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ANNUAL REPORT

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Project PC 123
Control of capsid bugs within IPM
programmes in protected crops.

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Commercial - In Confidence

ANNUAL REPORT

Project title: Control of capsid bugs within IPM programmes in protected crops.

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The results and conclusions in this report are based on a series of experiments and surveys. The conditions under which the work was carried out and the results 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.

Authentication

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

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PRACTICAL SECTION FOR GROWERS

Background

Capsid bugs belong to the Miridae; a large family of small to medium sized soft bodied insects which exploit a wide range of diverse habitats. The majority of species are plant feeders but a few are at least partly predatory (eg black-kneed capsid). In recent years, some plant feeding species have caused sporadic but important problems in protected salad crops, particularly cucumbers, peppers and aubergines.

Objectives

The overall objective of the project is to improve the knowledge of the biology and behaviour of plant feeding capsids in protected crops as a first step in formulating a sustainable control strategy within existing IPM programmes.

The specific targets set for the first year were to gather information about the problem by searching the scientific literature, monitoring cucumber, pepper, aubergine and tomato crops at two sites which had suffered capsid problems in recent years, and completing a grower survey to determine the full extent of the problem nationwide. The information was then to be used to increase grower awareness and to design a research programme to develop a control strategy.

Summary of Results

Detailed crop monitoring at two sites in Yorkshire has provided a much improved understanding of capsid problems in cucumbers and peppers but there is still a need for more information about infestations in aubergines. No damage has been seen or reported in tomatoes. So far, two species have been found causing damage; *Lygus rugulipennis* in cucumber crops and *Liocoris tripustulatus* in pepper crops. Detailed examination of vegetation in the immediate vicinity of the infested greenhouses has failed to locate important capsid breeding sites. It is therefore assumed that the insects migrate to the greenhouses from other areas but this requires further investigation.

A total of 120 growers participated in the national survey and 48 confirmed that they had seen capsid activity in their crops. Approximately one third of those who had seen damage, reported that it occurred over large areas of their crops. The most seriously affected were cucumbers where the estimated financial loss ranged from £300 to £2000 per 1000m². Many of the growers who reported less serious damage had restricted the development of the problem by applying insecticides but indicated that this had affected biological control of other pests and had resulted in secondary problems.

Approximately 90% of growers who reported damage, had first seen it during the last four years; thus confirming that capsid infestations in cucumbers, peppers and aubergines are recent problems. There were no distinct differences between geographical regions and it was therefore concluded that this is a nationwide problem.

The most effective insecticide used by growers was reported to be propoxur (Fumite

Propoxur Smoke) while cypermethrin (Ambush), deltamethrin (Decis), heptenophos (Hostaquick), nicotine (40% Shreds and XL-All Insecticide) and pirimiphos-methyl (Blex and Fumite Pirimiphos-Methyl Smoke) all gave some control. Unfortunately, these are all broad spectrum insecticides and none are compatible with the biological components of the IPM programmes. One grower reported some incidental control of capsids with buprofezin (Applaud) when it was applied against glasshouse whitefly. Buprofezin is compatible with many biological control agents and its use against capsids should be further investigated.

An illustrated information sheet entitled "Capsid Bugs in Protected Crops" (HDC Fact Sheet 37/96) has been produced to provide a guide to the recognition of capsids and symptoms of their damage in cucumbers and peppers.

Recommendations for further research

1. Aubergines - Further information is required from aubergine crops; particularly relating to the species of capsids causing damage and the development of infestations.
2. Studies outside greenhouses - More information is required about the natural habitats of the pest species and changes that have occurred in recent years which may have affected capsid development and survival. Detailed studies of these habitats may identify natural enemies which can be exploited in control programmes.
3. Biology of pest species - An improved understanding of the biology and behaviour of the pest species is required to identify weak points which may be exploited in control strategies.
4. Monitoring invasion - Improved traps are required to monitor capsid invasion and indicate when control measures should begin. The possibility of improving the attractiveness of traps by including pheromones should be investigated.
5. Control - The potential of the insect growth regulator, buprofezin (Applaud) and the entomopathogenic fungus, *Beauveria bassiana*, for the control of capsids within IPM programmes should be evaluated.

Practical and financial benefits from study

The provision of robust, sustainable and manageable strategies for the control of capsids in cucumbers, peppers and aubergines will:

1. Avoid direct damage and financial losses caused by these pests.
2. Avoid secondary problems associated with the breakdown of IPM in these crops.
3. Help to satisfy demands of UK's leading food retailers for produce grown under minimal pesticide regimes.

It is anticipated that ornamental crops will also suffer damage from capsids as growers move towards full IPM strategies. Therefore, the acquisition of knowledge and the development of new control measures against these pests will ultimately provide greater benefits within the whole UK horticultural industry.

EXPERIMENTAL SECTION

INTRODUCTION

Background

Capsid bugs belong to the Miridae; a large family of small to medium sized soft bodied insects which exploit a wide range of diverse habitats. The majority of species are plant feeders but a few are at least partly predatory (eg black-kneed capsid). At least two of the plant feeding species have caused sporadic but important problems in protected salad crops, particularly cucumbers, peppers and aubergines, since the advent of integrated pest management (IPM) programmes.

When pest control strategies were based entirely on chemicals, capsids were inadvertently controlled by treatments applied against other major pests. The removal of routine insecticidal treatments has allowed them to survive, sometimes to cause considerable direct damage and to disrupt whole IPM programmes.

Adult capsids may invade greenhouse crops as early as April but their activity becomes most noticeable in June and July. They and their offspring feed primarily in the growing points of plants and on developing fruits resulting in severe distortion as growth continues. In some situations growing points are completely destroyed and fruit are rendered unmarketable. By the time damage is detected it is usually well advanced and the insects have moved to other parts of the crop.

There are insecticides available which kill capsids but they are not compatible with the biological control agents used to control other pests. Their use can lead to the breakdown of IPM resulting in much wider use of chemicals to control all the other major pests; eg whiteflies, western flower thrips, spider mites and aphids. Furthermore, results with chemicals are often disappointing because it is so difficult to time the treatments correctly.

Difficulties in studying capsids

Capsids are difficult to study in glasshouse crops due to their sporadic occurrence and cryptic behaviour.

The adults are very mobile and have usually left the plant before distorted growth resulting from their feeding becomes obvious. In many cases growers have not even associated the damage with capsids. The nymphs are less mobile and may be found around the damaged parts of the plants but they are easily mistaken for aphids and growers have commonly blamed the wrong pest.

Commercial objective

The overall objective is to improve the knowledge of the biology and behaviour of plant feeding capsids in protected crops as a first step in formulating a sustainable control strategy

within the existing IPM programmes.

Scientific/technical targets of the project

1. A literature search to ensure that the research team have all available information.
2. The pests activity will be monitored at selected sites to improve the knowledge of the species involved, their natural habitats and the timing of crop invasion.
3. A fact sheet will be prepared aimed at improving grower awareness of the damage caused by capsids.
4. An industry survey will be completed to determine the full extent of the problem in protected edible crops.
5. The information gained from the above tasks will be used to design control strategies based on physical, cultural and/or biological techniques which are compatible with other components in the IPM programme. An additional project will be required to test fully the control methods.

Year 1 - Milestones

1. A literature search will gather all available information relevant to capsids in protected crops.
2. Two large nurseries producing cucumbers, peppers, tomatoes and aubergines that have suffered intermittent damage with capsids over the last 6 growing seasons have agreed to participate in the project. Surveys will be completed at both sites to gather more information about the species involved, the breeding sites in surrounding vegetation, timing of invasion and continuity of breeding in glasshouses. This will involve the development of specific monitoring techniques.
3. A catalogue of damage symptoms will be compiled.
4. An HDC illustrated information sheet describing capsid damage symptoms will be produced in collaboration with Mr D Hargreaves. The HDC will organise printing. The completion date, subject to available photographs and printing deadlines, will be July/August 1996.
5. An industry survey will be completed in the summer/early autumn of 1996 to establish the full extent of damage caused by capsids nationwide. This will be based on a brief questionnaire accompanied by the new information sheet. The HDC will provide names and addresses of participants.

PROGRESS REPORT

MILESTONE 1 - LITERATURE SEARCH

A literature search was completed in April 1996. The scientific literature is now scanned each month for new information relating to all aspects of this project.

MILESTONE 2 - CROP MONITORING

A range of crops were monitored at two sites which had suffered intermittent damage by capsids in recent growing seasons.

The vegetation surrounding the greenhouses was searched to determine the insects breeding sites, the time of crop invasion was recorded, the species identified and their continued activity observed within the crops.

Several types of traps were designed to aid the monitoring of capsids and they were evaluated in a range of crops.

Site 1

E. Baarda Ltd
Elloughton
East Yorkshire

Previous records of damage

This nursery grows cucumbers, peppers and tomatoes. Capsids have caused significant damage during the last two growing seasons. Cucumbers have been most seriously affected, particularly crops planted in June and July. The symptoms have included fruit distortion and damaged growing points. Peppers have suffered similar symptoms but the overall damage has been less significant. No damage has been seen in tomatoes.

First sighting in crops in 1996

Lygus rugulipennis, the European tarnished plant bug, was first observed in cucumber crops at this site on 23 April. This was a single adult specimen.

Liocoris tripustulatus was first recorded in the pepper crops at this site on 14 June. Both adults and young nymphs were seen, indicating that the insects had been in the crop for at least 2-3 weeks.

Summary of crop monitoring

Crops were monitored by Andrew Baarda and Derek Hargreaves under the guidance of Rob Jacobson.

Cucumbers - Although the first sighting of *L. rugulipennis* was in April, very little further capsid activity was observed in the crops until the end of May. On 11 June, adults and nymphs could be easily found in mature crops and in a recently planted crop. At the end of June, all the replanted cucumbers were infested and, in the worst cases, 70% of growing points had been destroyed. The damage continued throughout July when an accumulated financial loss of approximately £1500 per 1000m² forced the grower to resort to a chemical control programme. The only capsid species recorded in the cucumbers was *L. rugulipennis*.

Peppers - *L. tripustulatus* were numerous in one area on 25 June and then began to spread throughout the crop forcing the grower to apply broad spectrum insecticides. The damage symptoms (ie distorted fruit and "stopped" growing points) resulted in financial losses of £1000 per 1000m² in the worst areas. *L. tripustulatus* was the only capsid species recorded in the peppers.

Tomatoes - No capsid activity was observed.

Possible breeding sites outside the greenhouses

Vegetation within 20m of the greenhouses was searched on the 23 April and 4 June 1996 and capsids collected for identification.

No capsids were found on 23 April.

On 4 June, small numbers of *L. rugulipennis* and *L. tripustulatus* were found among nettles and cow parsley. Neither species were found in other vegetation, including barley, hawthorn, white deadnettle and rosebay willowherb.

The small numbers of capsids found did not indicate that these areas were important sources of infestation.

Site 2

Hedon Salads Ltd
Burstwick
East Yorkshire

Previous records of damage

This nursery grows cucumbers, peppers and aubergines. Capsids have caused significant damage in peppers during recent growing seasons but not in the other crops. Symptoms have mainly comprised feeding punctures and fruit scarring resulting in reduced quality.

First sighting in crops in 1996

Damage symptoms were seen in one area on 23 April and the first *L. tripustulatus* specimen was found during the following week.

Summary of crop monitoring

Crops were monitored by Alan Chambers and Rob Tooke under the guidance of Rob Jacobson.

Peppers - *L. tripustulatus* became numerous in one greenhouse in mid-June, resulting in significant numbers of scarred and distorted fruit. Further damage in that crop was limited by chemical treatments. Damage became more widespread in late July and early August resulting in the need for more insecticidal treatments. *L. tripustulatus* was the only capsid species recorded.

Cucumbers - No capsid activity was observed.

Aubergines - No capsid activity was observed.

Possible breeding sites outside the greenhouses

Vegetation within 20m of the greenhouses was searched on the 23 April and 4 June 1996 and capsids collected for identification.

Neither *L. rugulipennis* nor *L. tripustulatus* were found among the vegetation which was predominantly nettle and cow parsley. Moderate numbers of *Orthops campestris* (carrot plant bug) were found on 4 June but this species did not appear to move into the greenhouses.

As at site 1, the areas immediately around the greenhouses did not appear to be important sources of infestation.

Use of traps

Flat and cylindrical versions of white and yellow traps were tested in cucumber and pepper crops known to be infested with *L. rugulipennis* and *L. tripustulatus* respectively.

There were no differences between the numbers of capsids caught on the different types of traps. Overall, the numbers of capsids caught were quite small suggesting that the insects were not specifically attracted to them.

MILESTONE 3 - CATALOGUE OF DAMAGE SYMPTOMS

A catalogue of damage symptoms in cucumbers and peppers has been compiled by the author of this report. Examples of the most important symptoms are illustrated in HDC Fact Sheet 37/96 (Appendix 1).

Photographs of damage symptoms in aubergines are still required.

A number of growers have brought to our attention problems relating to capsid damage in ornamental crops; for example chrysanthemums, clematis and various pot plants. This is beyond the scope of this project but notes will be kept on file for future use.

MILESTONE 4 - FACT SHEET

An HDC illustrated information sheet entitled "Capsid Bugs in Protected Crops" (HDC Fact Sheet 37/96) has been produced in collaboration with Mr D Hargreaves. This document provides a guide to the recognition of capsids and symptoms of their damage in cucumbers and peppers.

In addition, an illustrated article entitled "Capsid Challenge to IPM Strategies" was prepared by Rob Jacobson and Derek Hargreaves and published in the Grower, 11 July 1996.

MILESTONE 5 - SURVEY OF COMMERCIAL CROPS

Surveys of cucumber, pepper and aubergine growers were completed during the winter of 1996/97 to determine the full extent of capsid problems nationwide.

The surveys were based on brief questionnaires which were sent to growers with Fact Sheet 37/96. The questionnaires were produced by Rob Jacobson and Derek Hargreaves (Appendix 2). The HDC provided names and addresses of participants, and coordinated the distribution of the questionnaires.

Information has been extracted from the completed questionnaires and data compiled at HRI Stockbridge House. The proportions of cucumber, pepper and aubergine growers who have suffered damage by capsids are summarised in Figure 1. More detailed summaries are provided below:

FIGURE 1

Survey of cucumber growers

Overall results

Seventy nine cucumber growers responded to the survey which represented approximately one third of those who had been sent questionnaires.

Forty six per cent of the growers had seen capsid activity in their crops during the last few years. Thirty per cent reported no capsid activity and were confident that they would have distinguished the damage from similar symptoms resulting from other crop problems. The remaining 24% of contributors would not have recognised the pest or the damage prior to receiving the HDC Fact Sheet.

The national results have been broken down into seven geographical areas (Figure 2).

When was capsid activity first seen

Seventy four per cent of growers who reported capsid activity had first seen the insects or symptoms of their damage during the last 2 to 4 years.

Approximately 15% had first seen activity in 1996. It is possible that at least some of these growers may have had capsid infestations prior to this but had not recognised the symptoms.

Only 11% of growers who had suffered damage remembered seeing symptoms more than 4 years ago.

The results indicate that this is a recent problem.

Time of year that symptoms were seen

The pest had been seen in crops between April and September but the majority of reports were in July and August. These records are summarised in Figure 3.

Type of symptoms

The majority of growers who had observed capsid activity in their crops reported damage to both fruit and stems/growing points.

Fewer respondents had seen torn or distorted leaves.

Extent of damage

Approximately one third of those who had seen damage, reported that it occurred over large areas of their crops and in these situations the average estimated financial loss was £984 per 1000m² (ranging from £300 to £2000 per 1000m²).

Some of the growers who reported less serious damage had restricted the development of the problem by applying insecticides but indicated that this had affected biological control of other pests and resulted in secondary problems.

FIGURE 2

FIGURE 3

Control measures

Several growers provided information about the effect of insecticidal treatments on capsids. In total, there were observations from the application of eight different chemicals. Only treatments with propoxur (Fumite Propoxur Smoke) were successful in all reported cases. Cypermethrin (Ambush), heptenophos (Hostaquick), nicotine (40% Shreds and XL-All Insecticide) and pirimiphos-methyl (Blex and Fumite Pirimiphos-Methyl Smoke) had given variable results. A pirimicarb (Pirimor) treatment had been unsuccessful.

Survey of pepper growers

Overall results

Thirty four pepper growers responded to the survey which represented approximately one third of those who had been sent questionnaires.

Twenty seven per cent of the growers had seen capsid activity in their crops during the last few years and the cases were distributed throughout the country. Fifty per cent reported no capsid activity and were confident that they would have recognised the damage symptoms. The remaining 24% of contributors had not seen capsid damage but said they would not have distinguished it from similar symptoms resulting from other crop problems (Figure 1).

When was capsid activity first seen

Two thirds of the pepper growers who had seen capsid activity in their crops reported the first instance to be during the last 2 to 4 years.

Eleven per cent of growers had seen capsid activity for the first time in 1996.

Approximately 20% of pepper growers had seen capsid damage in their crops more than four years ago.

Time of year that symptoms were seen

The pest had been seen in crops between May and September but the majority of reports were between June and August. The records are summarised in Figure 4.

Type of symptoms

The most common symptoms were torn/distorted leaves and scarred/misshapen fruit.

One grower reported destroyed growing points and commented that, unlike cucumbers, the pepper plants did not recover from this damage.

FIGURE 4

Extent of damage

Approximately one third of growers who had seen damage reported that it had occurred over large areas of the crop. In these cases, the average estimated financial loss was £534 per 1000m² (ranging from £100 to £1000 per 1000m²). The greatest losses were recorded where growing points had been damaged.

Several growers who had seen only limited damage were using chemical pest control regimes and believed that insecticides used against other pests were keeping capsids under control.

Control measures

Few growers provided detailed information about insecticide applications but the limited reports suggested that pyrethroids (Decis and Ambush) and heptenophos (Hostaquick) provided some control, while nicotine (40% Shreds) and pirimor (Pirimicarb) were unsuccessful.

Survey of aubergine growers

Overall results

Questionnaires were sent to fourteen aubergine growers and half responded.

Three of the growers reported seeing capsid damage in their crops; that is in Evesham, West Sussex and East Yorkshire. Of those who did not report capsid activity, half indicated that they would not have recognised the symptoms.

When was capsid activity first seen

All the growers who had seen damage said it had first been noticed during the last 2 to 4 years.

Time of year that symptoms were seen

The records of capsid activity in aubergine crops were evenly distributed between May and August.

Type of symptoms and extent of damage

Symptoms were described as torn/distorted leaves, scarred fruit and destroyed growing points. There were no reports of misshapen fruit.

One grower reported damage to large areas of the crop and also commented that flowers were attacked which resulted in premature flower drop and failure to set.

None of the growers attempted to estimate financial losses resulting from the damage to aubergines.

Control measures

One grower who had suffered slight damage indicated that insecticides applied against other pests had kept the capsids under control.

Buprofezin (Applaud) applied against whiteflies was reported to have given some control of capsids at one site.

DISCUSSION AND CONCLUSIONS

Detailed crop monitoring at two sites in Yorkshire has provided a much improved understanding of capsid problems in cucumbers and peppers but there is still a need for more information about infestations in aubergines.

So far, two species of capsids have been found causing damage; *Lygus rugulipennis* in cucumber crops and *Liocoris tripustulatus* in pepper crops.

Detailed examination of vegetation in the immediate vicinity of infested greenhouses failed to identify breeding sites used by the insects. Capsids are strong fliers but it is not known how far they could migrate to reach greenhouses. It is important that the insect's usual breeding sites are located and that they are studied carefully to provide information about natural enemies which could be exploited in control programmes.

The survey of cucumber, pepper and aubergine growers has established a picture of the extent of capsid problems nationwide. A total of 120 growers completed the questionnaires and 48 confirmed that they had seen capsid damage in their crops. Thirty three of the respondents did not think that they would have recognised either the pest or the damage symptoms and several comments on the questionnaires indicated that recent publicity had increased awareness of the problem, for example:

"Without your fact sheet I did not appreciate the damage was probably due the capsid bug".

"I thought they (capsids) were beneficial and was pleased to see them"

"I did not realise the damage was caused by this pest. Thankyou".

"At the time we did not realise what was causing the damage".

"I was not aware damage was caused by capsids, so no preventative measures taken".

If only those growers who were confident of recognising capsids or their damage are included in the calculation, then 55% of respondents reported seeing the pest.

There were no distinct differences between geographical regions and it is therefore concluded that this is a nationwide problem.

Infestations occurred slightly earlier in the season in peppers than in the other two crops but peaks of activity were between May and September in all cases. This is consistent with the belief that capsids overwinter outside and invade greenhouses in late spring and early summer. An effective monitoring system is required to alert growers to the potential threat.

Approximately 90% of growers who reported damage, had first seen it during the last four years; thus confirming that capsid infestations in cucumbers, peppers and aubergines are recent problems. Furthermore, grower comments suggest that the problems are becoming

more serious.

It is unclear why capsids should have become more troublesome in cucumbers, peppers and aubergines in recent years. It is unlikely that the behaviour of the two insect species has simultaneously changed, so the difference is probably due to differences in the availability of plant food or natural habitats. There has been no widespread change in crop husbandry or insecticide usage in these crops which could have allowed capsids a new opportunity to colonise, so the most probable explanation is a change in their natural habitats outside the greenhouses.

Many of the growers who reported damage had restricted the pest's progress by applying insecticides. The most effective product was reported to be propoxur (Fumite Propoxur Smoke) while cypermethrin (Ambush), deltamethrin (Decis), heptenophos (Hostaquick), nicotine (40% Shreds and XL-All Insecticide) and pirimiphos-methyl (Blex and Fumite Pirimiphos-Methyl Smoke) all gave some control. Unfortunately, these are all broad spectrum insecticides and none are compatible with the biological components of the IPM programmes. Several growers commented that the use of these chemicals had resulted in secondary problems with other pests such as spider mites, thrips and whiteflies. One grower reported some incidental control of capsids with buprofezin (Applaud) when it was applied against glasshouse whitefly. Buprofezin is compatible with many biological control agents and its use should be further investigated.

Opportunities to exploit biological control organisms for the control of capsids are extremely limited. Parasitoids which attack eggs and nymphs of insects belonging to the family Miridae are known but there is little information about those which attack the pest species reported here. In any case, the effect of such parasitoids would not prevent the extensive damage caused by invading adult capsids. The entomopathogenic fungus, *Beauveria bassiana*, may have greater potential. Trials in the USA have demonstrated that the patented JW-1 strain of *B. bassiana* (trade mark, Naturalis) is effective against a wide range of insect species and it appears to infect them at lower relative humidity than *Verticillium lecanii*. Small scale studies are required to further evaluate this product against capsids in the UK.

RECOMMENDATIONS

1. Aubergines

Further information is required from aubergine crops; particularly relating to species of capsids causing damage and the development of infestations.

2. Studies outside greenhouses

More information is required about the natural habitats of the pest species and changes that have occurred in recent years which may have affected capsid development and survival.

Detailed studies of these habitats may identify natural enemies which can be exploited in control programmes.

3. Biology of pest species

An improved understanding of the biology and behaviour of the pest species is required to identify weak points which may be exploited in control strategies.

4. Monitoring invasion

Improved traps are required to monitor capsid invasion and indicate when control measures should begin. The possibility of improving the attractiveness of traps by including pheromones should be investigated.

5. Control - chemical

The potential of the insect growth regulator, buprofezin (Applaud), to control capsids within IPM programmes must be evaluated.

6. Control - biological

Small scale studies should begin to evaluate the potential of the entomopathogenic fungus, *Beauveria bassiana*, for the control of capsids within IPM programmes.

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Appendix 1. HDC Fact Sheet 37/96

Appendix 2. Survey questionnaires