BIOLOGICAL PEST CONTROL, HUMBER GROWERS' EXPERIENCE

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Introduction

Insect pests reproduce very quickly especially in protected environments, for instance Aphis gossypi will increase tenfold in seven days in English greenhouses. The use of conventional pesticides behaves as a selection pressure. Also, inefficent spray selection exposes insects to sub lethal doses. These two factors result in insects developing races which are resistant. Red spider mites can complete their life cicles in 3 1/2 days at 32ºC, this results in a very quick build up of mites especially in the summer. Therefore they experience many pesticide treatments during the life of the crop.

Cucumber growers have reported up to twenty-three sprays against spider mite in one season. These sprays adversely affect yield.

The cost of developing new pesticides is enormous and can take up to ten years. With this background the pests Red spider mite and Whitefly develop resistant strains and subsequent failure of control faster than the development of alternative pesticides. Humber Growers was no exception to this rule. In 1976 I joined Humber Growers to initiate and manage biological pest control.

Mass Production of Beneficial Insects

Humber Growers is still unique in that it owns and runs its own mass production unit. Some of the rules for successful biological control are discovered as a result of rearing your natural enemies on site. At Humber Growers, mass production is done in twenty-one individual greenhouses. We grow tobacco plants to culture the pest, glasshouse whitefly. These are subsequently exposed to their natural enemy encarsia formosa to produce large numbers of parasites which are introduced into our production houses once a fortnight. Runner beans are grown and infected with red spider mite and subsequently its natural enemy Phytoseilus is introduced.

These are also introduced into our production houses. Undertaking your own mass production teaches you a lot about how the pest and its natural enemies behave, this is very useful in developing successful control strategies.

Economics

Although at first sight this aspect would appear not to be relevant to biological control it is however fundamental to its success. We make a charge per unit area rather than a charge per natural enemy this allows for great flexibility in the development of successful programmes, and gives the capacity to react quickly to problems. This connection between the economics and successful biological control was proved by me on Channel Islands of Jersey and Guernsey. Ten years of failure of biological control was turned to success by changing the economic approach from cash per insect to cash per unit area. This is similar in some ways to Almeria in that there is a high level of pest which requires a high level of natural enemies, this results in conflict between the cost of purchasing sufficient natural enemies to obtain control and the cost the grower is willing to pay.

Reduced use of pesticide results in increases in production. Cucumber growers have reported a 25% increase in yield as a result of changing from chemical to biological control. If you run your own mass production unit this economic benefit can be included in the overall economics.

A further difficulty was discovered in that the pest, Red Spider Mite, needs to be introduced first to achieve the best results. Growers naturally do not like this but having your own unit allows you to introduce the pest and predator together.

Control of black root rot (Phomopsis sclerotioides)

At Humber Growers' Marketing Organisation Ltd cucumber were traditionally grown on steam sterilised soil and are trained and trimmed to the umbrella system which involves stopping the main leader at the supportin wire and allowing the laterals to hang down.

At fuel costs continued to rise, our attempts to eliminate Black root rot by introducing soilless cultures eliminated the need to steam sterilise the soil.

As these new techniques for growing cucumbers in Growbags and Rockwool, came into use thrips became a serious problem. The standard soil treatment with HCH for control of *tabaci* in a integrated programme for pest of cucumbers adversely affected the natural enemies, *Phytoseiulus persimilis and Encarsia formosa* through its fumigant action. Numerous alternative chemicals were evaluated but all failed to produce satisfactory control. An alternative method was investigated. It was believed that ensuring exposure of Thrips prepupae to a suitable insecticide when they descend to pupate on the soil was the key factor rather than insecticides being in effective.

Trials with mixtures of polybutenes and insecticides sprayed into sheets of plastic on the ground below were successful in controlling Thrips by killing the larvae prepupae when they descend to pupate. This method leaves the natural enemies *Phytoseiulus* and *Encarsia* unaffected on the aerial parts of the plant as the mixture does not vaporise. The results of trials are as follows:

Trial I: Polybutene and Deltamethrin

Four plots, each containing seven plants, were selected:

Plot (a) Average Thrip damage - equal parts by volume of Polybutene 5 and water to which was added 4.16 cc Deltamethrin per litre of the above mixture and sprayed into plastic beneath the crop at the rate of 0.87 cc Deltamethrin in 210 cc of the mixture (46.2 cc a.i. per ha, 444 litres of mixtures per ha).

Plot (b) Severe Thrip damage - as (a).

Plot (c) Control Average Thrip damage - clean plastic laid beneath the crop

Plot (d) Control - average Thrip damage - clean plastic laid beneath the crop.

During this trial leaves were removed from the lower, middle and upper parts of the plants and the Thrips population counted. Counts were also made on the plastic in areas A and B.

The results of Trial I after 14 days showed that control of Thrips was possible using Polybutene 5 plus Deltamethrin which has a lower viscosity thus rendering the product suitable for commercial application.

A further trial was, therefore, carried out to test the product on a larger scale and to provide more conclusive evidence of its suitability.

Trial II: Polybutene + Deltamethrin

Four plots, each containing 13 plants in Growbags, were treated as follows:

- Plot A Polybutene 5 and Deltamethrin sprayed into sheets of plastic beneath the crop.
- Plot B Polybutene 5 and Deltamethrin sprayed into sheets of beneath the crop.
- Plot C Control - clean sheets of plastic beneath the crop.
- Plot D Control - clean sheets of plastic beneath the crop.

Thrip damage was severe in all areas. Individual plants were assessed for damage every 3-4 days which was expressed as a percentage of the leaves damaged. Sections of plastic sheets were removed at the same time and replaced by freshly sprayed sheets. A count of Trips was made on the sections removed.

RESULTS

Trial I

This trial produced highly satisfactory results. Control of Thrips in Plots A and B with correspondingly high numbers trapped on the plastic sheets was excellent, Table 1. In Plots C and D large numbers of Thrips were found on the leaves and none on the floor.

Trial II

Table 2 shows the declining damage as the plants in treatments A and B recover and the diminishing number of thrips trapped on the plastic sheets. The totals for each column are the average of ten 2.5 cm^2 taken from one 30.5 cm^2 at four day intervals, the control D was taken on the final days and shows an increase in the Thrip population. (Thrip counts in areas A and D are cumulative over 4 days.)

From the evidence of trials the mixture of Polybutene and Deltamethrin used to control Thrips was extended to a total of 70 acres of cucumbers in the 1981 season.

Some areas did not achieve as good a control as was expected. It was through that the reason for this failure was due to too little plastic on the floor and starting when the Thrips had become well established, rather than the volume of Polybutene and Deltamethrin being applied. Tests were carried out to establish how long the mixture in lethal to Thrips once applied, as there was little evidence that the volume applied afeccted the degree of control in the range 120 litres per acre to 240 litres per acre of the mixture (30.8 cc a.i. per ha, 296.5 litres of mixture per ha; 61.7 cc a.i. per ha, 593.0 litres of mixture per ha).

The mixture was applied to petri dishes and Thrips introduced and observations made after two hours. This shows that Polybutene +

Deltamethrin is lethal to Thrips in covered dishes in excess of twenty weeks. Dishes with pesticide alone proved ineffective, Polybutene alone was also ineffective. Trials in the field indicate the mixture is lethal for at least ten weeks.

The results indicate that the sites in 1981 (seven acres) which failed to give a satisfactory Thrip control was most likely due to insufficient plastic or applying the mixture too late as the mixture is lethal for a considerable length of time.

During the winter of 1981/82 the product was further developed being granted a trade name "Thripstick" and given provisional clearance in the UK. Thripstick is now supplied in 25 kilogram drums with the pesticide added and is ready to apply. Following experience gained in 1981 the following programme for control was initiated for the 1982 season:

1. The polythene sheeting is laid either to completely cover the glass-house floor or to partially cover the floor and folded back until required. A wide spectrum insecticide is applied to the floor (Parathion) 2-3 weeks after plantin (to ensure a clean start).

3. Thripstick is applied as soon as the pest is seen on the crop.

This treatment was followed this season with highly satisfactory results on ninety-two acres. This represents 100% of cucumber grown in Growbags and Rockwool using Humber Growers' Biological Pest Control Unit.

Table 1: Thrips Trial I - sample counts per leaf (2 leaves x 7 plants each treatment) and floor trap 21 days after treatment.

Treatmen	Infestation	Thrips population per 14 leaves Lower Middle Upper	Thrips mean 10 samples	Trapped per 1 ft2 = 924 cm2
polybutene 5+ Deltamethrin (a)	Average	2 2 8	6. 3	907
polybutene 5+ Deltamethrin (b)	Severe	2 1 2	9. 0	1296
Control (c)	Average	115 102 106	---	---
Control (d)	Average	614 105 114	---	---

Table 2: Trial 2 - Decline in damage and numbers of thrips trapped after treatment of severe infestation

Treatment	Days after treatment	% infested foliage	Nº thrips per 2,5 cm² of trap (mean of 10)
polybutene + Deltamethrin (A,B)	4	100	55
"	12	82	30
"	20	60	5
"	28	58	2
Control	28	100	115

Virus Control: Beet pseudo yellows

This Company was first alerted to this problem by Glasshouse Crops Research Institute Littlehampton because we had successfully established biological control. As with any biological control system the pest is always present. The possibility of having a virus disease transmitted by glasshouse whitefly obviously raises serious issues. The symptoms of Beet Pseudo Yellows are indistinct we therefore conducted tests to find out what viruses were present.

We found Green mottle mosaic virus and devised a code of practice to avoid this problem.

This code of practice highlights the benefit of being able to get all of our growers to follow a coherent and united plan.

Aphids

For several years there were no problems but we have always recognised the fact that Aphis gossypi is the weak link. We rely on one chemical for its control (pirimicarb). In 1988 Aphis gossypi arrived in our greenhouses completely resistant to this chemical. Inevitably other chemicals were used to control it, their use is damaging to biological controls resulting in poor control of Whitefly. In the presence of large numbers of Whitefly Beet Pseudo Yellows became obvious. Attempts to find a way of introducing encarsia led me to the development of Hugtite.

We considered alternative ways of controlling the Whiteflies instead of trying to control the aphids head on. The idea was conceived that strengthening the pupae case may result in the adult failing to hatch out successfully. When Whiteflies pupate they cease to feed. Hatching out of their pupae case is an energy expensive business therefore if you find a way of strengthening this case, death by exhaustion should occur.

It was considered that a domestic starch (Robin Starch) might produce this effect and was therefore tried. The above mentioned scenario was exactly what occurred, but the domestic starch was phytotoxic to plants and left an unsightly deposit. Different starches were investigated and a particular Starch dextrin chosen. The use of a wetting agent improved its performance and a food approved preservative was added. This dextrin leaves no unsghtly deposit and is not phytotoxic.

The full potential of this idea started to make itself felt. Physical control mechanisms generally do not differentiate, therefore a wide range of pests should be controlled. Organisms do not generally become resistant to changes in the physical environment. The safety to the crop, operator, consumer and the environment was obvious and vigorously pursued. This starch dextrin is approved in the UK and the USA for direct addition into food, and therefore should result in a very safe pesticide indeed.

As a result of scaling up our experiments to whole plants other effects came to light. Powdery mildew was controlled and Aphis gossypii also died. We have also shown that Red Spider Mite and Thrips are also killed.

SUMMARY

Implications for Spanish Growers.

Biological control as practiced at Humber Growers may not in its present form be applicable to growers in Spain, however the underlying principles and products (Thripstick/Hugtite) almost certainly will. These new techniques although born out of necessity for control of pests are leading us away from conventional use of pesticides on our crops thus reducing residue levels.

Some small experiments have been carried out in Almeria with encouraging results, I will leave you with a summary of Hugtite.

This is a new compound which shows promise when used against a range of insect pests including red spider mite, whitefly, aphids and thrips including (Western Flower Thrip) etc. However, because of

the limited work that has been done, no firm recommendation can be given in regard to the concentration of Hugtite, rate of wetting agent and the type of spraying equipment used. Hugtite is an innocuous substance made from potato starch.

It is suggested that various pests be treated with several dilution rates and the results observed. The control mechanism is physical not chemical, therefore it is important to realise that the physical aspects of spraying such as concentration, volume applied, drying time, insect and leaf cover will affect the result.

So far no phytotoxic effects on plants have been observed but as with any new compound some caution would be wise. If it is found that a treatment fails, it must not be assumed that Hugtite will not work as varying the three physical aspects, concentration, wetting agent and spray type (ie high volume to mist) can enhance the effectiveness dramatically.

As this compound kills insects physically, it is possible that at a certain concentration, larvae may not be controlled but the product could control the adults, and/or the eggs in an insects life cycle.

Control mechanisms which are physical have two other aspects which are worthy of comment. This compound does not generally differentiate between species ie if glasshouse whitefly (Trialeurodes vaporariorum) is controlled, it can reasonably be assume that a control of tobacco whitefly (Bemisia tabacci) is also possible.

The insect controlled will not become resistant to Hugtite. Thus the usual problem of repeated pesticide applications leading to resistance is removed.

It is believed that Hugtite will integrate with biological control of whitefly and red spider mite. Encarsia have been seen to emerge from scales sprayed with Hugtite even at the highest concentrations sprayed in trials to date. Some adults are killed but Hugtite also interferes with the pests life cycles, therefore the balance is in favour of the parasite.

Spider mites are more susceptible to Hugtite than predators. In our trials repeated sprays of Hugtite did not interfere with the biological control of spider mite. It should be noted that Hugtite will kill diapausing spider mites which are normally very difficult to control with pesticides known to integrate with biological control systems. Neither can diapausing mites be easily controlled by the introduction of predators which appear reluctant to attack them.

Interesting results have been obtained in trials with Hugtite as a control for powdery mildew on cucumber plants. Over a 3 month period, no other chemical treatment was necessary to control the mildew where as the control set of plants received repeated treatments. Hugtite may also have beneficial effects against other diseases.

As a guide the following spray concentrations have been used. 1 part Hugtite diluted with 10 parts water plus a wetting agent, (either PBI spreader at 1.25 cc per litre of Agral at 0.3 cc per litre).

Aphids requiere complete wetting of the insect. Therefore high volume sprays to "run off" give the best results. Spray pattern and pressure appear to influence this as well. Because Hugtite is in itself innocuous, light sprays giving only partial cover do not cause death of aphids. In one trial the concentration was increased to 15% Hugtite which appeared to give good control. For Whitefly eggs, pupae and spider mites this seems to be less important.

This is particularly relevant for spider mite where their hairy body is readily coated with Hugtite.