Note

Control of Greenhouse Whitefly (*Trialeurodes vaporariorum*) Using Visually Attractive Targets Impregnated with Pyriproxyfen

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The chemosterilant effect of a photo-stable juvenoid, pyriproxyfen, was investigated on greenhouse whitefly. Yellow fabric lures coated with 1 mg of pyriproxyfen per cm^2 drastically suppressed whitefly populations on bean plants in laboratory and glasshouse experiments. Numbers of eggs and larvae were reduced practically to zero over a period of several weeks. The success of such treated rectangular targets (25 cm×5 cm) placed among bean plants in a glasshouse prompted the development of Lano®-Tape, a roll of yellow tape treated with pyriproxyfen. It provides a labor saving method of whitefly control in commercial glasshouses as a substitute for conventional insecticide application techniques. © Pesticide Science Society of Japan

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INTRODUCTION

Pyriproxyfen, 4-phenoxyphenyl (*RS*)-2-(2-pyridyl-oxypropyl) ether, is a juvenile hormone mimic which effectively sterilizes a number of insect species.[1] It was highly effective as a sterilant for the tsetse fly, *Glossina morsitans*,[2] and this prompted development of an oil formulation for use on visually attractive lures accompanied by an olfactory attractant, to control tsetse in the field.[3–6] Similar attention has been paid to the control of glasshouse pests such as the sweet potato whitefly, *Bemisia tabaci*.[7] The present communication describes experiments conducted on the greenhouse whitefly (*Trialeurodes vaporariorum*) in England during the autumn of 1991, using visually attractive, yellow targets,[8] impregnated with an oil- formulation of pyriproxyfen. The aim has been to develop a labour-saving technique for the control of this pest in commercial glasshouses.

MATERIALS AND METHODS

1. *Insects*

Natural infestations of the greenhouse whitefly, *T. vaporariorum on* dwarf kidney bean plants, *Phaseolus vulgaris* (var. The Prince), were used in experiments.

2. *Preparation of Sterilizing Lures*

Rectangular lures (25 cm×5 cm) made of a commercially available, yellow cotton and polyester cloth (optimal reflectance at a wavelength of 550 nm), were dipped into a 300 ml mixture of a chlorinated paraffin (Cereclor S45®, ICI, UK) and acetone (1 : 1 v/v) containing 10 g of pyriproxyfen. After evaporation of the acetone in air, the lures retained 1 mg of pyriproxyfen and 15 μl of oil cm^{-2}. Control lures were impregnated only with a cereclor:acetone (1 : 1 v/v) mixture and air dried in the same way.

3. *Laboratory Experiments*

Bean plants at about the 10-leaf stage were allowed to become infested with whitefly (numbers were not recorded but the distribution was reasonably uniform). A single, infested plant was placed in a plastic, cylindrical cage (height 60 cm and diameter 20 cm). A 25 cm×5 cm, pyriproxyfen-treated lure was placed vertically alongside the infested plant in each of two experimental cages. Two treated control cages contained lures impregnated only with oil, while two untreated control cages contained no lures. The 6 cages were placed on a laboratory bench close to a window and two plant growth bulbs were suspended above them giving an L : D of 15 : 9. The temperature ranged from 18°C to 22°C. Since only a single plant was involved in each cage, a count of the total number of whiteflies in each cage was undertaken weekly.

4. *Glasshouse Experiments*

Two rectangular glasshouses (2.5 m×1.8 m) were planted out with 12 bean plants each in a block formation at intervals of 30 to 40 cm. The plants were all infested with *T. vaporariorum*. Sixteen rectangular cloth lures (25 cm×5 cm) were suspended vertically in a regular array among and around the plants. Lures in the experimental glasshouse were impregnated with the oil-formulated pyriproxyfen, while those in the control glasshouse were impregnated only with oil. Minimum temperatures of 12–15°C were maintained with a 1 kW fan heater. Daily maxima rarely exceeded 21°C. A 100 W plant growth lamp was placed 1 m above each group of plants in order to ensure a L : D regime of 15 : 9. Whitefly populations in the two houses were assessed weekly by examining 7 plants at random in each group and sampling 3 leaves per plant (1 lower, 1 middle and 1 upper). Total numbers of eggs, larvae, L4 larvae and adults were recorded in a 2 cm×2 cm area of each leaf.

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Table 1. Numbers of adult *T. vaporariorum* per bean plant per cylindrical plastic cage in the laboratory

Plant Replicates		Days after treatment					
		1	10	14	21	28	35
Expt.[a]	No. 1	48	11	2	4	2	2
	No. 2	142	37	25	6	4	2
Cont.[b]	No. 1	96	32	28	322	189	322
	No. 2	100	26	17	11	25	178
Non-T[c]	No. 1	45	50	37	163	120	Plant dead
	No. 2	——No observation——				58	>400

[a] Yellow target impregnated with pyriproxyfen.
[b] Control: yellow target impregnated with Cereclor only.
[c] Untreated control without a target.

5. Data Treatment

Numbers of insects observed in the laboratory experiments have not been subjected to any statistical analysis because the effects of pyriproxyfen on population numbers are obvious from the raw data. In order to normalize variances, numbers of insects recorded in the glasshouse experiments have been subjected to logarithmic transformation before finding the means and standard errors. The means and their standard errors were de-transformed before plotting on the graphs. Hence the standard error bars are asymmetrical (±SEM).

RESULTS AND DISCUSSION

1. Laboratory Experiments

Results are presented in Table 1 from which it is clear that the presence of pyriproxyfen-impregnated lures drastically reduced the whitefly population in the experimental cages, while after an initial fall in the treated controls, populations rose rapidly. The initial falls may have been due to an excessive contamination of individuals with oil during the first 10 to 14 days, or it may be that adults spent too much time on the lures and neglected feeding through dis-orientation. Un-treated control insect populations expanded as expected over the 28–35 days of the experiment. Fluctuations in numbers of whiteflies on host plants are often due to the physiological state of the plants. Hence, it may have taken 14 days for the plants in our test cages to re-establish themselves under their new regime. Nevertheless, on the basis of these results a small scale glasshouse trial seemed to be justified.

2. Glasshouse Experiments

Results are presented in Figs. 1–3 from which it can be seen that numbers of eggs and larvae remained relatively low and constant in both control and experimental houses for the first 50 days (Figs. 1 and 2). The numbers of adults in the control house rose with respect to experimental conditions between days 10 and 15 (Fig. 3) but this was mirrored by a corresponding fall in the numbers of larvae over the same period (Fig. 2) and probably indicates no more than a slightly higher number of mature larvae in the control house at the start of the experiment. Of greatest interest is the dramatic rise in population numbers at all life stages in the control house after day 50 and the corresponding population collapse in the experimental house (Figs. 1, 2 and 3). It is not

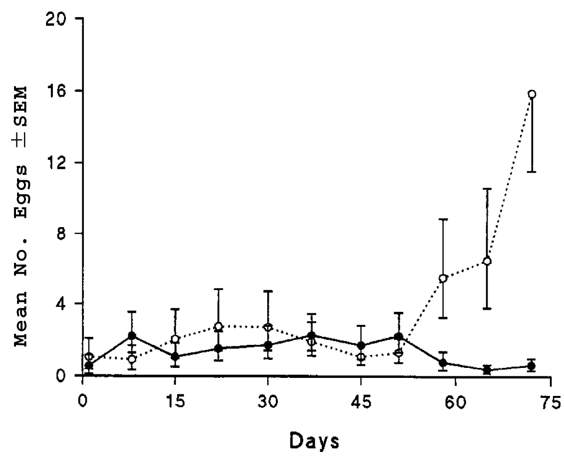

Fig. 1. Mean number/leaf (2 cm×2 cm) of eggs of *T. vaporariorum*. ○------○; Control, ●——●; experimental.

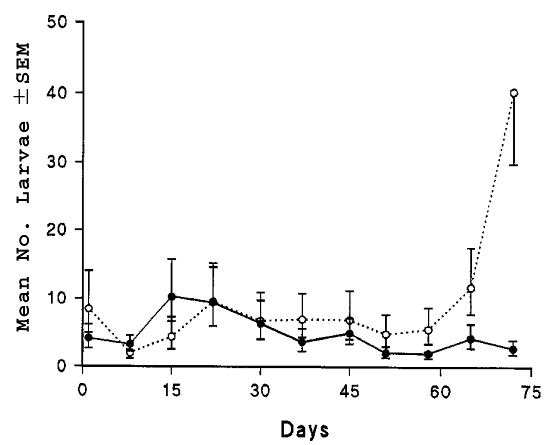

Fig. 2. Mean number/leaf (2 cm×2 cm) of larvae of *T. vaporariorum*. ○------○; Control, ●——●; experimental.

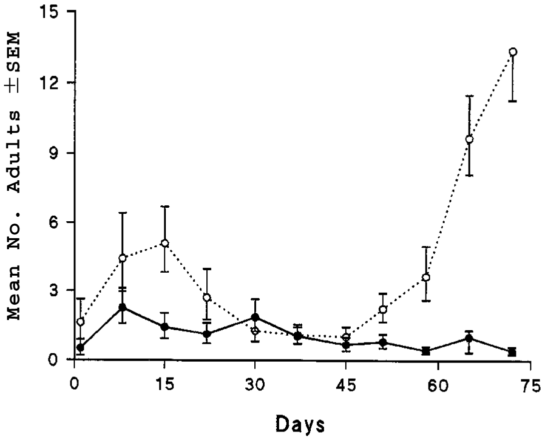

Fig. 3. Mean number/leaf (2 cm×2 cm) of adults of *T. vaporariorum.* ○------○ ; Control, ●——● ; experimental.

possible to predict the generation interval in this experiment because the temperature was not controlled or monitored accurately. However, it is clear that after 50 days the difference between an untreated population and one exposed to lures treated with pyriproxyfen was dramatic.

Clearly, the control of whitefly populations in glasshouses without intervention using insecticides on the plants is not only possible but is preferable to any other conventional measure including the use of predators and parasites. Neither is it necessary to consider the individual placement of lures among the plants, which would be time-consuming and labor-intensive. The impregnation of rolls of yellow tape,[9] which are easily unwound, would provide the ideal solution in a large commercial glasshouse where labor costs are a serious consideration.

Further work will be needed in order to optimize the placement of lures in relation to the plants to be protected[10] but the advantages of the pyriproxyfen-impregnated lure system remain to be exploited among numerous other insect pest species.

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REFERENCES

1) M. Hatakoshi and I. Nakayama: *Shokubutsu-Boeki* **41**, 339–347 (1987) (in Japanese).
2) P. Langley, T. Felton and H. Oouchi: *Med. Vet. Entomol*. **2**, 29–35 (1988).
3) P. Langley, V. Howl and H. Oouchi: *Entomol. Exp. Appl*. **57**, 271–279 (1990).
4) J. Hargrove and P. Langley: *Bull. Entomol. Res*. **80,** 397–403 (1990).
5) P. Langley, J. Hargrove, B. Mauchamp, C. Royer and H. Oouchi: *Entomol. Exp. Appl.* **66**, 153–159 (1993).
6) J. Hargrove and P. Langley: *Bull. Entomol. Res*. **83**, 361–368 (1993).
7) S. Nakamura, M. Inoue H. Fujimoto and M. Kasamatsu: *Appl. Entomol. Zool*. **29**, 452–556 (1994).
8) L. Lloyd: *Bull. Entomol. Res*. **12**, 355–359 (1921).
9) M. Inoue and S. Nakamura: Sumitomo Chemical Co. Ltd. Technical Report **1999-1**, 16–24 (1999) (in Japanese).
10) L. Senior: Ph.D. Thesis, University of Wales, Cardiff, UK (1997).