

# INTEGRATED PEST MANAGEMENT OF WEST INDIAN SWEET POTATO WEEVIL *EUSCEPES POSTFASCIATUS* (FAIRMAIRE) AND SWEET POTATO WEEVIL *CYLAS FORMICARIUS* (FABRICIUS) IN OKINAWA, JAPAN

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## ABSTRACT

*The West Indian sweetpotato weevil Euscepes postfasciatus (FAIRMAIRE) (WSPW) and the sweetpotato weevil, Cylas formicarius (FABRICIUS) (SPW), are the most destructive pests of sweetpotato all over the world (Jansson 1991), including the southwestern islands of Japan. This paper reports on the following; 1) Ecology of weevils in relation to pest management, 2) Population threshold at which control action should be taken, 3) Use of sex pheromones to control sweetpotato weevil, including a new type of visual lure, 4) A modified sex pheromone trap for infecting SPW with pathogenic fungi, Beauveria bassiana, 5) Integrated control measures.*

## SWEETPOTATO WEEVILS IN JAPAN

Two species of weevil, the West Indian sweetpotato weevil, *Euscepes postfasciatus* (FAIRMAIRE) (WSPW) and the sweetpotato weevil, *Cylas formicarius* (FABRICIUS) (SPW), are major pests of sweetpotato in the southwestern islands of Japan. Larvae of these pests bore into roots and make sweetpotatoes taste bitter, drastically decreasing the market value of the crop. It is difficult to control these pests with chemicals, since chemicals seldom reach the pests living in the soil, stems and tubers.

### Ecology of Weevils in Relation to Pest Management

Both weevils have almost the same life cycle in sweetpotato fields. Adult weevils enter sweetpotato fields by crawling in, or when tubers infested with weevils are dumped near the field (Yasuda 1997a). The occurrence of the weevils and the damage they cause in sweetpotato fields treated with insecticides, was surveyed from planting to harvesting, and compared to their occurrence in untreated fields. Weevil females invading the fields

first oviposited in the stems. The mean number of insects, including larvae, pupae and adults, in stems increased to 1.22 - 3.90 per plant in untreated plots (Yasuda 1997). The first appearance in tubers came later than in stems. The mean number of weevils in the tubers increased to 5.04 - 7.97 per plant at harvesting. In untreated plots, stem damage by the West Indian sweetpotato weevil larvae was found 30 - 60 days earlier than tuber damage. When insecticide was applied topically on the ground near the stems, the level of damage and the number of weevils were much lower in both stems and tubers (Fig. 1).

Damage to stems did not affect the growth of the sweetpotato. It is possible that the ratio of damaged stems can predict tuber damage, and indicate whether insecticide should be applied or not.

### Population Threshold for Taking Control Action

The effectiveness of different insecticides against weevils was compared in sweetpotato fields. Granules of carbosurufan, benfuracarb and prothiofos were more effective than conventional insecticides. When 3% carbosurufan granules

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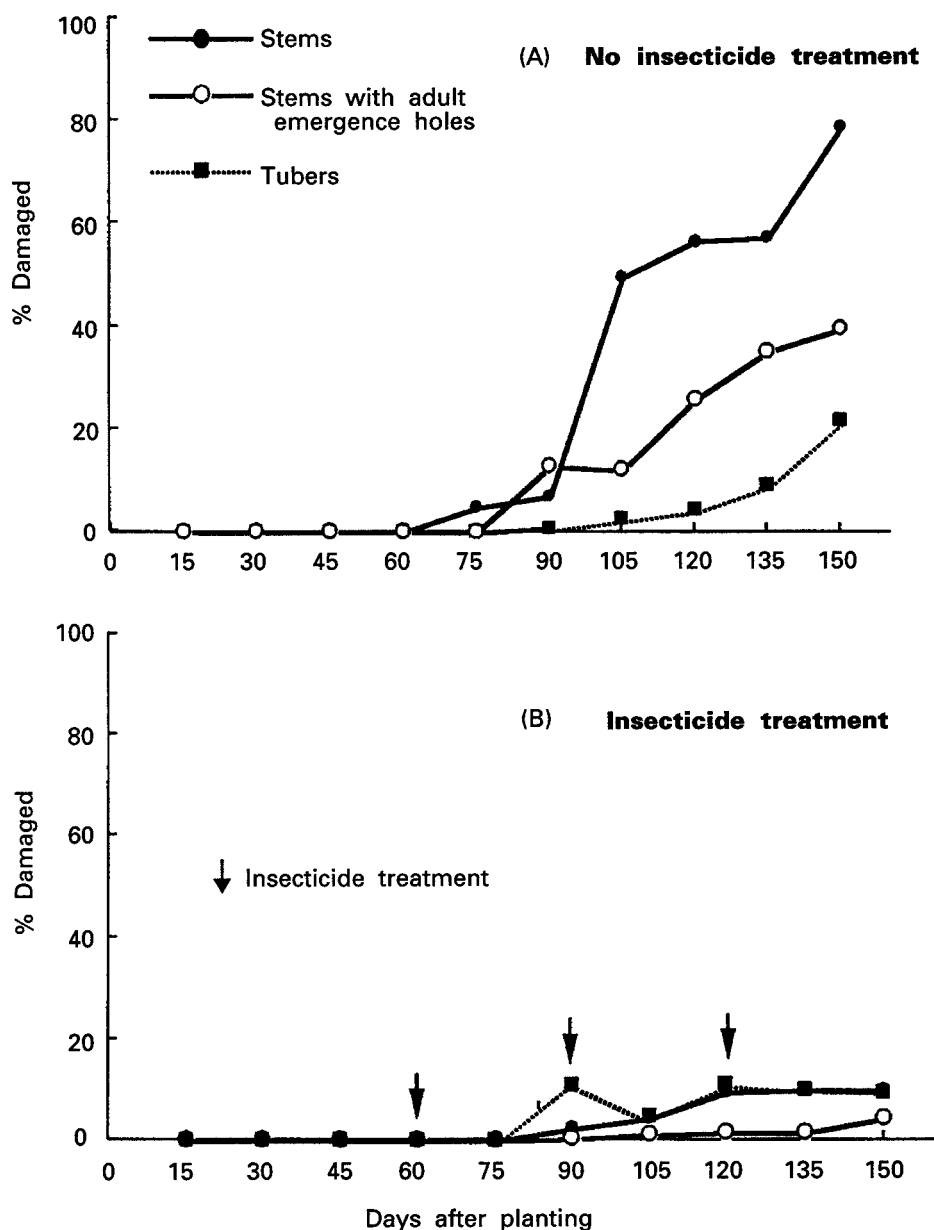


Fig. 1. Changes in percentage of stems and tubers damaged by larvae of *E. postfasciatus*, and stems with adult emergence holes in insecticide-untreated (A) and treated (B) sweetpotato fields

were applied on the ground near stems at a dose of 1g/plant by a special applicator (Fig. 2), the level of damage and number of weevils were suppressed in both stems and tubers.

The residual effect of the insecticide was seen until almost one month later. Insecticide taken up by the roots and transferred to the stem might kill larvae.

Damage to stems by the larvae did not affect the growth of the sweetpotato. The damage to stems

was 30 - 60 days earlier than the damage to tubers in untreated fields. It is possible to predict the proportion of damaged tubers from the number of damaged stems. Residual insecticide was no longer found in tubers 30 days after application. These facts can be used as the basis for a decision whether to apply insecticide or not, by assessing the damage to stems. To obtain the control threshold for weevils, the relationship between the occurrence of sweetpotato stems injured by the larvae and the proportion



Fig. 2. Granule applicator

of damaged tubers at harvest was studied in both insecticide-treated and untreated plots. The ratio of damaged tubers at harvest was high in plots where injured stems occurred early and/or the proportion of injured stems was high.

The regression equation,  $Y = 20.83 + 0.95X$  ( $r = 0.639^*$ ) expresses the relationship between the proportion of damaged tubers at harvest ( $Y$ ) and the percentage of injured stems on day 75 after planting ( $X$ ). Based on this modified equation, the control threshold level of stems injured during the growing period for a tolerable injury level (13.6% of tubers damaged at harvest) was estimated to be 5% (Yasuda 1997b). The application of insecticide at this control threshold was as effective as conventional applications, and three applications could be reduced to two (Fig. 3).

#### Use of Sex Pheromones to Control SPW, Including a New Type of Visual Lure

Pheromone traps have been developed for monitoring weevil populations in the field (Proshold *et al.* 1986; Jansson *et al.* 1991; Yasuda *et al.* 1992). Mason and Jansson (1991) observed that the mating behavior of males became confused when synthetic sex pheromone was used, and suggested that pheromone is effective for controlling this pest. Our study was carried out to determine whether mass-trapping with pheromone is effective in controlling sweetpotato weevil (SPW) in the field.

The suppressing effect of mass trapping with a synthetic pheromone on the population of the SPW was studied in a small sweet- potato field in

Okinawa, Japan. Ten traps captured 65,214 males and 18 females from July, 1989 to December, 1990. In the pheromone-treated field, the sex ratio of the population was skewed in favor of females, and the mating rate of females was reduced. The density of weevils notably decreased in the pheromone-treated field, probably due to male annihilation and mating disturbance. Thus, mass-trapping is promising as a control agent against the sweetpotato weevil. However, the ratio of damaged sweetpotatoes did not decrease significantly.

#### New type of visual lure

We examined the effect of color, shape and size on SPW male mating behavior using artificial females, the surface of which was coated with pheromones. Male mating behavior was strongly dependent on the shape, size and color. The models were made from 2mm boll biscuit clay, blue color and a pheromone coating (Fig. 4). This model is a new type of visual lure for controlling SPW. When we compared its effectiveness with the fiber board formerly used with lure-toxicant, mass-trapping using the models gave better control.

#### 4) A Modified Sex Pheromone Trap for Infecting SPW with Pathogenic Fungi, *Beauveria bassiana*

Among possible alternatives to chemical insecticides, the use of biological control agents may be promising. SPW is susceptible to many natural enemies, including parasitoids, predators

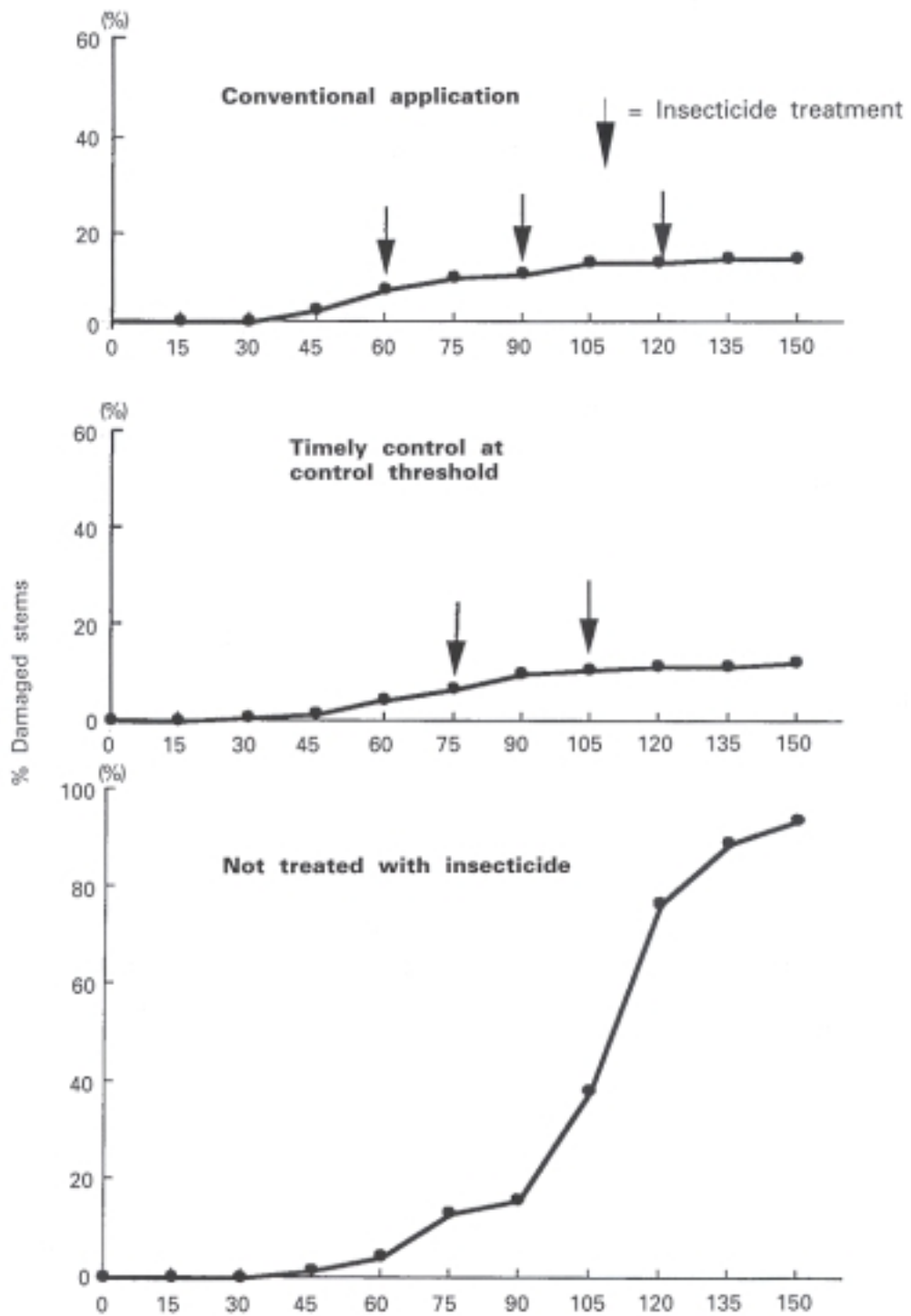


Fig. 3. Changes in percentage of stems damaged by larvae of *E. postfasciatus* in sweetpotato fields.



Fig. 4. New pheromone lure for sweetpotato weevil, which is accompanied by visual stimulation

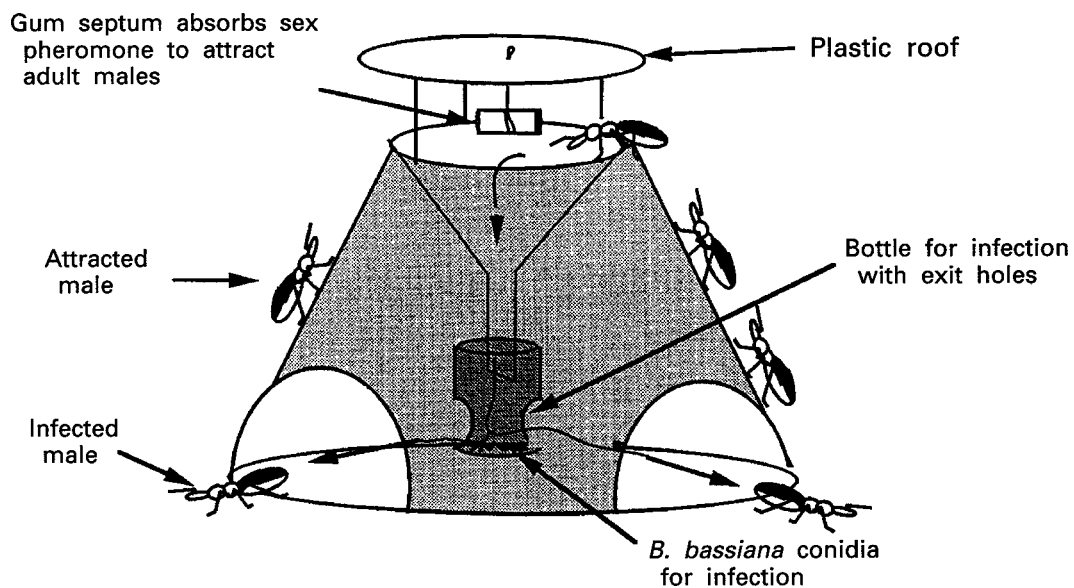


Fig. 5. Process by which weevils are infected with *Beauveria bassiana*

and pathogens (Jansson 1992). In particular, a fungal pathogen, *B. bassiana*, is known to attack sweetpotato weevils (Jansson 1992; Carruthers and Soper 1987; Castineiras *et al.* 1984; Sherman and Tamashiro 1954).

An auto-infection system consisting of a modified sex pheromone trap and a bottle with exit holes containing conidia of the fungus *B. bassiana*

( $9.4 \times 10^{10}/1\text{g}$  medium) was designed (Fig. 5) and tested as a method of controlling SPW. Male weevils were attracted to the trap by the pheromone, and left after becoming infected. In the sweetpotato field where the traps were placed, the highest mortality rate among males from the fungus disease was 96.2% on 21 days after treatment. That of

females was 24.0%, 35 days after treatment. The proportion of weevils which were carriers of the fungus was 57.9% for males and 31.6% for females. In the treated field, the sex ratio of the weevil population was greatly skewed in favor of females. Females seemed to be infected through mating with males carrying the fungus.

The advantages of this system are:

- Attracted males are efficiently auto-infected with the fungus;
- Only sweetpotato weevils are infected;
- The fungus is easy to mass-produce;
- The cost of the system is low compared with conventional field sprays;
- Once attracted and infected, males can be expected to return to their own habitat, which accelerates dispersal of the fungus.

## IPM

Integrated pest management (IPM) systems for the sweetpotato weevils are very promising. Indications so far are that weevil control will include the following strategies:

### Biological Control

This will be based on the use of an auto-infection system consisting of a modified sex pheromone trap with the fungus *Beauveria bassiana*.

### Cultural Control

Discarding infested tubers and stems in sweetpotato fields results in a rapid increase in the weevils and consequent damage to the host. Any infested tubers should be promptly disposed of by putting them in a hole and covering them with soil.

### Pesticide Control

The control threshold level of stem injury was estimated to be 5%. Insecticides should be applied when this threshold is reached.

### Pheromones

Pheromones have been used in SPW management programs in developing countries, but were not very effective in high-density fields. In such cases, an auto-infection system is more

favorable.

We confirmed the existence of contact sex pheromone on the body surface of female West Indian sweetpotato weevils. If this pheromone can be identified, and artificially produced, it is a promising control system for the future.

In IPM programs to control weevils, more information is needed on the environment of the sweetpotato and the biology of weevils. In addition to research, efforts should be directed to educate farmers in IPM techniques.

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