O.39 - Sex pheromone traps for monitoring wireworm populations: how effective are they?

Blackshaw, R.P.[1], Hicks, H.[1], Vernon, R.S.[2]

[1] School of Biological Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, UK
[2] Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Agassiz Research Station, P.O. Box 1000 – 6947, #7 Highway, Agassiz, British Columbia V0M 1AO, Canada

Contact: rblackshaw@plymouth.ac.uk

Abstract

Sex pheromone traps have been developed to trap the adult males of the three main UK wireworm pest species. Recommendations have been issued for their use with an emphasis on monitoring populations in grass the year before potatoes are planted. There are three assumptions underlying this method; that annual wireworm cohorts are of equal size; that adult male distributions relate to larval distributions; and that activity/density relationships are similar for the three species. Data are presented to challenge each of these assumptions and it is concluded that current advisory recommendations lack scientific credibility.

Introduction

Wireworms, the larvae of click beetles, are one of the more pernicious soil pests confronting growers. They spend up to five years feeding in the soil prior to pupation. Damage is caused by direct plant losses and by cosmetic damage when they burrow into, for example, potato tubers. Wireworms can also be considered cryptic in two senses; their habitat makes them difficult to detect, and they are often difficult for non-experts to identify to species. In addition, economically damaging populations are often smaller than the detection threshold for any realistic sampling method. This is particularly the case for the important UK pest species – *Agriotes lineatus*, *A. obscurus* and *A. sputator* (Parker & Howard 2001).

These challenges have prompted the development of sex pheromone traps in order to monitor adult males as a surrogate for larvae (Toth et al. 2003). There is attractiveness to this system. Click beetles are more easily detected than wireworms and sampling effort is less. Furthermore, the use of count data gives the illusion of accuracy because of its apparent precision.

Advice on how to use these traps has been issued in the UK. Recommendations are to place a trap for each species at a minimum of 40m separation, and to capture adult males over a 12 week period in early summer in fields intended for a potato crop the following year; counts are then added and compared to a table to estimate overall risk of wireworm attack (Table 1).

Table 1 Advisory outcomes from sex pheromone trap catches of adult male click beetles (Anon 2006).

Season-long trap catch per set of three traps	Predicted wireworm population ha^{-1}	Approximate risk of damage to potatoes
Nil	No or very low infestation	No or very low risk
Less than 50	25,000 to 250,000	Some damage likely
50 to 100	150,000 to 250,000	Significant damage likely
More than 150	More than 250,000	Severe damage likely

This monitoring system, however, is predicated on three assumptions. The adults that are trapped in any given season arise from a population cohort from five years earlier. For this cohort to be quantitatively related to the residual wireworm population (that will cause the damage the next season) requires each annual cohort to be of approximately equal size. This is the first assumption. The second assumption is that the distribution of adult sex pheromone trap catches can be related to that of the wireworms themselves, i.e. that adult counts can predict larval population size. Finally, the instruction to add the separate counts for each species to estimate overall pest burden counts will only be legitimate if the activity/density responses in relation to the trapping system are similar for the different species. In this paper we present data that allow us to test each of these assumptions.

Table 2. Size frequency classification of a wireworm population

Wireworm size (mm)	Number
3.1 – 5.0	11
5.1 – 8.8	42
8.9 – 18.0	265
>18.0	97

Size of Annual Cohorts

In a recent study Blackshaw & Vernon (2008) reported the size frequency distribution of a population of wireworms in a strawberry field in British Columbia, Canada. The size classes were chosen to approximate to annual cohorts (modified from Subklew (1934)) and showed marked differences in cohort size (Table 2).

Click beetle and wireworm distributions

In a study into the distribution of click beetles of the species *A. lineatus*, *A. obscurus* and *A. sputator,* and wireworms in an agricultural landscape in the South Hams, Devon, UK, sex pheromone trap catches for the three species were compared with wireworm population counts recovered from soil sampling (Hicks and Blackshaw unpublished). Data were subject to principle components analysis and showed that the three *Agriotes* species were not uniformly found in the 95 sampled fields and only *A. obscurus* was distributed in a similar way to wireworms (Fig 1). Furthermore, it is worth noting that whilst all fields yielded some click beetles, wireworms were recovered from only 17 at a population detection level of 62,500 ha^{-1}.

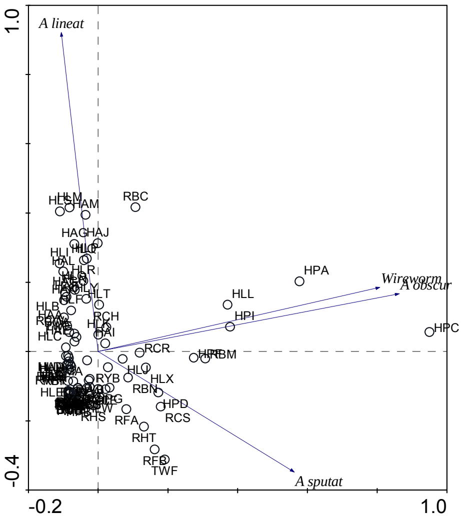

Figure 1. Ordination diagram of PCA of three adult *Agriotes* species and the complex of *Agriotes* wireworm, the open circles with 3-letter labels are individual fields sampled Note: species names are truncated.

Activity/density responses to pheromone traps

Mark-recapture studies have been used to compare and quantify the responses of *A. lineatus*, *A. obscurus* and *A. sputator* adult males to their respective sex pheromone traps (Hicks & Blackshaw In press). *A. lineatus* had the greatest maximum sampling range followed by *A. obscurus* and then *A. sputator* and the effective sampling area was similarly ranked (Table 3). However, the times to the maximums differed with this being achieved by *A. sputator* 15 days after release of marked individuals, *A. lineatus* after 30 days, with *A. obscurus* trapping parameters still expanding after 30 days.

		Cumulative sampling days since release of marked individuals		
		15	30	45
A. lineatus	r_s	43.29	80.35	82.00
	α	2588	6908	6768
A. obscurus	r_s	37.80	42.59	51.31
	α	2580	2795	3636
A. sputator	r_s	24.57	22.40	22.40
	α	1698	1335	1335

Table 3. Estimated values for the maximum sampling range (rs) and effective sampling area (α) for three species of click beetles responding to sex pheromone traps.

Discussion

In this paper we have set out available data to test the assumptions that underpin the current recommendations for the use of sex pheromone traps in the management of wireworms in UK potato crops. The first of these assumptions is that wireworm age cohorts are of equal size. Table 2 suggests that this is not the case. This is not unexpected since a different result would imply that wireworms are unaffected by both abiotic and biotic influences on their population dynamics. However, we point out that these data were gathered as a result of bait trapping and differential behavioural responses may have affected the outcome.

The extensive fieldwork carried out in the UK, summarised in Figure 1, shows that the relationships between the distribution of adult males – as measured by sex pheromone trap counts – and wireworms is complex. The three species are influenced by different factors (further analyses of these data in relation to environmental variables confirms this), but only *A. obscurus* appears to be aligned with wireworm populations. A similar occurrence of *A. obscurus* rather than *A. lineatus* being spatially related to wireworm distributions was reported from a field in Canada (Blackshaw & Vernon 2008).

Our ability to interpret results such as these has been severely limited by an inability to reliably separate wireworms into species. We have recently developed a robust method based on Terminal Restriction Fragment Length Polymorphism which overcomes this problem (Ellis *et al*. In press); a fascinating outcome from identifying wireworms recovered in the South Hams study is that we have yet to find a larval *A. lineatus*. Blackshaw & Vernon (2008) postulated that *A. lineatus* would move faster than *A. obscurus* and the mark-recapture outcomes (Table 3) are consistent with this, though not yet conclusive. The most important applied result is that the three species have quantifiably different responses to their respective sex pheromone traps. It is therefore inappropriate to simply add trap counts in the way outlined in Table 1. There are also suggestions in the data that there may be underlying differences in behaviours as well as differences in rates of response to the pheromones; the data for *A. sputator* could be interpreted as the species being relatively static.

We have tested the three assumptions that are essential for sex pheromone traps to provide quantitative predictions of wireworm populations and have been able to reject them. We do not argue that sex pheromone trapping has no role to play in wireworm management, rather that we need to better understand the spatio-temporal dynamics of the system and inter-specific differences. For example, trap interference through overlapping sampling areas, postulated by Blackshaw & Vernon (2008) will confound interpretation of counts.

There is now evidence from two geographically separate studies that *A. obscurus* adult male counts may provide a better predictor of wireworm numbers than those of other species. This remains speculative because evidence is indirect and we lack a causal mechanism, but there is the potential reward of a simplified and cheaper monitoring system.

Until aspects such as these are resolved we should carefully consider the advice given on the basis of sex pheromone trap counts. The fact that adults may be ubiquitous in fields in mixed agricultural landscapes when wireworms are more limited in their within-field distributions argues for caution. Sex pheromone traps are potentially powerful tools in pest management; poor advice to growers now may limit their future uptake when we better know how to make use of them.

References

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