Protected cropping in raspberry accelerates onset of oviposition by vine weevils

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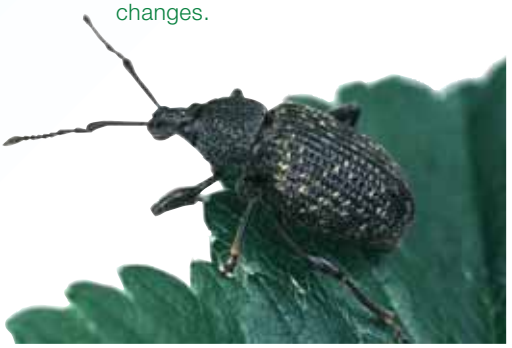
Following emergence in spring, adult vine weevils (*Otiorhynchus sulcatus*) must undergo a period of feeding prior to egg laying (the pre-oviposition period) usually lasting 4–5 weeks (Blackshaw, 1992). Predicting the duration of pre-oviposition periods is considered essential for controlling vine weevils, whether directing control at the sexually immature adults (e.g. insecticides) before they lay eggs, or targeting the first cohort of larvae (e.g. entomopathogenic nematodes) before they colonise roots.

The use of polytunnels for protected soft fruit production has become widespread, enabling longer growing seasons together with higher grade and more consistent fruit production. Protected cropping may have significant impacts on many insects, such as vine weevils, because of changes in the localised environment (e.g. temperature, humidity and light quality) and host plant physiology and chemistry (e.g. growth and nutritional quality).

The objective of this project was to determine how such protected environments affected key climatic factors (temperature and humidity), plant growth (plant height, foliar number, area and mass), foliar chemistry (six mineral nutrients) and vine weevil behaviour (reproduction and feeding) following adult emergence in late spring. Here, we report the response of vine weevils to such changes.



Methods

- Forty identical raspberry plants (cv. Glen Ample) were placed in mesh cages and transferred to plant beds within a polytunnel and adjacent field plantation (replacing existing plants). After one week, ten plants were inoculated with five newly emerged weevils at each site. The other ten plants remained weevil-free.
- Temperature, humidity and light quality were measured in field and tunnel environments at 1hr intervals throughout the study. Individual weevils were examined at random to ascertain when oviposition had commenced.
- Plants were harvested four weeks later. Weevil eggs were manually recovered from leaves and from the gravel using a flotation method. Leaf consumption was quantified using a leaf area meter with predicted intact leaf perimeters.
- A degree-day model (Son & Lewis, 2005) was used to predict when adults would begin ovipositing based on temperatures experienced in field and tunnel environments.

Results

- While 2008 was a generally cool summer in the UK, temperatures in the tunnels remained significantly higher than those in the field (Fig 1).
- Significantly more weevils had begun laying eggs in the tunnels when plants were harvested. Moreover, weevils in tunnels laid significantly more eggs and consumed significantly more leaf material (Table 1) than those in the field.
- Degree-day model predictions based on recorded temperatures were accurate for weevils in the field but overestimated the pre-ovipositon period for weevils in tunnels (Table 1).

Fig.1 Mean daily temperature in field (●) and tunnel (○) enviroments (t_{24} =5.71, P <0.001).

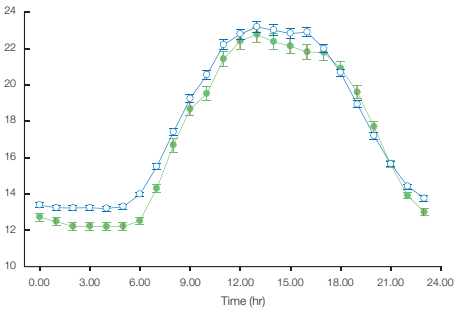


Table 1 Vine weevil responses when developing in field and tunnel environments.

	Field	Tunnel
Plants with weevil eggs	10%	70%*
Number of eggs laid (mean ± S.E.)	1.4 ± 0.4	23.0 ± 12.49*
Leaf consumption (cm^2) (mean ± S.E.)	61.57 ± 9.67	129.88 ± 47.94*
Model prediction for pre-oviposition period	41 days	37 days
Actual pre-oviposition period	39 days	26 days

* P < 0.05

Conclusions

- Elevated temperatures accelerated onset of oviposition by weevils in tunnels, compared to those in the field. The increase in tunnel temperatures was modest in 2008, suggesting that even small temperature increases can alter the life-cycle of vine weevils.
- The degree-day model used in this study (based on strawberry) was reliable for predicting oviposition in field populations of weevils, but not those in tunnels. This suggests that temperature alone was not solely responsible for accelerated oviposition.
- Increased feeding by weevils in tunnel grown raspberries may also accelerate egg production and particularly so if foliage is more nutritious. Analysis of mineral nutrients is currently underway.

References: Blackshaw, R.P. (1992) Black vine weevil (*Otiorhynchus sulcatus* (F.)) oviposition on polyanthus plants outdoors in Northern Ireland. *Journal of Horticultural Science*, **67**(5), 641–46.

Son, Y. & Lewis, E.E. (2005) Effects of temperature on the reproductive life history of the black vine weevil, *Otiorhynchus sulcatus*. *Entomologia Experimentalis et Applicata*, **114**(1), 15–24.