The pest and vector from the East: *Thrips palmi*

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Abstract: Heavy damage to vegetables caused by *Thrips palmi* is widespread in the tropical and subtropical regions of the world. The first appearance of this species in Japan occurred in Kyushu in 1978. It has since become the most serious pest of fruit vegetables in western Japan. The following characteristics make it an important pest: preference for young tissues of plants; high reproductive rate; wide range of host plants; low sensitivity to insecticides. Various types of chemicals, and various kinds of physical control methods have been tested against *T. palmi* in Japan, and integration of several control methods is necessary. Studies on *T. palmi* conducted by Japanese applied entomologists are summarized here.

Worldwide spread

Since the late 1970s, *Thrips palmi* has become widely distributed in tropical and sub-tropical regions, including Southeast Asia, the Pacific Islands, the Caribbean Islands and South America (Fig.1). *Thrips palmi* was found in Japan in 1978 and became the most serious pest of eggplant, cucumber and sweet pepper both in greenhouses and in open fields in the western part of Japan. No one commented on seeing serious thrips damage to vegetable crops in Japan before this invasion by *T. palmi*. The recent spread of the species, and its increase in abundance, in Japan are indicated in Fig. 2 (Kawai, 2000). Many Japanese applied entomologists have studied the host plants, life cycle, population dynamics and control methods of this insect. In this review, I discuss the wide range of studies on *T. palmi* conducted in Japan since 1978.

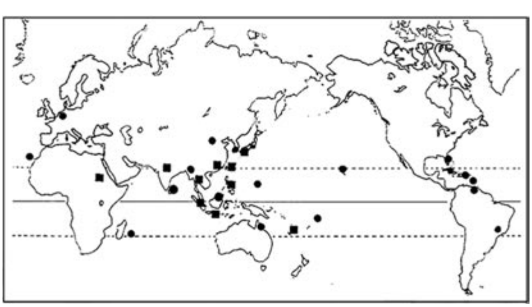


Fig. 1. Distribution of *Thrips palmi* in the world. ■ before 1981; ● after 1982

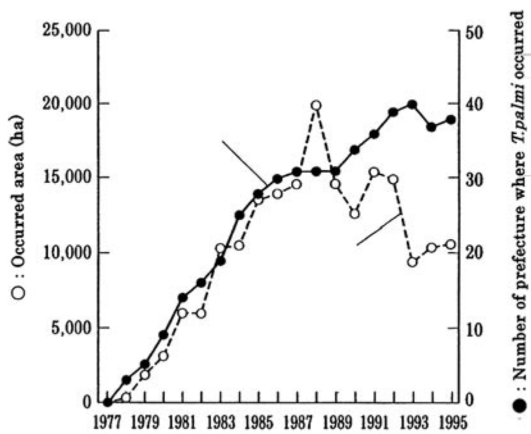


Fig. 2. Spread of *T. palmi* in Japan since 1977.

Biology

Host plants: The host plants and distribution of *T. palmi* were surveyed in the area of infestation. The species has a very wide range of its host plants, 34 families and 117 species of host plant being recorded in Japan (Miyazaki & Kudo, 1988). Almost all green house crops were damaged by *T. palmi* except for strawberry and tomato. *Life cycle:* Development of *T. palmi* is rapid and population increase rate is high. Effects of temperature on the population growth of *T. palmi* feeding on cucumber leaves in the laboratory are shown in Table 1. Generation time was reduced under higher temperatures. The net reproductive rate reached a maximum at 25ºC, and the threshold temperature of development and thermal constant

	15 °C	20 °C	25 °C	30 °C
Mean generation time (days)	80.2	40.7	24.8	20.5
Net reproduction rate	16.5	25.9	28.0	19.1
Intrinsic rate of natural increase/day	0.035	0.080	0.134	0.144
Reproductive rate/ month	2.9	11.0	55.7	75.2

Table 1. Population growth of *T. palmi* fed on cucumber leaves at different temperatures (Kawai, 1985a)

Crop	Generation time (days)	Net reproduction rate	Intrinsic rate of natural increase/ day	Reproductive rate / month
Cucumber	24.8	28.0	0.134	55.7
Melon	23.2	13.0	0.111	27.9
Pumpkin	24.8	7.3	0.080	11.0
Balsam pear	25.0	2.7	0.040	3.3
Eggplant	25.4	13.3	0.102	21.3
Sweet pepper	22.8	2.9	0.047	4.1
Kidney bean	25.2	4.7	0.061	6.2
Okura	25.9	0.5	-0.027	0.4
Chrysanthemum	21.2	0.1	-0.109	0.0

Table 2. Population growth of *T. palmi* fed on various crops (Kawai, 1986a)

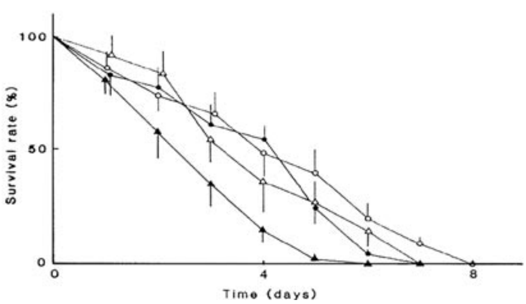


Fig. 3. Survival period of summer population of *Thrips palmi* exposed to a constant temperature of 0 oC.

○:Second instar larvae with food
●: Second instar larvae without food
▲:Adult without food

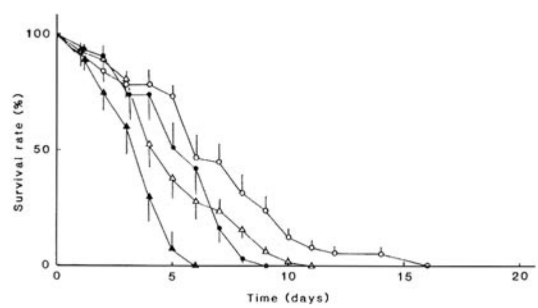


Fig. 4. Survival period of winter population of *Thrips palmi* exposed to a constant temperature of 0 oC. Symbols are the same as in Fig.3.

for the pre-adult stage was estimated at 11.6°C and 189.1 day-degrees, respectively (Kawai, 1985).

Thrips palmi has a very wide range of host plants, and there is considerable variation in population growth among the hosts. The plants fed on during the growth stage of larvae and adults have limited effects on pre-adult development and adult longevity, but they seriously affect fecundity. The maximum intrinsic rate of natural increase of *T. palmi* is seen on cucumber, and a fairly high rate occurs on melon, eggplant and pumpkin (Table 2). Although *T. palmi* is an important pest of sweet pepper, the population growth on this crop is not high (Kawai, 1986). *Thrips palmi* does not complete its life cycle on tomato or strawberry (Kawai, 1986).

The summer population is susceptible to exposure to low temperatures, whereas the winter population is more tolerant of low temperatures (Fig.3, 4). Maximum survival period of the overwintering adults and second instar larvae exposed to a constant temperature of 0 °C with food was 11 days and 16 days, respectively, while under the fluctuating temperature conditions, the period was 28 days and 18 days, respectively (Tsumuki et al, 1987). Pupae can tolerate the low temperature for a long time. However, the duration before all pupae die is 8 days at 0 °C, 255min at –5 °C or 35min at –10 °C (Tsumuki et al. 1990). *Thrips palmi* cannot overwinter under the natural conditions except for the southern part of Japan.

Chemical control

The effects on *T. palmi* of several insecticides are shown in Fig. 5 compared with the effects on *Thrips setosus* Moulton, an indigenous and minor pest in Japan. Most of chemicals have high mortality to *T. setosus*, but only a few chemicals have a high mortality to *T. palmi*. New chemicals, such as imidacloprid and its mimics are effective to *T. palmi*. Insecticides are used in the form of foliar application as well as soil application. Granular type insecticides are generally used, and effective only in the seedling stage.

Recently, resistant populations to imidacloprid and other chemicals have appeared in some districts in the southern part of Japan (Komi, unpublished data).

Cultural control

Rotation of crops: In districts without suitable host crops in summer, the winter population in cultivation is low. In contrast, in districts under eggplant or cucumber cultivation in summer, the population in winter cultivation is high. Although *T. palmi* has a very wide range of host plants, including a number of weeds, the most suitable host plants quantitatively as

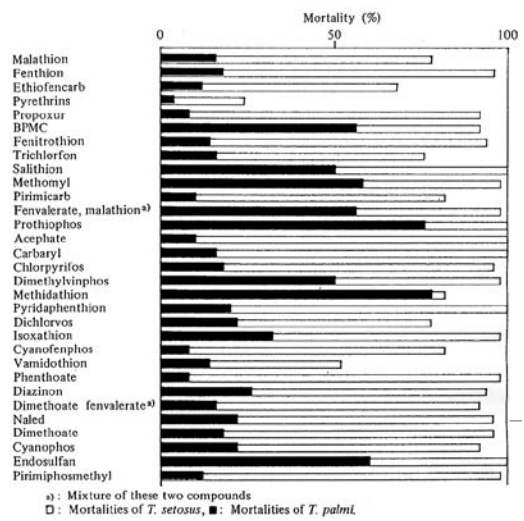


Fig. 5. Comparison of the effects of insecticides on two species of thrips, *Thrips palmi* and *T. setosus.* All chemicals were used as 1000-time dilution of commercial products.

Population	Collection site	Collection date	LC50 (ppm)	R/S ratio
①	Nangoku	1999 March	67.9	16.6
②	Nangoku	1999 May	15.1	3.7
③	Yasuda	2000 Feb.	13.2	3.2
④	Aki	2000 Feb.	26.5	6.5
⑤	Tosashimizu	2000 Feb.	30.5	7.4
⑥	Tosashimizu	2000 Feb.	36.7	9.0
⑦	Haruno	2000 Feb.	31.2	7.6
⑧	Hiratuka	1993	4.1	–

a) Population ⑧ is susceptible strain

Table 3. Susceptibility of *Thrips palmi* to imidacloprid (Komi, unpublished)

Population	Collection site	Collection date	LC_{50} (ppm)
A	Nangoku	2000 Nov.	88.8
B	Nangoku	2000 Nov.	72.2
E	Kubokawa	2000 Dec.	126.9
F	Kubokawa	2000 Dec.	167.2
H	Nangoku	1998 Sep.	91.9
I	Hiratuka	1993	61.8
J	Kochi	1992	115-325
K	Kochi	1984	4.0

Table 4. Susceptibility of Thrips palmi larva to sulprofos (Komi, unpublished)

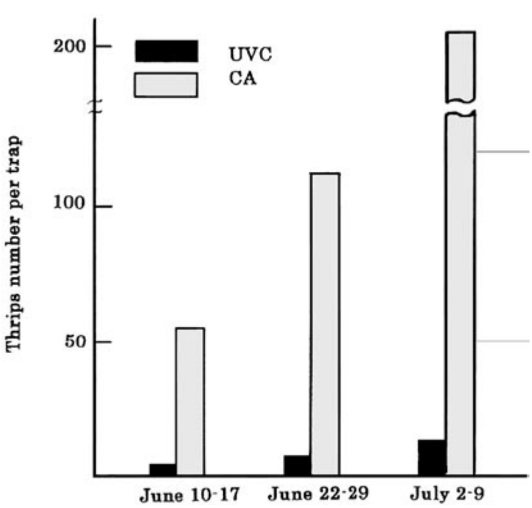
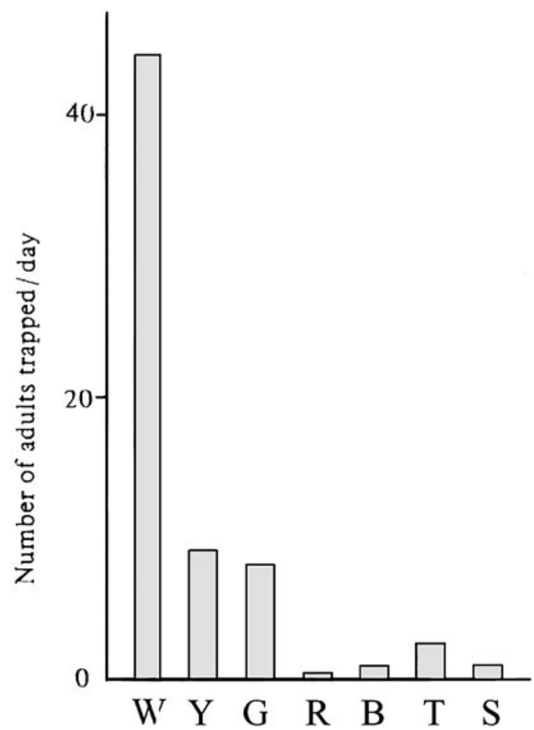


Fig. 6. Effect of ultra-violet absorbing vinyl film on prevention of Thrips palmi invasion (Nagai & Nonaka, 1982).

well as qualitatively are limited to a few kinds of vegetables, such as cucumber, melon and eggplant. It is important that such favorable host plants should never be cultivated successively. *Ultra violet absorbing vinyl film (UVA):* 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 is seen in the density of aphids or whiteflies. However, the reproduction of *T. palmi* in greenhouses covered by UVA is the same as that in greenhouses covered by CA.



W: White; Y: Yellow; G: Green; R: Red; B: Black; T: Transparent; S: Silver

Fig. 7. The number of adults of *Thrips palmi* trapped by various colored sticky traps.(Nonaka & Nagai, 1984)

The invasion into greenhouses covered by UVA is about 10% of that into greenhouses covered by CA (Nonaka & Nagai, 1983). UVA is usually used for those greenhouses where sweet pepper, cucumber or water melon are cultivated. *Blue sticky ribbon: Thrips palmi* is attracted by white and bright blue colors and avoids red, black and silver colors (Fig.7). *Thrips palmi* is not attracted by white and blue colors which reflect the ultra violet region spectrum, but only by white and blue colors that absorb those wavelengths. The blue sticky ribbons are generally used for mass trapping. When these ribbons are set every 2-3 m^2 in a greenhouse, the density of *T. palmi* is reduced to 1/5 to 1/10 of that in greenhouses without ribbons (Nonaka & Nagai,1984). *Silver film:* The density in plots with silver film is 27% of that in control plots, and the effect of black film with silver stripes is smaller than that of silver film (Makino, 1984; Suzuki & Miyara, 1984). Silver polyethylene films are usually used to cover the ground, both in open fields as well as in greenhouse cultivation.

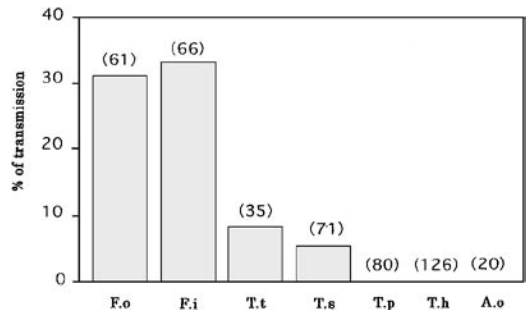
Biological Control

Several natural enemies of *T. palmi* are known. Hirose et al. 1990) found that the larval endoparasitoid *Ceranisus menes* attacks *T. palmi* both in Japan and Thailand. The predatory bug, *Orius sauteri*, is a well-known predator of thrips and is the most important natural enemy of *T. palmi* in sweet pepper and eggplant fields (Hirose, 1990; Kajita, 1985). It is mass-produced by Japanese companies as a biological control agent. In eggplant fields, *O. sauteri* can be used as part of IPM strategies.

Entomopathogenic fungi, *Beauveria bassiane* and *Verticilium* lecanii, and entomogenous nematodes have been tested in fields. (Saito, 1991, Saito & Kobayashi, 1987). Saito et al. (1989) found *Neozygites parvispora* on *T. palmi* as a new entomopathogenic fungus. However, these agents have not yet provided a practical control method.

Tospovirus transmission

Thrips palmi transmits Water melon silver mottle Virus (WSMoV) (Iwaki et al, 1984). Kato 2000) recently reported that melon yellow spot virus (MYSV) was also transmitted by *Thrips palmi* on melon and cucumber. Fujisawa et al. 1988) reported that *T. palmi* could transmit TSWV. However, we could not confirm TSWV transmission by *T.*



F.o: *Frankliniella occidentalis*; F.i: *Frankliniella intonsa*; T.t: *Thrips tabaci*; T.s: *Thrips setosus*; T.p: *Thrips palmi*; T.h: *Thrips hawaiiensis*; A.o: *Anaphothrips obscurus*. Tested number indicated in parenthesis.

Fig. 8. Efficiency of transmission of tomato spotted wilt virus (TSWV) by several thrips species to petunia leaf disks (Inoue et al., 2000).

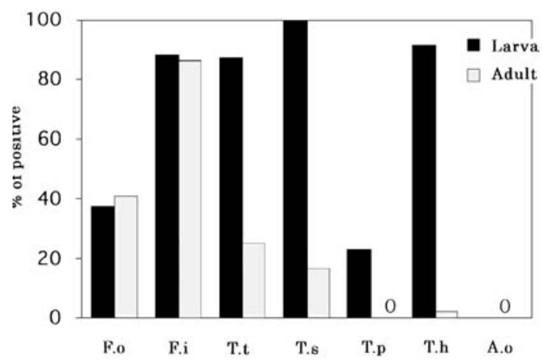


Fig. 9. Frequencies of positive thrips for TSWV by TAS-LISA.

palmi by petunia leaf disk method (Fig.8). Virus accumulates in the larval body, but virus could not be detected in adults by TAS-ELISA (Fig. 9).

Studies on Thrips palmi published in Japan

Many studies on control and ecology of *T. palmi* have been conducted by Japanese applied entomologists in the southern parts of Japan, but most of these studies were published in Japanese. These data might be very useful for understanding the biology and control of *T. palmi* and should be referred to for the methodology of studying this and other thrips species. The following list of literature on *T. palmi* published in Japan is modified from Kawai 2000).

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