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Pest Management Systems for Eggplant Arthropods: A Plan to Control Pest Resurgence Resulting from the Destruction of Natural Enemies

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Abstract

Eggplants in an experimental plot were continuously sprayed with the insecticides permethrin, milbemectin, phenthoate and imidacloprid to evaluate their respective side-effects. Effects on populations of pests and of their natural enemies were assessed. The results revealed the importance of natural enemies such as anthocorid bugs, *orius spp*. Application of a pesticide may cause a resurgence of a pest population because of (1) the development of resistance by the pest and (2) nonselective killing of predators. The author therefore attempted to develop methods of control of pests that would not affect substantially natural enemies. Imidacloprid which is highly effective against the pests Hemiptera and *T. palmi* caused a resurgence of the spider mite. Milbemectin which exerts a minimal adverse effect on *Orius spp*. when used in combination with imidacloprid, maximized the latter's advantages while minimizing its disadvantages.

Discipline: Insect pest
Additional key words: *Thrips palmi, Aphis gossypii, Tetranychus kanzawai, Orius spp.,* imidacloprid

Introduction

Eggplant growth has been severely impaired by *Thrips palmi* Karny in recent years in Japan, and utmost efforts have been made to control this pest. The control of only one species of pest is not relevant for eggplants that require simultaneous protection from other pests. However, the use of a certain type of pesticide may actually cause a resurgence of *T. palmi*[1)] and of *Tetranychus kanzawai* Kishida[6)]. It is also known that the use of imidacloprid which is highly effective against pests such as Hemiptera and *T. palmi* causes a resurgence of the spider mite[4)]. The relationship among the various pests found in eggplant farms and their natural enemies has remained relatively unexplored except for that between *T. palmi* and anthocorid bugs *Orius* spp.[1–3)]. The author continuously sprayed eggplants with various pesticides and assessed the effects of these substances on the populations of pests and predators of the crop. Based on the results obtained he attempted to develop methods of control of the pests that would not affect appreciably their natural enemies.

Methods

Test 1: The test was conducted in a farm in Saitama Horticultural Experiment Station (SHES), Saitama Prefecture, Japan. The variety of eggplant used was Senryo-2-go grafted onto Karehen root stock (planted on May 6–7, 1992). The test was conducted in several plots, each approximately 100 m^2 without replication. The areas for pesticide tests were sprayed with an emulsion of permethrin, milbemectin or phenthoate at intervals of 10–15 days during the experimental period. In another plot, imidacloprid granules which are known to cause a resurgence of the spider mite[4)] were placed in each planting hole at a rate of 1 g per plant and sprayed with a 1/2,000 solution of water dispersible powder of imidacloprid (applied twice: on August 21 and on September 2). The solution was applied with a power sprayer. The infestation density index was determined by examining the 10 uppermost unfolding leaves of 20 plants sequentially selected in each area, and scoring the degree to which these leaves were infested by adult pests as follows: (0) none; (1) negligible

(1 - 5 arthropods per 10 leaves); (2) minimal (1 - 5 arthropods per leaf); (3) moderate (approximately 25 arthropods per leaf); (4) high (approximately 50 arthropods per leaf); and (5) extremely high (more than 100 insects per leaf). Beneficial invertebrates were also counted by visual observation prior to the application of the test compounds.

Test 2: Imidacloprid granules which are known to cause a resurgence of spider mites[4] were placed in each planting hole at a rate of 1 g per plant. The treated areas were divided into one which had been sprayed with a 1/2,000 solution of water dispersible powder of imidacloprid (applied twice on the same dates as above) and a second which had been sprayed with a 1/1,000 solution of milbemectin emulsion (applied once on August 21); again, a power sprayer was used. Pests and predators were counted as in Test 1. The tests which were conducted in areas approximately 72 m^2 were not repeated. Fruits harvested on September 21 were divided into (1) those damaged by *T. palmi* and/or broad mites *Polyphagotarsonemus latus* (Banks), (2) those damaged

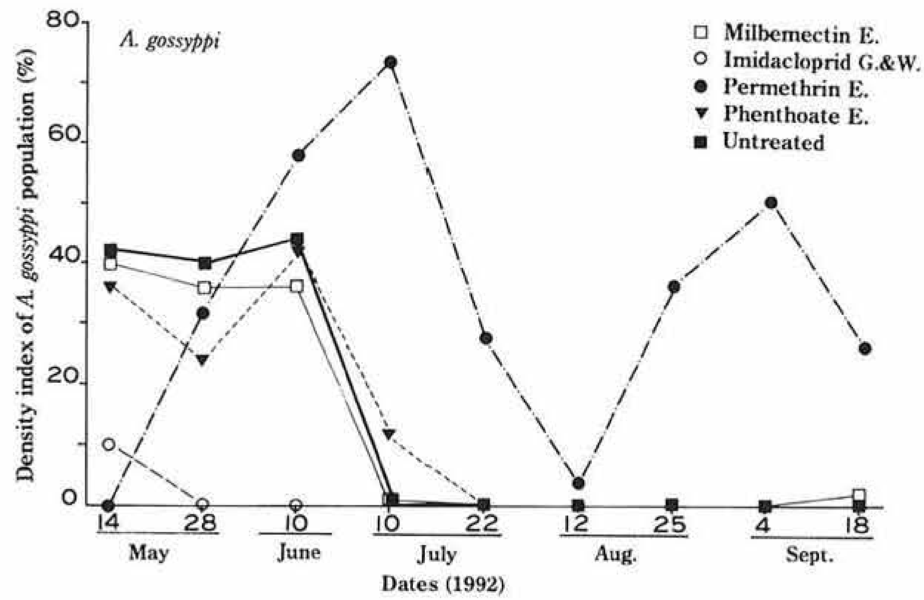

Fig. 1. Effect of insecticide treatments on *Aphis gossypii* populations on eggplants

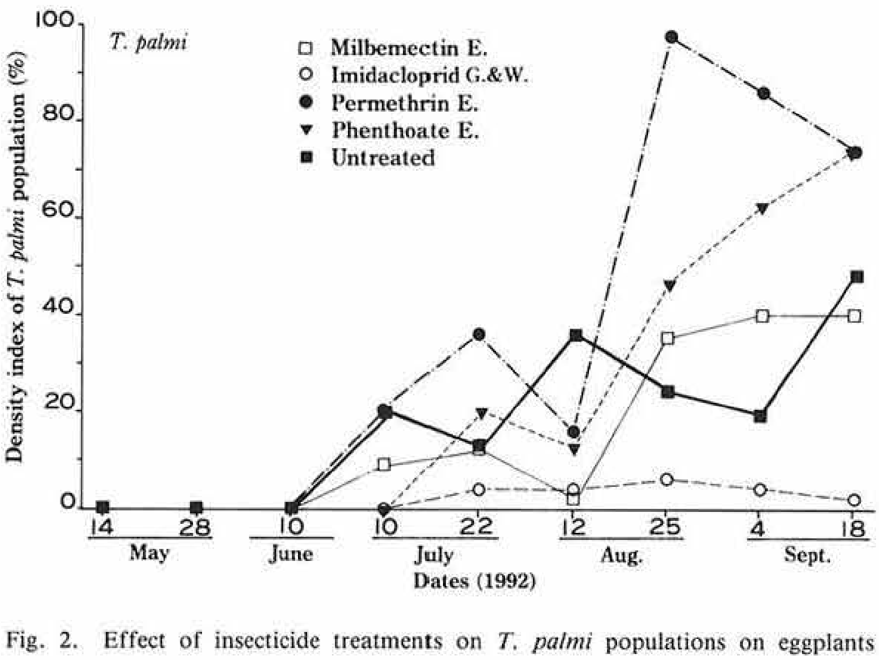

Fig. 2. Effect of insecticide treatments on *T. palmi* populations on eggplants

by common cutworms *Spodoptera litura* (Fabricius), and (3) normal fruits. The number of fruits in each group was recorded.

Results and discussion

The resurgence of three types of pests — *T. palmi*, cotton aphids *Aphis gossypii* Glover and Kanzawa spider mite *Tetranychus kanzawai* Kishida — was observed in the area previously subjected to treatment with permethrin, and the resurgence of *T. palmi* was detected in the area exposed to phenthoate (Figs. 1, 2 and 3). Permethrin strongly reduced the population density of *Orius sauteri* Poppius and *O. minutus* Linnaeus which are known to be predators of *T. palmi* (Fig. 4). Ohtani et al.[6] also reported that outbreaks of *T. kanzawai* on the eggplants occurred because of the adverse effects of permethrin sprays on the mite predators. The population density of coccinellid beetles was reduced by treatment with permethrin or phenthoate. The aphid, *A. gossypii*, populations exhibited two distinct peaks in the plot

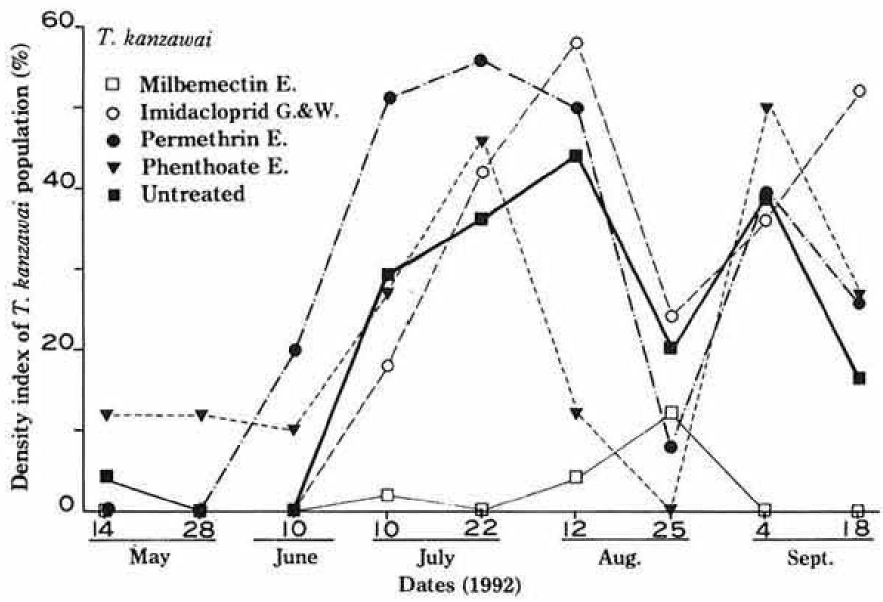

Fig. 3. Effect of insecticide treatments on *T. kanzawai* populations on eggplants

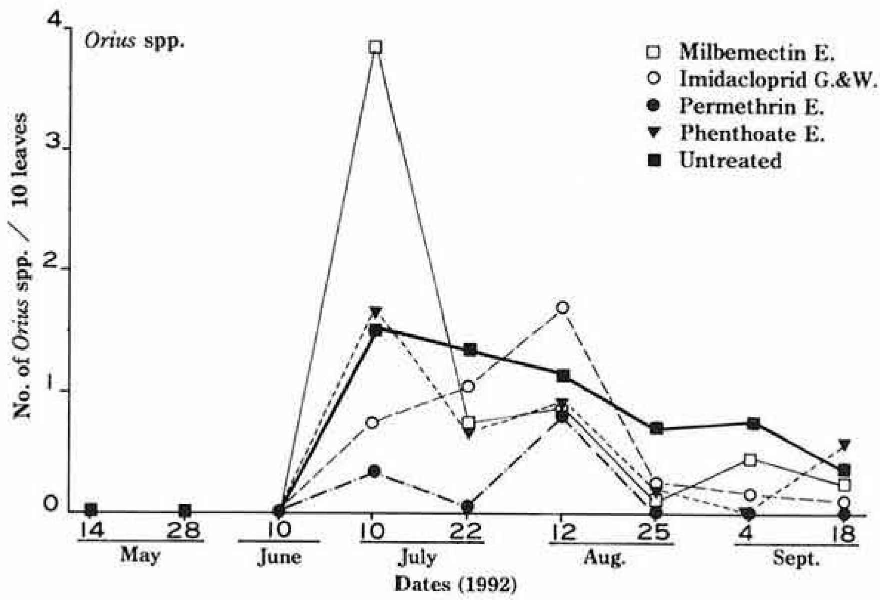

Fig. 4. Effect of insecticide treatments on *Orius sauteri* and *O. minutus* populations on eggplants

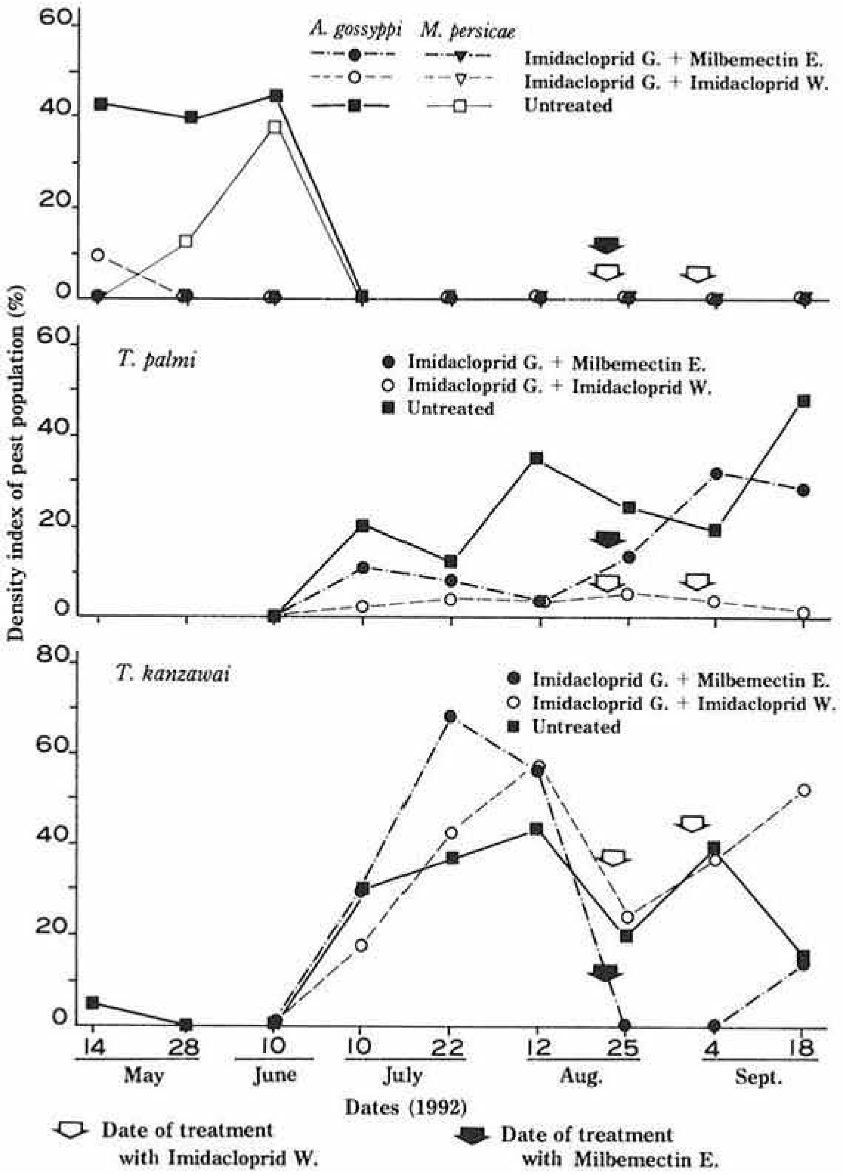

Fig. 5. Effect of insecticide treatments on the pests populations on eggplants

sprayed with permethrin and the peak densities after July were much higher than in the untreated plot (Fig. 1). Thus there is a very high probability that pesticides like permethrin which have a strong eradicating effect on the natural enemies of pests cause the resurgence of the pests themselves. Nemoto[5] listed (1) resistance to the insecticide, (2) differential mortality levels between diamondback moth (DBM) *Plutella xylostella* and its predator which is responsible for a large part of the pest mortality, and (3) stimulation of the reproductive potential, as causes of the resurgence of DBM which infests vegetables of the Brassica family. Causes (1) and (2) may also apply to the resurgence of the three types of pests listed above following permethrin treatment.

Meanwhile, densities of *T. palmi*, *A. gossypii* and *T. kanzawai* in the milbemectin-sprayed plot were not as high as in the untreated plot (Figs. 1–3). Milbemectin showed a minimal adverse effect on predators such as *Orius* spp. except for coccinellid beetles (Fig. 4). Although milbemectin reduced the population density of spider mites (Fig. 3), it had hardly any effect on the population densities of adult cotton aphids and adult *T. palmi* (Figs. 1 and 2). Although there were few larvae of *T. palmi*, most of them were adults. This observation suggests that milbemectin shows a certain physiological activity against *T. palmi*, by possibly preventing oviposition or inhibiting stages other than the adult stage.

Treatment with imidacloprid granules at the time of planting is known to be very effective against the infestation with pests such as *T. palmi*, *A. gossypii* and the green peach aphid *Myzus persicae* (Sulzer) (Fig. 5). However, it has also been reported that treatment with imidacloprid granules caused a problematic resurgence of spider mites from mid-July through mid-August[4] (Fig. 5). The present study did not enable to clarify the cause of the resurgence following treatment with imidacloprid granules at planting time. Predators such as *Orius* spp. and phytoseiid mites played an important role as biotic mortality agents of *T. palmi* and *T. kanzawai*[3,6]. Peak densities of *Orius* spp. in the imidacloprid-treated plot appeared later than in the untreated plot (Fig. 4). It is possible that the pesticide exerts an adverse effect on predators of the spider mite such as *Orius* spp. and phytoseiid mites.

Treatment with imidacloprid granules should be applied when there are relatively few natural enemies. The treatment has no direct effect on the natural enemies. The application of imidacloprid granules at the time of planting enabled to control *T. palmi*, *A. gossypii* and *M. persicae* in the eggplant plot for more than 3 months after planting (Fig. 5). The author, therefore, considered that not only imidacloprid but also natural enemies played an important role in the control of the insect pests in this plot. The plants in this study which were treated with granules at the time of planting, then sprayed once with milbemectin on August 21, displayed a significantly lower degree of infestation with spider mites following the permeation, while pest damage of fruits (harvest on September 21) was reduced (Fig. 6). The control of only one species of pest is not relevant for eggplants that require simultaneous protection from other pests. Imidacloprid granules thus may be used effectively in combination with a pesticide such as a solution of milbemectin which exerts a minimal adverse effect on predators like *Orius* spp. This method which maximizes the advantages of imidacloprid and minimizes the disadvantages could be applied in the IPM system.

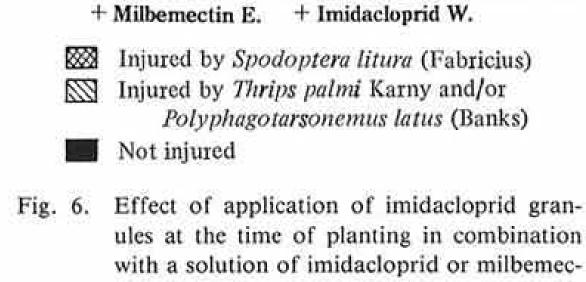

Fig. 6. Effect of application of imidacloprid granules at the time of planting in combination with a solution of imidacloprid or milbemectin on the pests populations on eggplants

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