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Brassicas: Biology and Control of Brassica Flea Beetles by Integrating Trap Crops with Insecticide Use

Final Report 2002

by

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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Brassicas: Biology and Control of Brassica Flea Beetles by Integrating Trap Crops with Insecticide Use

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DISCLAIMER

The results and conclusions in this report are based on an investigation conducted over one year. The conditions under which the experiment was carried out and the results obtained have been reported with detail and accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results especially if they are used as the basis for commercial product recommendations.

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Commercial benefits of the project

The brassica flea beetle complex, (a range of *Phyllotreta* species) is becoming an increasing problem for vegetable brassica growers during the spring and summer. Attacks occur on both speciality salad vegetables and on drilled brassicas such as swedes. Severe attacks can necessitate re-drilling, and even moderate attacks on speciality salads can severely reduce leaf quality. This project aims to benefit brassica growers by:

- Identifying the potential of trap cropping as a non-chemical tool for helping to manage the flea beetle complex. If successful, this will reduce the insecticide burden on the brassica crop, thus reducing the risks of pesticide residues in produce and helping to maintain natural enemy populations. This will help fulfil the requirements of Assured Produce protocols to adopt Integrated Pest Management (IPM) techniques.
- Identifying the efficacy of existing and new potential insecticides to replace those likely to be lost in current UK and EC based reviews.
- Assessing the extent to which organic growers could adopt trap cropping as an alternative to the use of fleece crop covers for flea beetle management.

Project objectives

The overall aim of this three year project was to reduce the number of insecticide applications made to some crops for flea beetle control, and to identify additional non-chemical means of flea beetle management consistent with the principles of Integrated Crop Management (ICM).

The objectives of the first and second year's work were:

1. To confirm the duration of *Phyllotreta* spp. flea beetle activity and identity of the flea beetle species complex species at a range of geographical locations around the country.
2. To confirm the 'attractiveness' of the potential trap crops identified in year 1, and to investigate the potential distance over which they may exert an effect of flea beetle population distribution in the field.
3. To investigate alternatives to current insecticides.

The objectives of the third year were to:

1. To investigate on a field scale the impact of different separation distances between trap crop strips on flea beetle damage to the field brassica crop.

Key results and conclusions

Flea beetle monitoring

- The monitoring work in 1999 and 2000 clearly demonstrated that *Phyllotreta* flea beetles could potentially be active for the whole of the May to July period, although at most sites there were clear peaks of activity lasting four to six weeks within this time-frame. The extended monitoring at HRI Wellesbourne in 1999 and 2000 also showed that flea beetles continued to be active, albeit at a lower level of activity, into the early autumn.

- Non-crucifer feeding flea beetle species were commonly found in water traps, but were rarely found in significant numbers in the brassica field crops. This indicates that water-trapping may be an unreliable practical tool for assessing flea beetle risk in a commercial situation.

Trap cropping

- Trap crop were clearly shown to be more attractive to flea beetles than field crops (broccoli or swede) in both 1999 and 2000.

- Summer turnip (cv. White Lady) was the most consistently effective attractive trap crop species, followed by Chinese cabbage (cv. Kasumi). Indian mustard (*Brassica juncea* var. *crispifolia*) was not effective.

- Attractiveness of the trap crops tended to increase with plant age. They were most effective when sown at least two weeks in advance of the field crop.

- There was some evidence the different flea beetle species may have preferences for different trap crops. Determining the dominant *Phyllotreta* species in specific localities may therefore be important in selecting effective trap crops. Alternatively, a ‘trap crop’ consisting of a mixture of brassica types, for example the summer turnip/Chinese cabbage mix used in Devon in 2001, could be used.

- Data from 2000 and particularly 2001 have shown that trap crop strips tend to result in higher flea beetle numbers and damage occurring in the field crop area immediately adjacent (within 1 to 2 m) to a trap crop strip. Once outside the immediate proximity of the trap crop, damage (and flea beetle numbers) declines rapidly. The clear implication is that widely spaced (>20 m at least) trap crop strips are likely to be more effective in potentially reducing crop damage than those sown close together.

- The evidence also suggests that a perceived drawback of trap cropping – that planting trap crop strips through a field crop may bring more beetles into the field crop – may in fact not be serious issue. This is because flea beetle distribution does not appear to be limited to the field margins only.

Insecticides

- Of the seed treatments tested in 1999 and 2000, imdacloprid (Gaucho) and carbofuran (Furadan 440) were the most consistently effective in reducing plant damage and maintaining plant populations. Tefluthrin (Force) and fipronil were less effective. None of the treatments gave control levels above *c*. 60-70%.

- Single sprays of pyrethroid insecticides (λ-cyhalothrin, cypermethrin, deltamethrin) and spinosad (not currently Approved) suppressed the flea beetle population for at least one to two days, although by seven days after the first treatment damage on treated and untreated plots was similar. However, seedling survival was substantially increased by a single spray and was maintained by a second spray applied nine days after the first. Thus provided flea beetle attacks are not overwhelming, a two-spray programme of pyrethroids should provide sufficient protection.
- The question of whether just treating the trap crop with insecticide (whether seed treatment or foliar spray) could reduce or eliminate the need for insecticide applications to the field crop still remains open.

Action points for growers

- Growers with persistent flea beetle problems could consider growing strips of trap crops either alongside or interspersed with their field crops of brassicas. The most effective trap crop is likely to be a 1:1 mixture of summer turnip, cv. White Lady and Chinese cabbage (cv. Kasumi). Seed can be obtained from Stokes Seeds, St Catherines, Ontario, Canada (http://www.stokeseeds.com).
- Based on results obtained during this work, trap crop strips would probably need to be sown at no less than 20 m intervals within the field crop, and possibly at greater distances apart. Trap crop strip should not be sown close together as flea beetles tend to be found in high number in the field crop immediately adjacent (1-2 m) to trap crop strips.
- Of the currently available insecticide treatments, a two spray programme of Hallmark, Decis or Ashlade Cypermethrin can allow a proportion of seedlings to survive flea beetle attack, although a high proportion of seedlings will be damaged. Of the seed treatments, only Gaucho currently has a Specific Off-label Approval (SOLA) for use on brassicas for the control of peach-potato aphid (*Myzus persicae*), but is only Approved for use on cabbage, Brussels sprout, cauliflower,

calabrese and broccoli (SOLA 2571/2000). It cannot be used on speciality brassicas.

Anticipated practical and financial benefits

- Any further development of trap cropping should concentrate on identifying opportunities for moving insecticide treatment away from the field crop and on to the trap crop. Treating flea beetle populations on trap crops rather than on crops grown for harvest will potentially lessen the risk of pesticide residues in harvested produce, as well as reducing the overall use of insecticide on vegetables.

- Trap cropping has potential as a pest management tool for organic growers in particular, and the principle could be extended to other pests such as diamond-back moth and cabbage root fly.

- Several studies done elsewhere in the world suggest that the use of trap cropping can bring financial benefits. On average, a 10-30% overall increase in net profits, mainly resulting from reduced insecticide use and/or reduced pest attack, has been reported. It is not clear at this stage if this level of financial benefit will accrue from this project. A clearer view of this should be possible once the project has been completed.

- SpinTor (spinosad) has potential as an alternative insecticide treatment to pyrethroids for flea beetle management. However, there is no immediate prospect of this treatment being approved for use in the UK.

EXPERIMENTAL SECTION

General Introduction

The brassica flea beetle complex, (a range of *Phyllotreta* species) is becoming an increasing problem for vegetable brassica growers during the spring and summer. Attacks occur on both speciality salad vegetables and on drilled brassicas such as swedes. Severe attacks can necessitate re-drilling, and even moderate attacks on speciality salads can severely reduce leaf quality. Although effective insecticides are available for flea beetle control (principally pyrethroids such as α-cypermethrin and deltamethrin), they are not persistent. Re-invasion of the crop after spraying can be very rapid and even repeated insecticide treatment often fails to give adequate control. The withdrawal of the organochlorine compound γ-HCH as a seed treatment in June 1999 and more recently for all agricultural use has further compounded flea beetle control problems.

Other insecticides approved on brassicas can give incidental control of flea beetles. These include the carbamates aldicarb, carbofuran and carbosulfan, which are used primarily for cabbage root fly (*Delia radicum*) control. However, because of the problems of enhanced degradation, these soil-applied insecticides can only be used once a year in any one field, and not in the same field in consecutive years. In principle, organophosphorous (OP) insecticides could also be used for flea beetle control. However, current consumer and retailer concerns over the use of such products set a practical limit on their use. On-going regulatory reviews are also substantially reducing product availability - both carbofuran and carbosulfan are likely to cease to be available for use on vegetable brassicas as a result of EC reviews of Maximum Residue Limits (MRLs)).

There is therefore an urgent need to identify new effective insecticides for flea beetle management specifically on brassicas. Although some recent work has been done on flea beetle control with insecticides on brassicas (Finch & Edmonds, 1999) and other crops (Oakley *et al*., 1996; Cullis *et al*., 1999), further work is still required.

The increasing emphasis on Integrated Crop Management (ICM) in vegetable production means that growers are under pressure from their major customers to reduce insecticide use, and to integrate insecticidal control with non-chemical methods of pest management. One of the most promising techniques for flea beetle management on brassicas without insecticides is trap cropping (Vargas & Kershaw, 1979; McKeown, pers. comm.). Trap cropping is based on the principle that virtually all pests show a distinct preference for certain plant species, cultivars or crops of a certain age. Therefore, offering pests an attractive 'alternative' to the target crop at critical times during the pest's and/or the crop's development results in the concentration of the pest on the 'alternative' host - the trap crop. Protection is achieved either by preventing the pest from reaching the crop or by concentrating the pest into an area which can be economically treated with an insecticide (Hokkanen, 1991).

To be successful, trap crops must be more attractive to the pest than the main crop. Differences in attractiveness can be achieved in one of two ways. Firstly, by using a preferred plant or cultivar planted alongside the crop. Alternatively, the same crop plant as the main crop can be used, but at a different, more attractive, growth stage than the actual crop. Knowledge of the target pest, including information on overwintering, hibernation sites and the direction of infestation is also important when using trap crops (Hokkanen, 1991).

Work done at the University of Guelph, Ontario, Canada in 1996 identified that certain exotic mustard species were highly attractive to flea beetles. These reduced or in some circumstances eliminated the need for insecticide treatment in brassicas planted alongside strips of trap crops (McKeown, pers.comm.). These Canadian experiences provided the basis for investigating the effectiveness and practical use of trap cropping for flea beetle management in the UK done as part of this project.

Summary of work done in 1999 and 2000

Over the course of three years, the project has investigated three aspects of brassica flea beetle biology and control:

1. The range of *Phyllotreta* (and other flea beetle) species and the duration of their activity during the summer at different geographical locations.
2. The effectiveness of insecticides applied either as foliar sprays or seed treatments for flea beetle control.
3. The potential use of trap crops as an aid to flea beetle management.

Progress on each of these aspects to date is summarised below.

Flea beetle species complex – years 1 and 2

Brassica flea beetles (mainly those in the genus *Phyllotreta*) were monitored through the summer at four field sites in 1999 and 2000 (the same sites were used in both years). Sites were located on commercial farms in East Lothian, Herefordshire and Devon, and at HRI Wellesbourne (Warwickshire).

In 1999, *Phyllotreta* flea beetles were found to vary in the number and species composition between sites. *Phyllotreta undulata* and *P. atra* predominated at the East Lothian and Herefordshire sites, whereas *P. vitula* and *P. nigripes* predominated at the Devon site. Other non-*Phyllotreta* (non-brassica feeding) species were caught in water traps, but were rarely found on trap crops. The number of beetles trapped also varied between sites. The timing of peak beetle activity varied from May/June at some sites to June/July at others. Beetles were caught at all sites throughout the monitoring periods (May to July at three sites, April to October at one site).

In 2000, the abundance and composition of the *Phyllotreta* species complex again varied between sites. *P. undulata* predominated at the Herefordshire and East Lothian sites, while *P. diadamata* was the most abundant species in Devon. Preliminary investigation from the Warwickshire site suggested that *P. atra* was the commonest species there. Large numbers of non-crucifer feeding flea beetle species were caught in water traps at the Herefordshire and Devon sites, but were rarely found on trap crops or field crops. The timing of the peak beetle activity varied from May/June at some sites to June/July at others. However, beetles were caught at all sites throughout the monitoring periods (May/June to July at two sites, May to August at a third site and April to August at a fourth).

Insecticide work – years 1 and 2

This work was done at HRI Wellesbourne in 1999 and 2000.

Seed treatments

In 1999, four insecticidal seed treatments were applied to swede seed. These were carbofuran (Furadan 440), imidacloprid (Gaucho), tefluthrin (Force) and fipronil. None of the treatments improved plant stand, but carbofuran and imidacloprid reduced the percentage of seedlings damaged by flea beetles by approximately 70% and 60% respectively.

In 2000, the use of insecticidal seed treatments on turnips sown on three separate drilling dates had little effect on the percentage of seedlings damaged, with the exception of carbofuran and imidacloprid on the first drilling, and carbofuran only on the third drilling. However, all insecticides tended to increase seedling survival, from *c.* 75-80% in untreated plots to 90-100% on treated plots. This suggests that the severity of damage on treated seedlings was lower, and hence allowed a greater proportion of plants to establish.

Foliar spray treatments

In 1999, single foliar treatments with pyrethroids λ-cyhalothrin (Hallmark), cypermethrin (Ashlade Cypermethrin) and deltamethrin (Decis) or γ-HCH (Gammacol) marginally improved plant stand of turnip seedlings, and reduced the percentage of seedlings damaged by flea beetles by 25-45%.

In 2000, the efficacy of a two-spray programme of either λ-cyhalothrin (Hallmark), deltamethirn (Decis), cypermethrin (Ashlade Cypermethirn) or spinosad (SpinTor) was broadly similar for all products tested. A single spray treatment suppressed the flea beetle population for at least one to two days, although by seven days after the first treatment damage on treated and untreated plots was similar. However, seedling survival was substantially increased by a single spray of all the products, and was maintained by a second spray applied nine days after the first.

Trap cropping work – years 1 and 2

This work was done at on two commercial farms, one in Herefordshire (an organic site) and one in Devon.

In the first year of the project (1999), the attractiveness to flea beetles of four exotic crucifers was evaluated. These were Chinese cabbage (*Brassica rapa* ssp. *pekinensis) cv.* Kasumi, summer turnip (*Brassica napus*) *cv.* White Lady, Chinese radish (Lo Bok, *Raphanus sativus*) and Indian mustard (*Brassica juncea* var. c*rispifolia*). These potential trap crops were sown on four different dates, and their efficacy in attracting flea beetles was compared with a 'typical' vegetable crop (broccoli or swede). Chinese cabbage and summer turnip were the most attractive to flea beetles, although all trap crops attracted more flea beetles than swede or broccoli. Older trap crops (four weeks older than the field crop) were also shown to be more attractive. This provided a sound basis on which to base the second and third year's work.

Work done in 2000 confirmed that summer turnip (cv. White Lady) consistently attracted more flea beetles than the control field crop (broccoli or swede) at both sites. Chinese cabbage (cv. Kasumi) was only found to be more attractive than the control field crop (broccoli) at the Herefordshire site, possibly reflecting the different *Phyllotreta* species composition at the two sites. The 'attractiveness' of trap crops was again shown to increase with age, suggesting that trap crops should be sown up to two weeks in advance of the drilling/planting of the field crop.

Rationale for work done in 2001

The 'distance of attractiveness' that trap crops exerted over flea beetles was not fully verified in 2000 (although indications were that this was in the order of 10 m). This work needed to be done on a much larger scale than was possible in 2000. In particular, further work was required to determine whether the use of trap crop strips on a field scale actually influenced crop damage levels. The objective of the final year of work was therefore to investigate on a field scale the impact of different separation distances between trap crop strips on flea beetle damage to the field brassica crop.

Materials and methods

Site Locations

Experiments were done on an ADAS experimental field site at Staplake Mount, Starcross, Devon, and on commercial horticultural land at Westlake Farm, Starcross, Devon.

Trap crop types

The selection of traps crops for detailed study was based on the results from the previous two years experiments. Chinese cabbage (cv. Kasumi) and summer turnip (cv. White lady) were both selected as there was some evidence from the previous years' work that different flea beetle species responded differentially to different trap crop species. Seed for both trap crops was obtained Stokes Seeds, St Catherines, Ontario, Canada.

Experimental procedure

Approximately two weeks prior to the field crop area being drilled, paired strips of trap crops were sown separated by one, two, four or eight bed widths. Each trap crop strip comprised one bed width (1.83 m) x 10 m long and was sown with both varieties of trap crop, with each different variety sown in alternate rows. Swedes (field crop) were drilled in the area between each pair of trap crop strips two weeks later.

Summer turnip and Chinese cabbage trap crops were drilled at the Westlake Farm site on 14 June 2001 and at the Staplake Mount site on 20 June 2001. All plots were drilled using a tractor-mounted seed drill. Six rows 30 cm apart were drilled on each bed, with a 6.25 within-row spacing (16 plants/m of row). Immediately after emergence trap crops were covered with Hortifleece to protect emerging plants from flea beetle damage prior to assessments. Covering dates were 21 June at the Westlake Farm site and 27 June at the Staplake Mount site. At Westlake Farm, the swede field crop (cv. Devon Champion) was drilled on 28 June 2001. Crop emergence was from 5 July 2001 onwards.

Experimental design

The experiment was a complete randomised block design with the four 'treatments' of different trap crop spacings replicated six times (see Figure 1 for an example layout). A 5 m guard of bare soil separated each replicate, and each trap crop pair/swede combination was separated by three bed widths of bare soil.

Assessments

Field crop establishment

Field crop (swede) areas were assessed for percentage establishment on the final assessment date, 8 days post field crop emergence. The total number of established swede plants within each 'plot' were counted and percentage emergence calculated relative to the original sowing density.

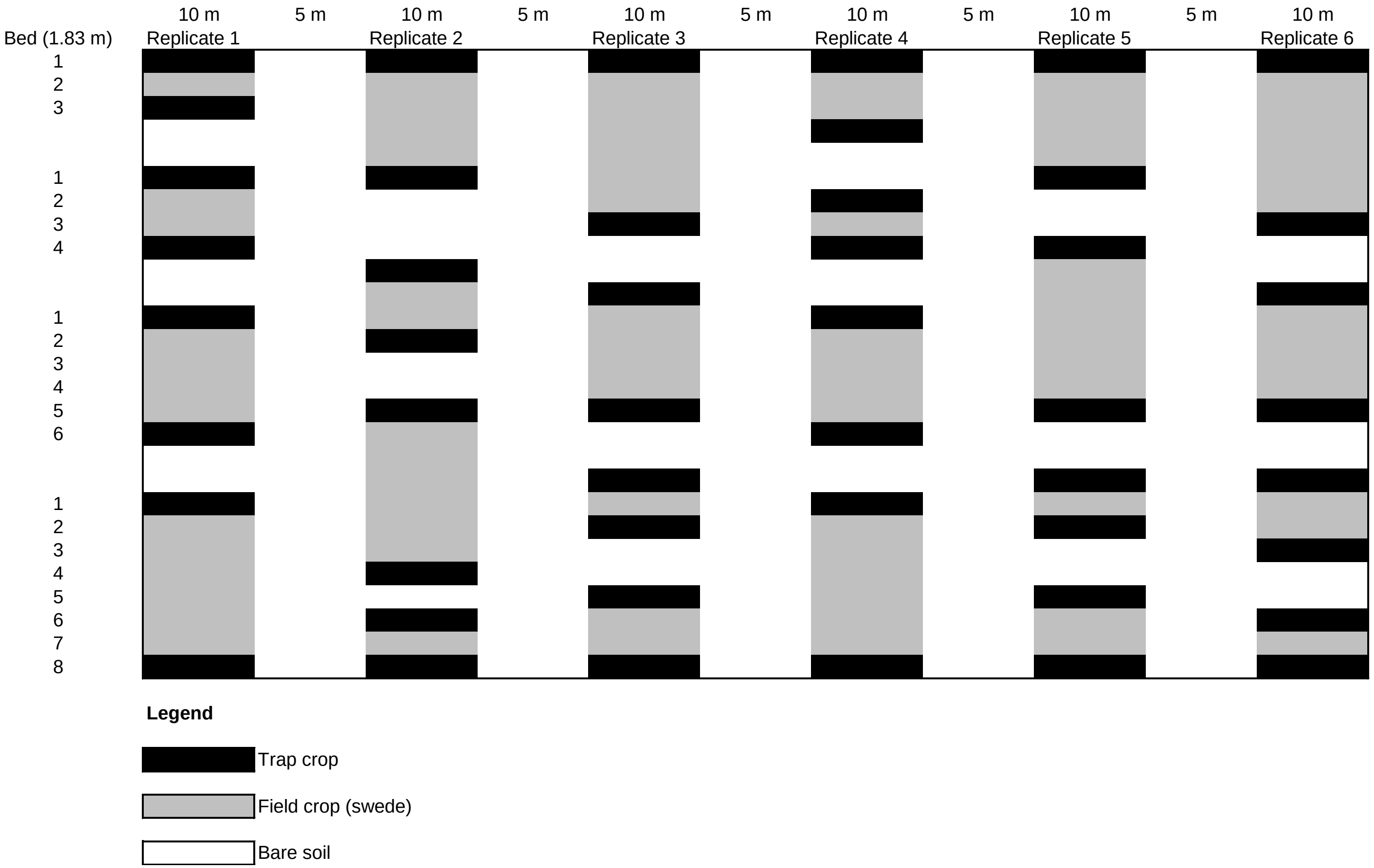
Crop damage assessment

Flea beetle damage assessments were made on the field crop one, two, three four, five and eight days after crop emergence. Assessments were done in each bed of field crop that separated two-paired strips of trap crop. On each occasion, three 1 m lengths of row were randomly selected from the central two rows of each bed. The number of holes per seedling (from 48 plants at 16 seedlings/metre) were counted and recorded.

Flea beetle species composition

Two days after the field crop had emerged one yellow, doubled sided sticky trap was placed on the edge of each trap crop/swede plot. The sticky traps were left for two days to allow beetles to be trapped on them. Flea beetles were removed the traps, cleaned in white spirit, and identified to species.

Figure 1. Example of experiment design.



Data analysis

Raw data was log10 (n+1) transformed prior to analysis to stabilise variances. Analysis of variance was then performed on these data, in which days post emergence (DPE), bed number and trap crop spacing interval were treated as factors.

Results

Staplake Mount site

The trap crop strips at the Staplake Mount site failed to germinate. The experiment was re-drilled on 14 July 2001, but the trap crops failed to germinate again. There was insufficient seed to re-drill the experiment a third time, and therefore this site had to be abandoned.

Westlake Farm site

Crop establishment

At this site, both the trap crops and the field swede crop germinated and established satisfactorily. Establishment for the two trap crop species, summer turnip and Chinese cabbage, was 97% in both cases. Percentage establishment for the swede crop was 100%.

Crop damage assessment

Damage to the swede crop significantly increased with time (F=3.96, d.f=3., P <0.001). Overall damage to the crop was relatively constant for the first five days post emergence, but had increased by Day 8 (Figure 2).

The number of beds between the trap crop strips also significantly influenced the overall level of flea beetle damage recorded on the swede crop in the intervening beds (F=8.06, d.f.=524 , P<0.001). Less crop damage occurred as the gap between the trap crop strips was increased (Figure 3).

Figure 2. Overall mean number of flea beetle holes/plant (± standard error) on swede plants assessed 1, 2, 4, 5 and 8 days after uncovering trap crop strips.

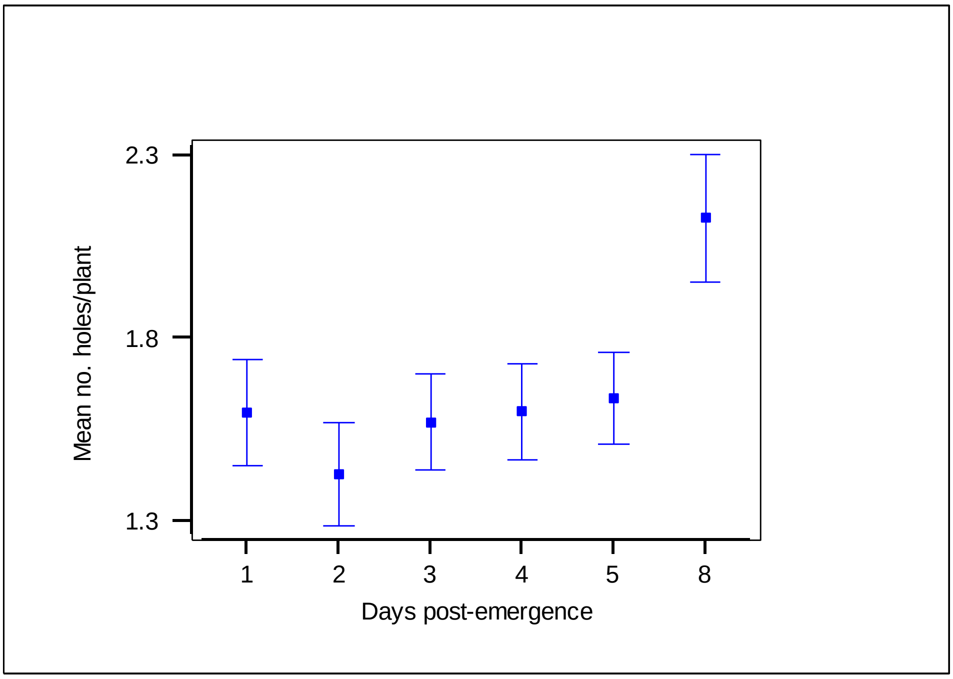


Figure 3. Effect of the number of crop beds between trap crop strips on the overall mean number of flea beetle holes/plant (± standard error)).

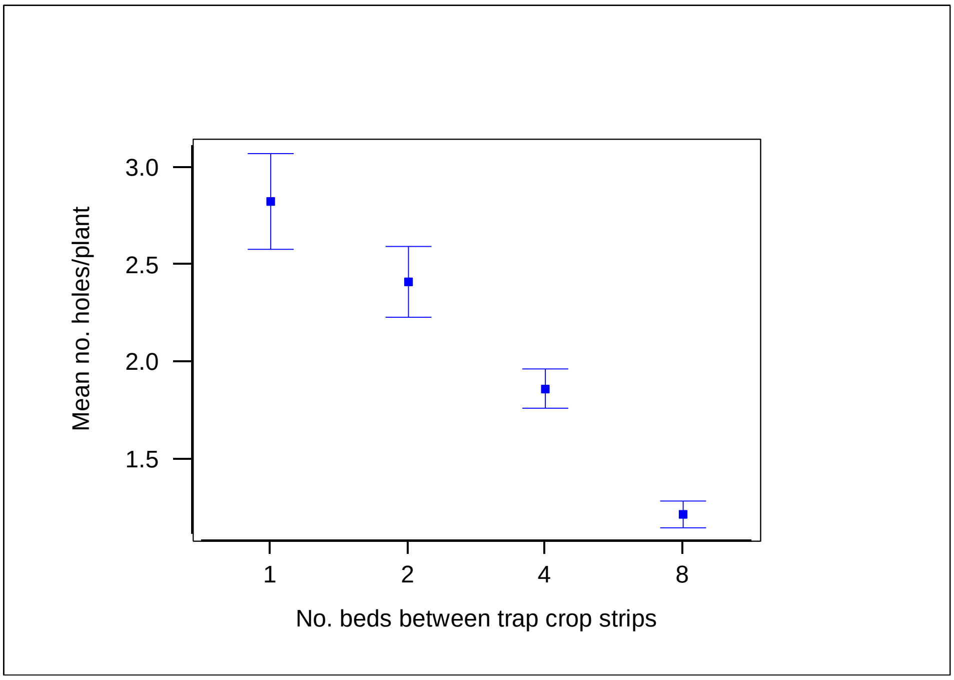
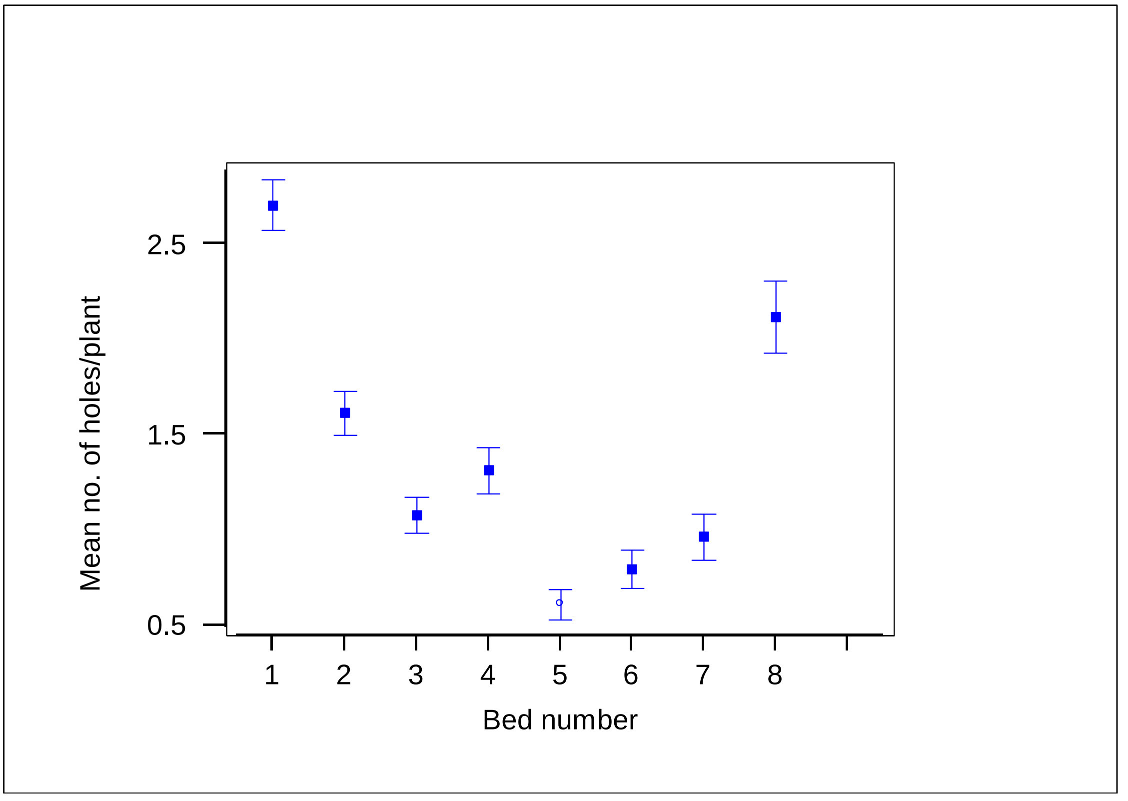


Figure 4. Mean number of flea beetle holes per plant (± standard error) in beds of swede located at different distances from trap crop strips (beds 1 and 8 are immediately adjacent to trap crops strips).

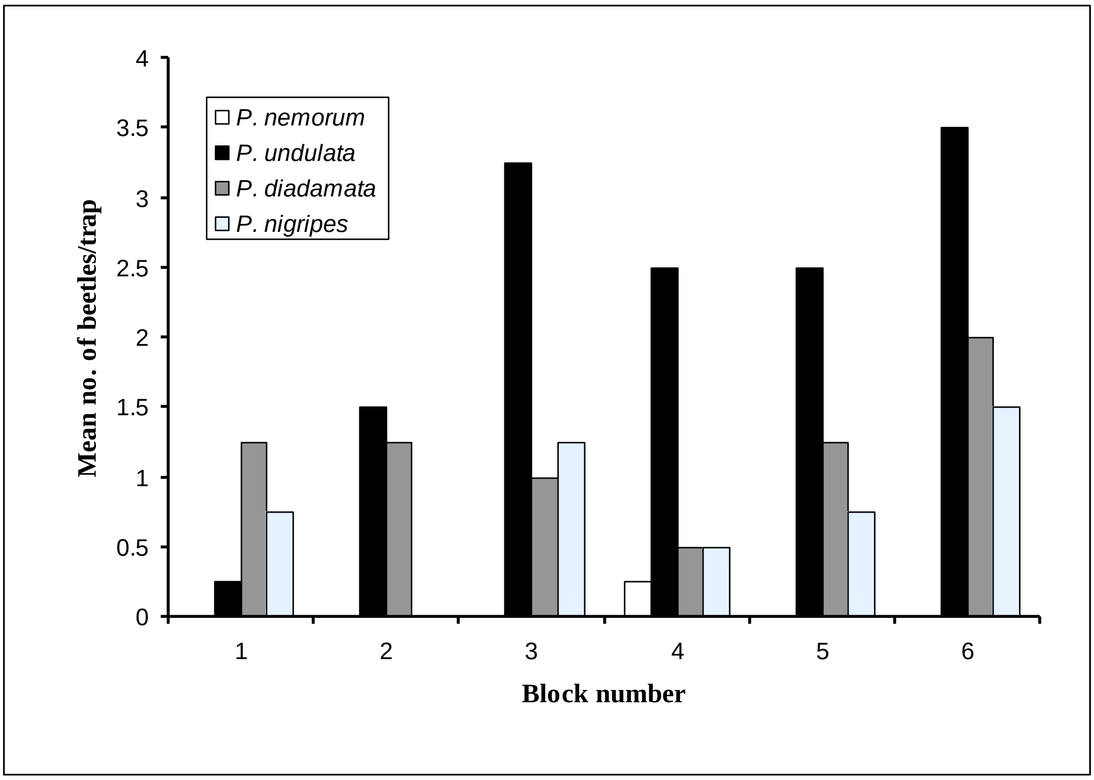


Analysis of the flea beetle damage recorded in beds of swede at different distances from trap crops strips indicated a significant effect of bed location on damage (F=18.09, d.f.=524, P<0.001). Crop damage was least in those beds furthest from the trap crops strips (maximum separation of three beds), and highest in those beds (beds 1 and 8, Figure 4) sown immediately adjacent to the trap crop strips.

Flea beetle species composition:

The number of *Phyllotreta* flea beetles recorded on sticky traps from day 2 to day 4 of the experiment are shown in Figure 5. *P. undulata* was the most numerous species caught (mean 2.25 beetles/trap). *P. diadamata* and *P. nigripes* were the next most numerous species. This species composition is consistent with that found in previous years' flea beetle trapping in this locality.

Figure 5. Mean number of *Phyllotreta* flea beetle species per sticky traps recorded at Westlake Farm, Devon in different experimental blocks.



Discussion

The distance between trap crop strips had a clear impact on crop damage levels, with narrower gaps between trap crop strips tending to result in higher crop damage in comparison to those plots where the gap between trap crop strips was much wider (Figure 3). This concurs with data from 2000 on flea beetle distribution in field crops in relation to trap crops grown on the field margin. These showed that more flea beetles tended to be found in the field crop immediately adjacent (within 1 m) to trap crop strips than further out into the field. Thus, assuming a relationship between flea beetle numbers and damage, a narrow gap between trap crop strips would tend to result in higher proportion of the crop effectively being adjacent to a trap crop strip, and thus prone to injury by higher flea beetle populations. The design of the 2001 experiment was such that a 'field margin' effect on flea beetle distribution was discounted.

Additional support for the observation that flea beetle damage tends to be higher immediately adjacent to trap crop strips in given by the data in Figure 4. This clearly shows that the distribution of flea beetle damage is influenced by crop proximity to the trap crop strips, as damage was highest in beds 1 and 8, those immediately adjacent to the trap crop strips. Crop damage rapidly declined as the distance from the trap crop strips increased.

It is not possible to draw conclusions on whether the absolute level of crop damage sustained was influenced by the presence of the trap crops in the field. This is because without further detailed study beyond the scope of this project, it cannot be shown whether the trap crops actually had the effect of bringing more flea beetles into the field, or simply re-distributed those that were already present within the field. Data and observations from work done on this project in 1999 and 200 suggest that initial flea beetle distribution within fields is not limited to the field margins, so the latter explanation is possibly more likely.

In conclusion, the data from 2001 have clearly shown that trap crops do influence the distribution of flea beetle damage on the field crop. Although the failure of the experiment at Staplake Mount did not allow the robustness of the Westlake Farm results to be fully validated, the data obtained was conclusive and concurred with the results of work done in 1999 and 2000. From a practical point of view, it is clear that trap crop strips should not be sown close together, and could probably be sown at wider spacings than those used in the 2001 experiment.

General Conclusions – years 1 to 3

Flea beetle monitoring

The monitoring work in 1999 and 2000 clearly demonstrated that *Phyllotreta* flea beetles could potentially be active for the whole of the May to July period, although at most sites there were clear peaks of activity lasting four to six weeks within this time-frame. The extended monitoring at HRI Wellesbourne in 1999 and 2000 also showed that flea beetles continued to be active, albeit at a lower level of activity, into the early autumn. There were also clear differences in the *Phyllotreta* species complex between sites. *P. undulata* was the dominant species in East Lothian and Herefordshire, while *P. diadamata* and *P. undulata* were the predominant species in Devon in 2000 and 2001 respectively. While determining the different species present is not important when considering flea beetle control using insecticides, there is some evidence from 1999 and 2000 data that flea beetle species may be attracted to varying degrees to different trap crops.

Non-crucifer feeding species were commonly found in water traps in Herefordshire and Devon, but were rarely found in significant numbers in the brassica field crops. This indicates that water-trapping may be an unreliable practical tool for assessing flea beetle risk in a commercial situation.

Trap cropping

Trap crop were clearly shown to be more attractive to flea beetles than field crops (broccoli or swede) in both 1999 and 2000 (Howard & Parker, 2000). Taken over the two years, Chinese cabbage (cv. Kasumi) and summer turnip (cv. White Lady) were the most effective trap crops. As the attractiveness of the trap crops tended to increase with plant age, they were most effective when sown at least two weeks in advance of the field crop. In both Devon and Herefordshire, summer turnip was the most attractive trap crop species. This concurs with published work, which has shown that amongst others, turnip was attractive to, and readily fed upon, by *Phyllotreta* spp. flea beetles (Vargas & Kershaw, 1979). Chinese cabbage was equally as attractive as summer turnip at the Herefordshire site but was no more attractive than the control (swede) at the Devon site. This is probably accounted for by differences in the species complex between the two sites. In both 1999 and 2000, there was some evidence the different flea beetle species may have preferences for different trap crops. Determining the dominant *Phyllotreta* species in specific localities may therefore be important in selecting effective trap crops. Alternatively, a ‘trap crop’ consisting of a mixture of brassica types, for example the summer turnip/Chinese cabbage mix used in Devon in 2001, could be used.

In terms of the impact on crop damage on the field use of trap crops, data from 2000 and 2001 have shown that trap crop strips tend to result in higher flea beetle numbers and damage occurring in the field crop area immediately adjacent (within 1 to 2 m) to a trap crop strip. Once outside the immediate proximity of the trap crop, damage and flea beetle numbers decline rapidly. The clear implication is that widely spaced (>20 m at least) trap crop strips are likely to be more effective in potentially reducing crop damage than those sown close together.

The evidence also suggests that a perceived drawback of trap cropping – that planting trap crop strips through a field crop may bring more beetles into the field crop – may in fact not be serious issue. This is because flea beetle distribution does not appear to be limited to the field margins only.

Trap crops may also have the added benefit of affecting other pests. For example studies done in Finland showed that Chinese cabbage (and other *Brassica* species) provided cauliflower almost complete protection against pollen beetle, *Meligethes aeneus* (Hokkanen *et al*., 1986) while results from Ontario suggested that cabbage root fly maggots also had host preferences with oilseed radish cv. Pigletta being particularly attractive.

Insecticides

Of the seed treatments tested in 1999 and 2000, imdacloprid (Gaucho) and carbofuran (Furadan 440) were the most consistently effective in reducing plant damage and maintaining plant populations. Tefluthrin (Force) and fipronil were less effective. None of the treatments gave control levels above *c*. 60-70%. Although Gaucho is Approved for use as a seed treatment on cabbage, Brussels sprout, cauliflower, calabrese and broccoli (SOLA 2571/2000), it cannot be used on speciality brassicas. None of the other treatments are currently Approved.

Single sprays of pyrethroid insecticides (λ-cyhalothrin, cypermethrin, deltamethrin) and spinosad (not currently Approved) suppressed the flea beetle population for at least one to two days, although by seven days after the first treatment damage on treated and untreated plots was similar. However, seedling survival was substantially increased by a single spray and was maintained by a second spray applied nine days after the first. Thus provided flea beetle attacks are not overwhelming, a two-spray programme of pyrethroids should provide sufficient protection.

The question of whether just treating the trap crop with insecticide (whether seed treatment or foliar spray) could reduce or eliminate the need for insecticide applications to the field crop still remains open.

Technology transfer

- HDC News article published in autumn 2000 reporting on the first year's work.
- Howard, J J & Parker, W E (2000). Evaluation of trap crops for the management of *Phyllotreta* flea beetles on brassicas. *Proceedings of the BCPC Conference - Pests and Diseases* 3: pp 975-980. This poster paper generated several press reports and consequently enquiries from some growers on the status of the work and the prospects for the wider use of trap cropping.
- Results from insecticide work reported at HRIA meetings at Wellesbourne (autumn 2000) and Kirton (January 2001).

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