**rep 2**	**rep 3**	**rep 1**	**rep 2**	**rep 3**
Glen Fyne	start date	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul
	weight of berries (g) (number)	27.5 (4)	26.3 (4)	26.5 (4)	27.4 (4)	25.8 (4)	27.4 (4)	26.3 (4)	26.3 (4)	29.4 (4)
Glen Ample	start date	10-Jul	13-Jul	13-Jul	10-Jul	10-Jul	13-Jul	10-Jul	10-Jul	13-Jul
	weight of berries (g) (number)	24.7 (5)	25.9 (6)	25.1 (5)	25.6 (5)	25.8 (5)	24.5 (6)	25.3 (5)	20.9 (4)	29.6 (7)
Glen Dee	start date	10-Jul	10-Jul	17-Jul	10-Jul	10-Jul	13-Jul	10-Jul	10-Jul	10-Jul
	weight of berries (g) (number)	26.2 (4)	27.5 (5)	29.2 (5)	28.2 (4)	25.6 (5)	28.3 (5)	26.0 (5)	25.9 (4)	25.4 (4)
RBC2OP33	start date	10-Jul	10-Jul	13-Jul	10-Jul	10-Jul	13-Jul	10-Jul	10-Jul	13-Jul
	weight of berries (g) (number)	27.4 (5)	26.3 (5)	27.3 (5)	28.2 (5)	27.3 (5)	24.9 (5)	25.8 (5)	24.9 (4)	23.6 (4)
Paris	start date	24-Jul	24-Jul	24-Jul	17-Jul	24-Jul	24-Jul	17-Jul	20-Jul	24-Jul
	weight of berries (g) (number)	24.7 (6)	27.2 (6)	26.9 (6)	26.6 (6)	27.3 (6)	26.1 (6)	23.5 (5)	29.3 (6)	11.3 (3)
1623H-3	start date	13-Jul	13-Jul	17-Jul	10-Jul	13-Jul	13-Jul	10-Jul	13-Jul	17-Jul
	weight of berries (g) (number)	25.9 (5)	25.8 (6)	25.3 (5)	26.7 (8)	26 (7)	26 (7)	27.7 (10)	25.5 (6)	27.3 (7)

Results. No SWD emerged from the control treatment pots showing that the mesh sleeves protected the berries from any SWD in the environment. In treatment 2, the berries were dissected after 5 days under a microscope to isolate larvae (**Fig. 7**). The number of larvae found varied between replicates and between varieties. In most cases the number of larvae found was less than the number of adults emerging from the Treatment 3 pots (left for 3 weeks) which suggests that dissecting the berries is not an accurate way of determining egg laying success.

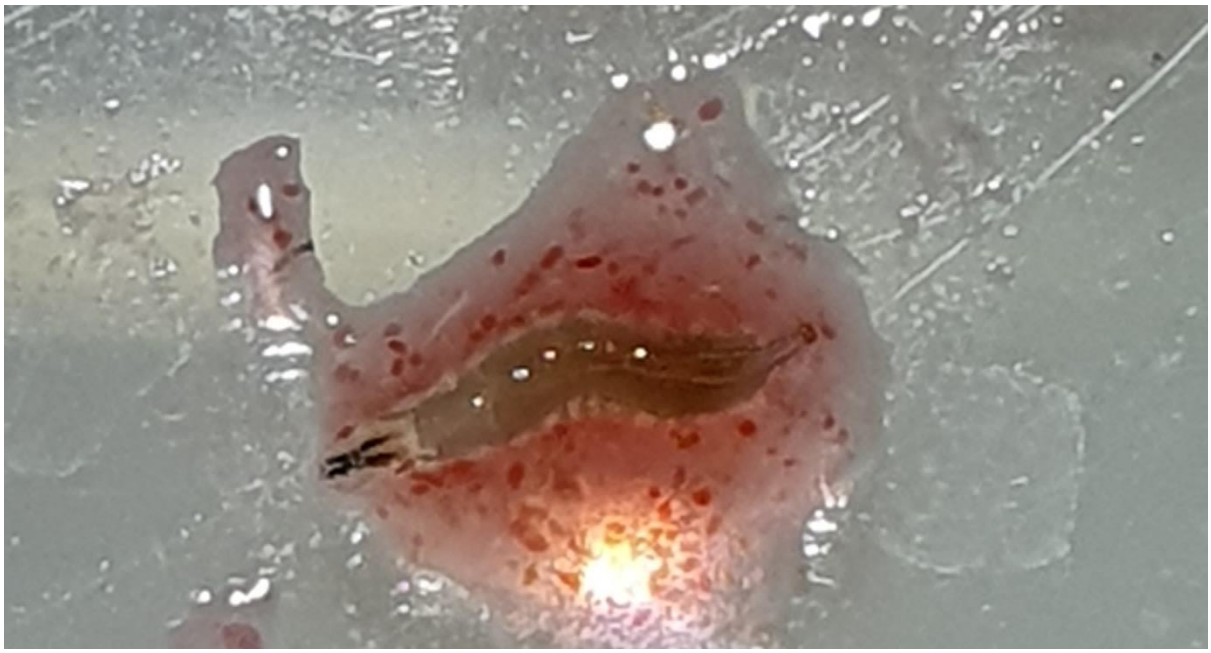

Figure 7. A SWD larva dissected from a raspberry fruit.

There was significant variation in the number of adults emerging from the different varieties (Chi-sq(5) = 51.4, $p<0.001$) with Paris, Glen Fyne and 1623H-6 all showing larger numbers of adults than

RBC20P33, Glen Dee or Glen Ample (**Fig. 8**). There was wide variation in the number of adults emerging between replicates of the same variety. For example, in the 3-week pots containing Glen Fyne, the number of adults emerging ranged from 0 to 39 individuals.

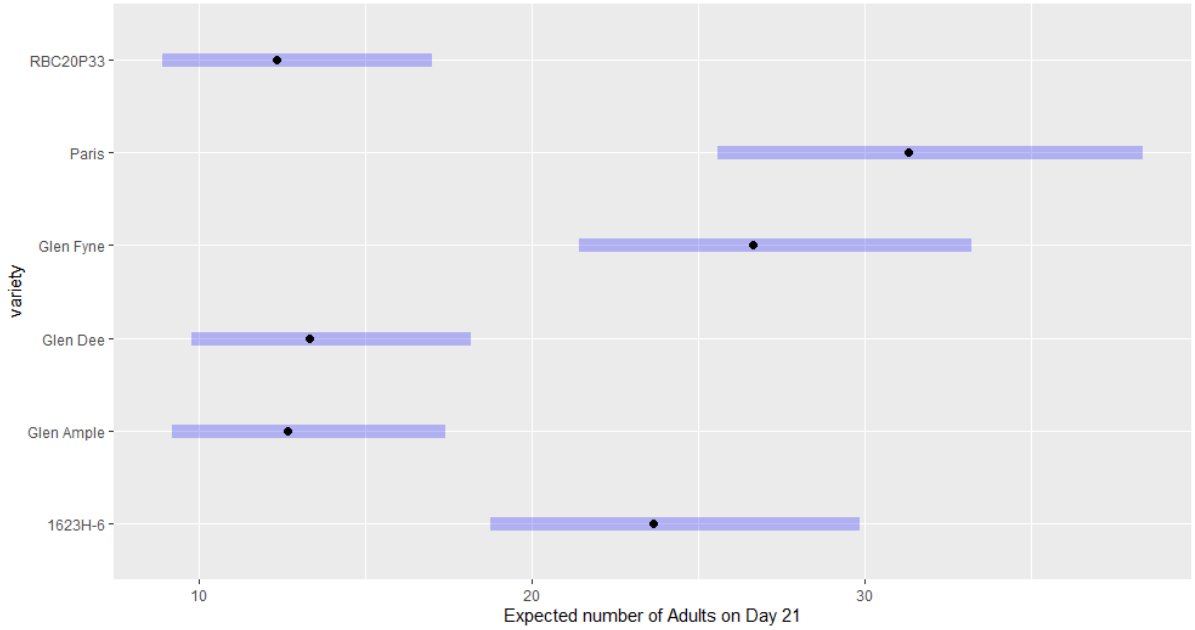

Figure 8. Expected number of SWD emerging from the six tested raspberry varieties.

SWD adults emerged between day 14 and day 17, but the time taken for the adults to emerge did not vary significantly between varieties (**Fig. 9**).

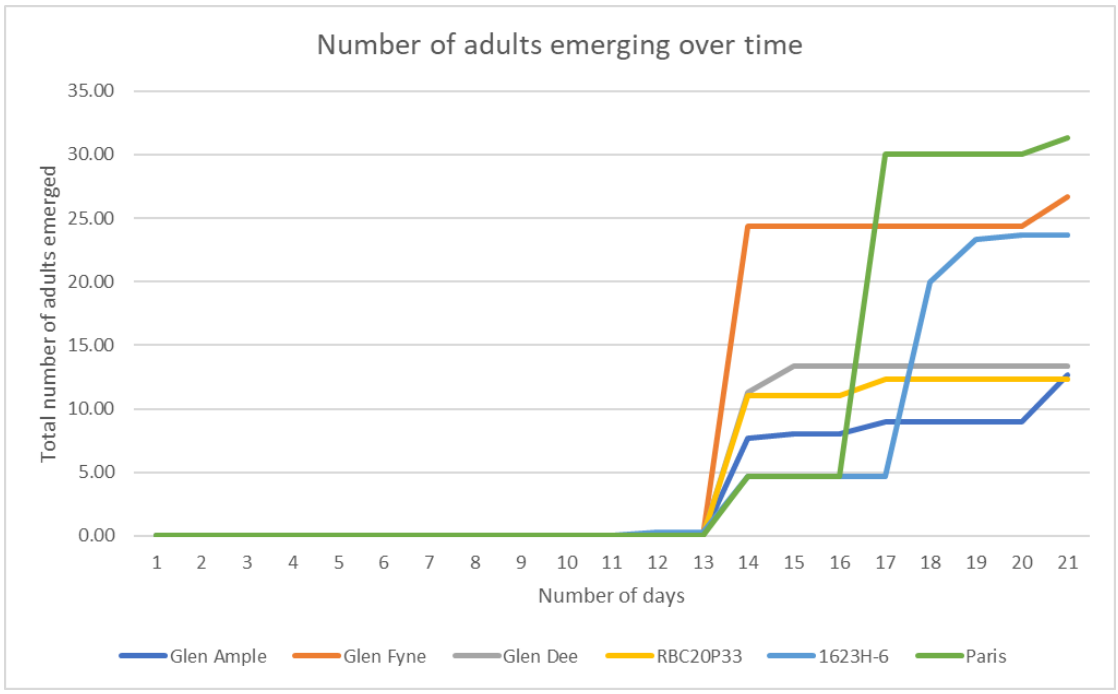

Figure 9 Mean number of SWD adults emerging each week from berries of six raspberry varieties.

Discussion. Using the mesh sleeves to cover the berries while they are still green is a successful way of preventing egg laying by SWD. The no choice assays showed that there are differences in susceptibility between varieties; further work is needed to establish the traits underlying this observation.

The assays were limited to three replicates due to the availability of berries, and more replicates would be desirable to confirm a lack of varietal differences in SWD susceptibility. Dissecting the berries to isolate SWD larvae appears to underestimate SWD infestation levels. To overcome this, fruit could be dissected when larvae are larger (but before adult emergence). Ideally, dissection would be carried out after egg laying to quantify oviposition success and again before adult emergence to quantify larval survival, to determine the success of egg laying and whether larval development is aborted in some cases.

Future work could focus on variety selection by female SWD when given a choice of fruit varieties and quantifying any fitness costs in the emerging adults such as adult size, sex ratio and female egg load.

Acknowledgements

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References

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