JARQ 24, 43-48 (1990)

Control of *Thrips palmi* KARNY in Japan

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Abstract

Several methods for controlling Thrips palmi in greenhouses in Japan were compared in their effectiveness on a population model. Since a use of chemicals alone is not effective, some other methods based on cultural practices were subjected to test. They included combined practices of rotation of crops, use of cheesecloth, ultra violet absorbing vinyl film, blue sticky ribbon and/or silver film. From the simulation on the basis of population model of T. palmi, the following conclusions are derived: 1) since the low density effect functions in an influential manner, it is recommended that the insect population be maintained at a very low density level: 2) considering the importance of the safe use of agricultural chemicals, insect control relying on insecticides alone is not adequate: 3) control methods based on cultural practices are considerably effective in suppressing the population density: and 4) an adequate integration of insecticide sprayings with the cultural control method is highly recommendable.

Discipline: Plant protection
Additional key words: cultural control, low density effect, population model

Introduction

Thrips palmi KARNY was found in Japan in 1978 and became the most serious pest of cucumber, eggplant and sweet pepper both in greenhouses and in open fields in the western part of Japan. The reproductive rate is high[1] and the sensitivity to a number of commercially available insecticides is low[8]. The eggs are deposited in plant tissues and the last instar larvae pupate in the soil. These properties make it difficult to control the thrips only with chemicals unless they are sprayed many times. In addition to pesticides, several cultural control methods have been thus far proposed. In this paper, the author will explain control methods of *T. plami* mainly in greenhouses in Japan, and evaluate the effectiveness of the control methods using a population model.

Chemical control

The effects of several insecticides to *T. palmi* are shown in Fig. 1 compared with those to *T. setosus* MOULTON, which is a native and minor pest in Japan. Most of the chemicals have high mortality to *T. setosus*, but only a few chemicals have high mortality to *T. palmi*. *T. palmi* probably had low sensitivity to many insecticides before invasion to Japan.

Insecticides are used in the form of forliar as well as soil application. Methidathion, BPMC, sulprofos, phosalone, cipermethrin and endosulfan are registered as chemicals for forliar application, and oxymyl, carbosulfan and benfuracarb are registered as those for soil application. In the latter case, granular type insecticides are generally used, and effective only in the seedling stage. Therefore, they are put in the pots at the seeding or the transplanting time (1—2 g/plant), being effective for three to four weeks.

Cultural control

Rotation of crops: The effect of crop rotation on the population of *T. palmi* is shown in Table 1.

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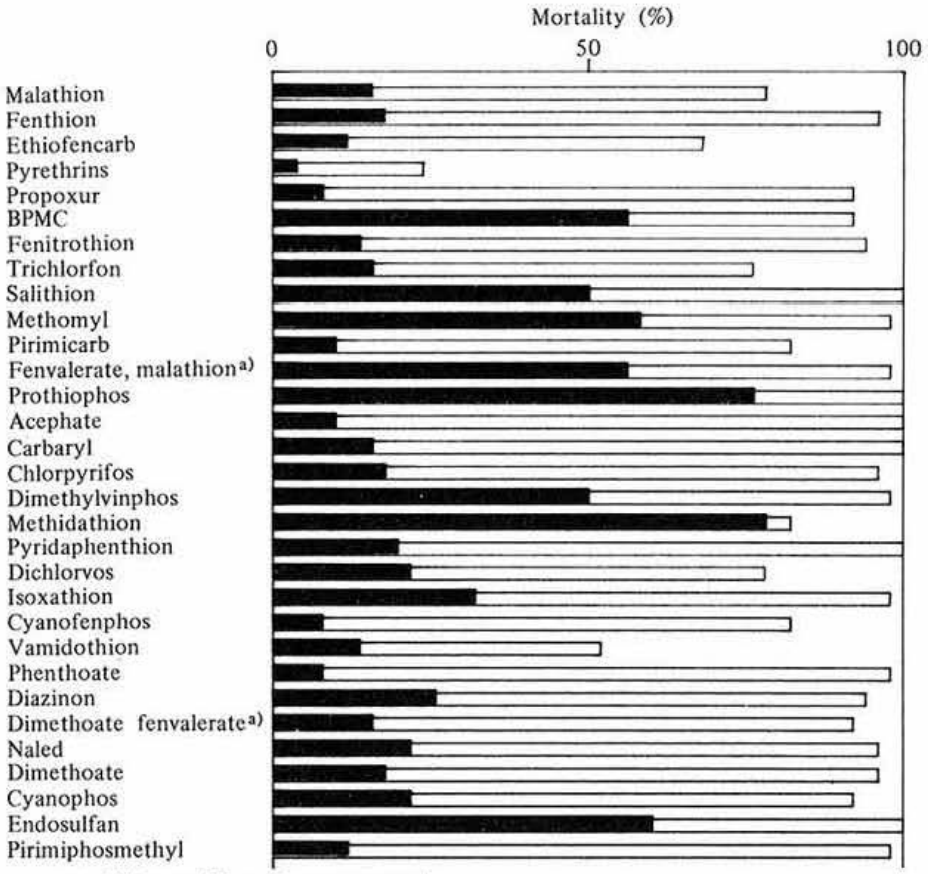
Table 1. Effect of crop rotation upon the population of *Thrips palmi* on sweet pepper cultivated in greenhouses in winter[9)]

District	Winter[a)] cultivation	Summer[b)] cultivation	% of houses with *T. palmi*	% of plants with injury	No. of *T. palmi* per flower
1	Sweet pepper	Eggplant	100	8–100 (38)[c)]	0.10–4.94 (1.46)[c)]
2	Sweet pepper	Cucumber	100	6– 36 (16)	0.16–1.56 (0.58)
3	Sweet pepper	Non host plant	31	0– 6 (1)	0 –0.30 (0.03)
4	Sweet pepper	Non host plant	30	0– 4 (0)	0 –0.06 (0.01)

a): Cultivated in greenhouses, b): Cultivated in open fields, c): Minimum–maximum (mean).



a): Mixture of these two compounds
■: Mortalities of *T. setosus*, □: Mortalities of *T. palmi*.

Fig. 1. Comparison of the effects of insecticides on two species of thrips, *Thrips palmi* and *T. setosus*[8)]
All chemicals were used as 1,000-time dilution of the commercial products, and mortalities were counted 24 hr after treatment.

In the district without any host crop in summer, the population in the winter cultivation is low. On the contrary, in the district under eggplant or cucumber cultivation in summer, the population in the winter cultivation is high. Although *T. plami* has a very wide range of host plants including a number of weeds, the host plants highly suitable quantitatively as well as qualitatively are limited to several kinds of vegetables such as cucumber, melon, eggplant and so forth. Since the flight activity is not high, *T. plami* cannot move on to a long distance by itself. It is important that favorable host plants should never be cultivated successively.

Cheesecloth: The density in the plot covered by cheesecloths for 30 days after planting is 3—19% of that in the control plot (Fig. 2). Covering with a cheesecloth is effective to reduce the invasion, and there is no clear difference of the effect among the various colored cheesecloths. Cheesecloths are usually used to cover the opening of a greenhouse or to cover the seedlings in open fields.

Ultra violet absorbing vinyl film (UVA): UVA is a special vinyl film which absorbs the ultra violet region spectrum. The density of *T. palmi* in greenhouses covered by UVA is lower than that in greenhouses covered by the common agricultural vinyl film (CA) just as seen in the density of aphids or greenhouse whiteflies. However, the reproduction of *T. palmi* in greenhouses covered by UVA is the same as that in greenhouses covered by CA[10]. The invasion of *T. plami* into the greenhouses covered by UVA is 1/10 of that into the greenhouses covered by CA[10]. The low density in greenhouses covered by UVA is due to the reduction of invasion. Since in the greenhouses covered by UVA, the fruit of eggplant does not become purple, UVA cannot be used for the greenhouses of growing eggplants. UVA is usually used for the greenhouses of sweet pepper, cucumber or water melon.

Blue sticky ribbon: *T. palmi* is attracted by white and bright blue colors and keeps out of red, black and silver colors (Fig. 3). However, *T. plami* is not attracted by white and blue colors which reflect the ultra violet region spectrum, but only by white and blue colors which absorb that spectrum. The blue sticky ribbons are made available in the market. The sticky ribbons are generally used for mass trapping. When the ribbons are set every 2—3 m^2 in the greenhouse, the density of *T. palmi* becomes 1/5 to 1/10 of that in the greenhouse without ribbons. The blue sticky ribbons are usually used in the greenhouses for growing sweet pepper or eggplant.

Silver film: Since adults of *T. plami* keep out of silver color (Fig. 4), the density in the plot with silver film is 27% of that in the control plot and effect of the black film with silver stripes is smaller than that of the silver film (Fig. 4). Silver polyethylene films are usually used to cover the ground both in open fields as well as in greenhouse cultivation. Since aphids also avoid silver color, silver films can also reduce population of the aphids.

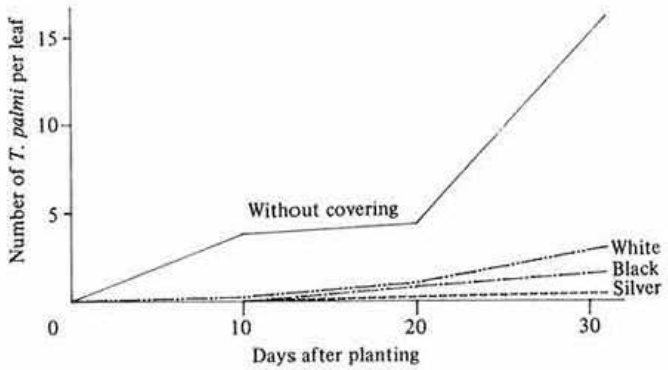


Fig. 2. Effect of covering with cheesecloths upon the increase of *Thrips paimi* on cucumber cultivated in open fields
Seedlings were covered by various colored cheesecloths.

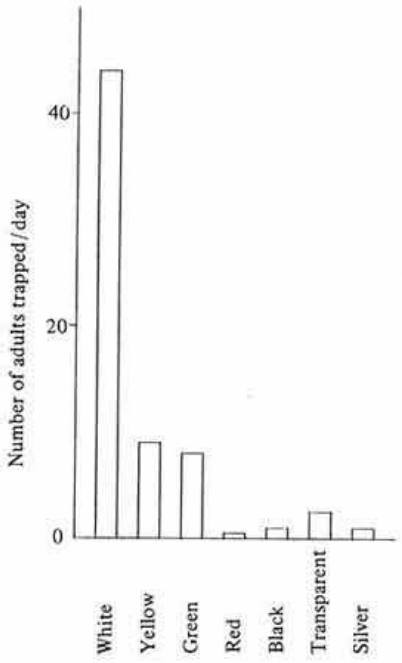


Fig. 3. The number of adults of *Thrips palmi* trapped by various colored sticky traps[11]

Population model

In order to establish an integrated control system, population models of *T. plami* in greenhouses were examined to evaluate the effectiveness of various control methods[5,6]. The model consisted of two matrices. One related to the population of *T. palmi* on leaves, and the other related to the population on flowers and fruits. The population was expressed as female number per leaf in case of cucumber and eggplant, and as female number per flower in case of sweet pepper. The low density effect on reproduction[4] was considered in the model as the decrease of the rate of population. The economic injury level (EIL) was fixed at the density when the yield loss of uninjured fruits reached 5%; namely, 3.1 female adults per leaf of cucumber[2], 0.06 female adult per leaf of eggplant and 0.08 female adult per flower of sweet pepper[3].

The relationship between the control threshold (CT) and the required frequency of spraying for the *T. palmi* population on cucumber for a period of 180 days is shown in Fig. 5. The required frequency considerably lessens as the CT is less than 0.5.

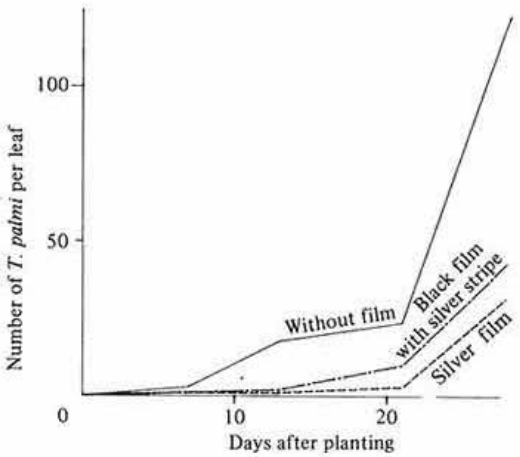


Fig. 4. Effect of covering the ground with silver polyethylene film upon the increase of *Thrips palmi* on cucumber cultivated in open fields[7]

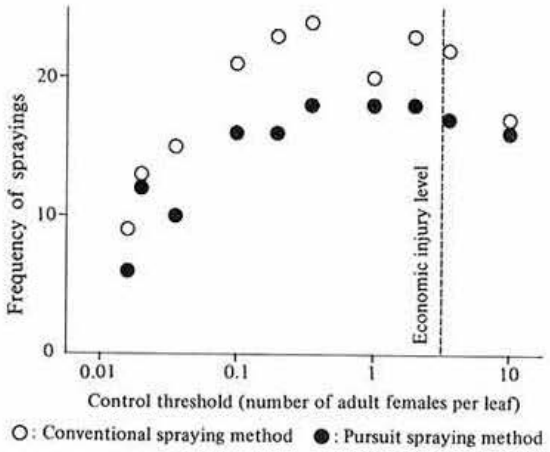


Fig. 5. Relationship between the control threshold level and the frequency of sprayings to *Thrips palmi* on cucumber for a period of 180 days[5]

Therefore, the low density effect is critical to achieve this result. In other words, in controlling *T. palmi*, it is most important that the population is controlled at a very low level of density so that the low-density effect can effectively operate. In order to control the insect pests which have such a low density effect, a high reproductive rate and a low sensitvity to insecticides, the CT must be set at a very low density regardless of EIL unlike in many other insects.

The frequency of sprayings on the basis of a "pursuit" spraying method, where each of the sprayings is practiced when the population exceeds CT level and followed by another spraying several days later regardless of population density, is always less than that based on the conventional method under which an insecticide is sprayed only when the population exceeds the CT (Fig. 5). The pursuit spraying method is recognized to be effective to control *T. palmi*. In this method, the second spraying has a significant role in controlling insects which escape from the first spraying at the stage of eggs or pupae. The pursuit spraying method is therefore effective to control insect pests which have such a free stage from the effective application of insecticides.

When insecticides are sprayed periodically starting at a very low density of insect population, effective control could be achieved even by spraying at long intervals, and the frequency is almost the same as that on the basis of CT. On the other hand, when the periodical spraying starts at a high density, insecticides have to be sprayed at short intervals. In practice, therefore, it would be recommendable to adopt periodical sprayings starting at a very low density, rather than spraying by setting a CT at a very low density. Periodical spraying would particularly be effective for the insect pests which have a low density effect, a high reproductive rate, a low sensitivity to insecticides and a different sensitivity to insecticides among stages.

The effects of insecticide sprayings for the insect population on eggplant and sweet pepper are generally the same as those on cucumber. However, the effectiveness on sweet pepper is slightly weak, since half of the insect population lives on fruit of sweet pepper, especially beneath the calyx, where the insects are free from insecticides. Therefore, several successive sprayings of insecticides at a short interval are required to rapidly reduce the population density on sweet pepper.

Comparison of the effects of the prevention of invasion into a greenhouse by cheesecloth or UVA among the above three crops is shown in Fig. 6. As the number of invading adults of *T. palmi* decreases, the duration until the population reaches EIL is extended in all the three crops. As far as the resulting effect of prevention of invasion is concerned, the least injuries take place on sweet pepper, while the greatest occur on cucumber. The prevention of invasion is more effective on the crops, such as sweet papper, which have a low reproductive rate. The effect of the prevention is generally the same as that of reducing insect density on seedlings and mass trapping with sticky traps. These methods based on cultural practices are effective for the above three crops, particularly sweet pepper.

Conclusions

From the above-stated results of the experiments, the following conclusions are derived: (1) since the low-density of *T. palmi* provides an effective basis for controlling it, it is recommended that the insect population be maintained at a very low density

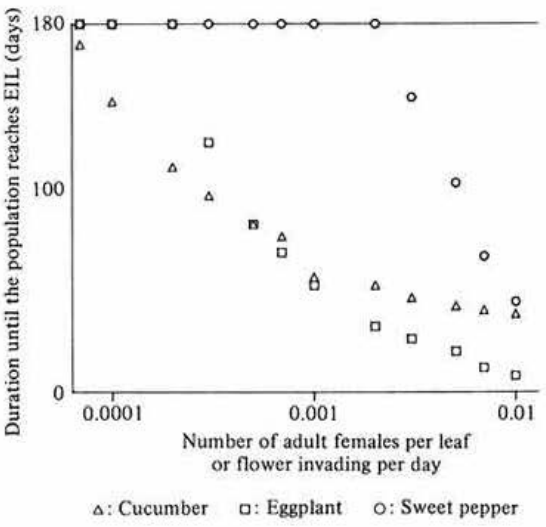


Fig. 6. Comparison of the effects of the prevention of invasion to the greenhouse upon the increase of *Thrips palmi* on cucumber, eggplant and sweet pepper[6)]

level; (2) considering the standard for the safe use of agricultural chemicals, insect control on the basis of insecticides alone is not adequate; (3) control methods based on cultural practices are also effective in suppressing the population density, especially in case where the reproductive rate of *T. palmi* is very low on the host plants; and (4) an adequate integration of insecticide sprayings with a cultural control method is highly recommendable.

These conclusions are applicable mainly to the population of *T. palmi* in greenhouses. The population dynamcis of *T. palmi* in open fields might be almost the same as those in greenhouses. However, since there might be some limitations with the control methods which could be used in open fields, further studies are required to establish an appropriate control system of *T. palmi* in open fields.

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(Received for publication, Feb. 14, 1989)