Annual Report to the Oregon Processed Vegetable Commission

Trap Cropping and Removal Trapping to Enhance Control Of Western Spotted Cucumber Beetle in Vegetable Crops

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Background and Situation

The western spotted cucumber beetle (WSCB) (*Diabrotica undecimpunctata undecimpunctata*) is the major insect pest of the Willamette Valley vegetable industry, attacking snap beans, sweet corn, and cucurbits. The Oregon processed vegetable industry is a significant contributor to the state agricultural economy, worth more than $67 million paid to farmers in 2000, with the total value of processed crops being considerably higher.

WSCB is a pest both as an *adult* (feeding on bean leaves and pods and cucurbit leaves and flowers), and as a *larvae* (feeding on corn roots and other crops). In snap beans, adult feeding damage to the pod reduces market value to the grower and excessive pod damage can cause load rejection. WSCB larvae can attack germinating seedlings of early-planted sweet corn, causing severe stand loss. Little is known about the economic injury status of the 2nd generation larvae in late July and August.

Insecticides are currently the predominate control strategy, but there are few effective, registered materials. Also increasing restrictions on organophosphate insecticides by the EPA will continue to reduce the availability of insecticides. The fate of insecticides in groundwater, rivers, and food and their effects on non-target organisms has caused concerns to consumers and environmentalists. Clearly integrated pest management (IPM) strategies that can improve pest control while reducing pesticide inputs offer advantages to farmers and society.

Two very promising potential control strategies for WSCB are *trap cropping* and *removal trapping*. These approaches are similar in that they are based on trapping and killing pest insects, but they are separate practices. *Trap cropping* involves the deliberate planting of strips or blocks of selected plants to attract pest insects away from target crops. Protection may be achieved either by preventing the pests from reaching the crop or by concentrating them in a certain part of the field where they can be economically destroyed. The principle of trap cropping rests on the fact that virtually all pests show distinct preferences for certain plant species, cultivars, or certain crop stages. Manipulations of the trap crops in time and space so that attractive host plants are offered at the critical time in the pests' and/or the crop's phenology can lead to the concentration of the pests in the trap crop.

Removal trapping uses physical traps that combine visual and olfactory cues to attract the pest insects to the traps where they are captured and killed. Traps can be certain colors or shapes with specific chemical compounds, such as pheromones and kairomones, used to increase the attractiveness of the traps.

Project Objectives

1. **Determine the seasonal life cycle and reproductive phenology of WSCB adults**
   Rationale: Although we have a general understanding of the seasonal life cycle of WSCB, we lack data on farm-specific population dynamics and reproductive phenology. Objectives 2 & 3 are clearly based on understanding the cucumber beetle life history.

2. **Evaluate WSCB seasonal aggregation and movement patterns within diversified vegetable cropping systems**
   Rationale: Objective 3 is clearly predicated on knowledge of the season aggregation and movement patterns to be able to optimize placement of trap crops and removal traps.

3. **Evaluate the potential for trap cropping and removal trapping strategies as cultural control components of an IPM program for the WSCB in western Oregon vegetable cropping systems**
   Rationale: These pest control tactics show potential for reducing insecticide applications by suppressing population levels of WSCB below economic threshold levels.

2003 Research Projects

Objective 1. Determine the seasonal life cycle and reproductive phenology of WSCB adults

Methods: *Collections of WSCB adults* were made on approximately 2-week intervals throughout the summer and fall season, 2003. Fifty to sixty adults beetles were randomly collected (by various methods, depending on the environment). We used sweep netting in squash and weedy areas and collected directly from flowers of squash throughout the season. Adults were sealed in a plastic bag and returned to the laboratory and frozen for later dissection. Because of the relative short duration of the annual crops during the summer, and the movement of adult beetles among crops, our beetle collection locations shifted about, but remained on the same farm. Thus the reported data represent "farm" population information.

Dissections of beetles. Adult beetles were dissected under a binocular microscope (Fig. 1) and the following determinations made: gender, presence of parasitoid larvae, and reproductive status of females (egg presence and development). Presence and stage of development of Tachinid parasitoids of the adult beetles was also recorded.

Results: The sex ratio of the beetles varied seasonally among the farms where we collected (Fig. 2). Among the females collected, there was a clear transition of egg-containing (and presumably laying) females to non-egg containing females during late summer (Fig. 3). During the latter part of the summer, adult female beetles were essentially without eggs. Presumably they had completed the egg-laying life cycle. Unfortunately our period of collections only covered the summer season and we were not able to determine the reproductive life history of the spring generation beetles.

Percent parasitism of adult beetles dropped rapidly after the first collection date (Aug. 15) at the Lakeside Farm, and remained low for the remainder of the summer generation (Fig. 4). Note that during this same period, there were no eggs within the female beetles and the Tachinid parasitod larvae feed preferentially on eggs within the adult.

Objective 2. Evaluate WSCB seasonal aggregation and movement patterns within diversified vegetable cropping systems

Two experiments were established in snap bean fields at Kenagy Family Farms near Albany, OR (Fig. 5). The goals of both experiments were to test hypotheses concerning colonization of snap bean fields by adult cucumber beetles and to evaluate trap design and placement.

We also evaluated a *new wing trap design* for determining directional beetle population movement within the farm. The wing trap consisted of four 1 ft^2 panels arranged vertically on 90 degree intervals near the top of a 3-ft wooden post (Fig. 4) All panel surfaces were painted bright yellow, a known attractive color for adult cucumber beetles. Each trap contained 8 separate panels. Each panel was given a unique name which incorporated the trap number, the *primary* directional orientation of the panel, and also the *secondary* directional orientation of the facing corresponding panel (for example 8 N-E). Each wing trap was installed on true North compass direction using a hand-bearing compass, compensating for local magnetic variation (Fig. 6).

Standard yellow sticky traps (YST) (6" x 12") were clipped to the center of each panel. A trapping period was approx. 48 hours and trapping intervals were approx. seven days At the end of each trapping period, the sticky panel was covered with clear plastic wrap and removed from the wing trap. The wing trap remained in the field without a YST until the next trapping period.

Trap lines, each consisting of four wing traps 100 apart, were used to assess direction of movement of beetle populations in the landscape (Fig. 7). Since this was exploratory, preliminary research, we established only *two* trap lines per field experiment. Thus our abilities to test hypothesis about movement were limited to a single direction perpendicular to the line of the traps. (Note: future experiments will involve a square grid of 16 –25 traps to better evaluate colonization from all directions).

Experiment 1. The 17-acre upper "upper " field was planted May 7. Trap lines were installed on North-South transects, parallel to the riparian border strips. Trap lines were located approx. 150' in from the east and west borders of the field to test whether there was a detectable colonization of the field from either riparian area.

Experiment 2. Two bean plantings were made in the lower "lower" field. Our trapping experiment was located in the last planting furthest to the south, planted June 14.

Results: The trap line analysis in the Kenagy Upper field showed a fairly distinct eastward trend on the trapping for the first two trapping dates (Fig. 8). The field had exceeded the action threshold for adult beetles based on sweep net sampling and the field was treated with an insecticide on June 30. Trap catches were reduced after the spray, but still remained at low levels.

In the Kenagy Lower field, there was a clear colonization effect from the south during the first two sampling dates (Fig. 9). This field was sprayed with an insecticide on July 28, again dropping beetle catch numbers, but not eliminating them.

These data clearly suggest that trap lines may be used to determine direction of colonization of beetles into a bean field. Future studies will involve a grid of 16-25 traps so that colonization from all directions can be examined.

Objective 3 . Evaluate the potential for trap cropping and removal trapping strategies as cultural control components of an IPM program for the WSCB in western Oregon vegetable cropping systems

Two experiments were established in a 20 acre field of pumpkins (Golden Delicious) at Stahlbush Island Farm, Riverside Farm in late summer, 2003. In the first experiment, a new 4-way dispenser (Fig. 10) was developed and 5 rates of synthetic kairomone (IBb) were applied (0 – 400 mg/trap). In early kairomone work by Hongtrakul (1997), a 50 mg/trap rate was used. We increased the rate to 400 mg to see if we could increase trap capture rate. The wing trap used in Objective 2 was used in this trial (Fig. 11). Wing traps were only equipped with YST's on four panels (instead of all 8 panels). Traps were placed 60' apart in parallel rows 300 feet apart.

In the second experiment, the kairomone dispenser was modified to a single plastic tube with 10 cotton wicks (Fig. 12). The kairomone rate was increased up to 1200 mg/trap. Instead of the wing trap, a single South-facing YST was used on a metal post. To minimize interference between traps, the distance between traps was increased to 90' (Fig. 13). Trap lines were placed on a 45 degree bearing because of the predominately northerly winds at that time of season.

Results: In the first experiment, the 400 mg rate trapped more beetles than the other rates, but catches were similar during the first two trappings (Fig. 14). Only at the latter two trapping dates did the 400 mg rate dramatically increase catch rate.

In the second study, using a higher kairomone rate as well as a different type of dispenser, there was a clear linear relationship between trap catch and kairomone rate at all of the trapping dates (Fig. 15). During periods of the highest catches, the YSTs were practically solid with adult beetles, thus we feel we are reaching the point of saturation of catch on the YSTs. But higher kairomone rates will need to be tested to determine maximum rate for attraction to adult beetles. The dispenser at these rates attracted beetles for at least one full week.

Trap Crops. Although no formal trap crop experiments were established in 2003, we were able to document the concentration of adult beetles late in the season in a spinach field on one of the farms we studied (Riverside Farm). Using direct sampling of adults (early in the morning while they are inactive), more than 2 million beetle per acre were found. This spinach was planted in mid August and was present to attract the late season partial generation beetles as they emerged from corn fields and other areas. Because spinach can be planted in the cool season as well as during the summer, we are anticipating using spinach as our trap crop during 2004 research trials. We will focus to trapping adults at two stages of their seasonal life cycle, including October, when the new over wintering generation is emerging, and again in early spring, when this same generation is leaving over wintering sites and dispersing into crop fields to lay eggs. Kairomone dispensers can also be used to enhance the attractiveness of the strip crops to the beetles.

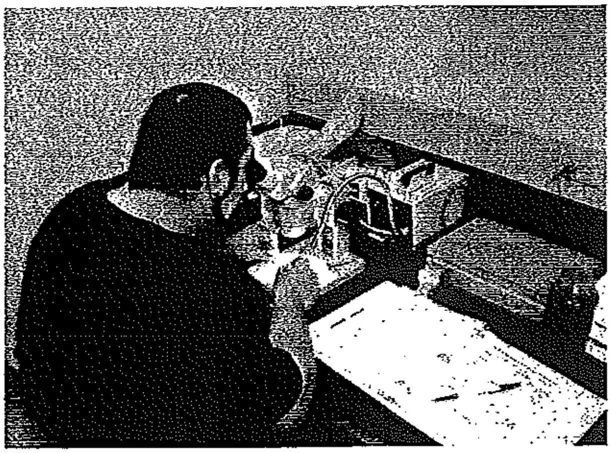

Fig. 1. Adult beetles were collected from several farms at regular intervals and dissected to determine reproductive status and percent parasitism

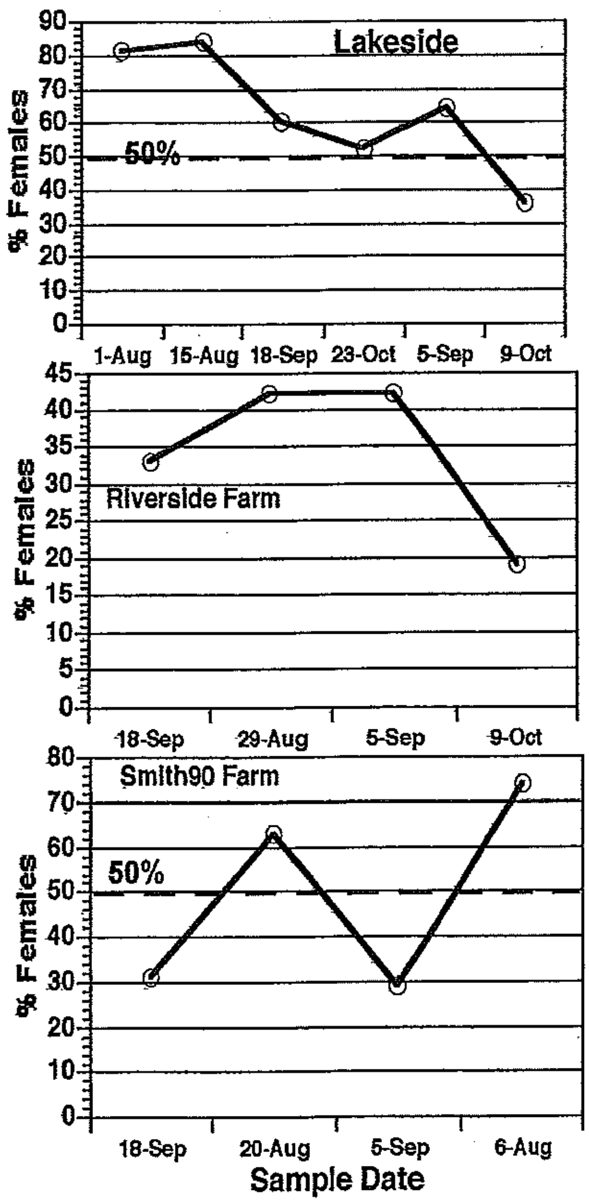

Fig. 2 Percent females from periodic collections of 50-60 adult beetles per location

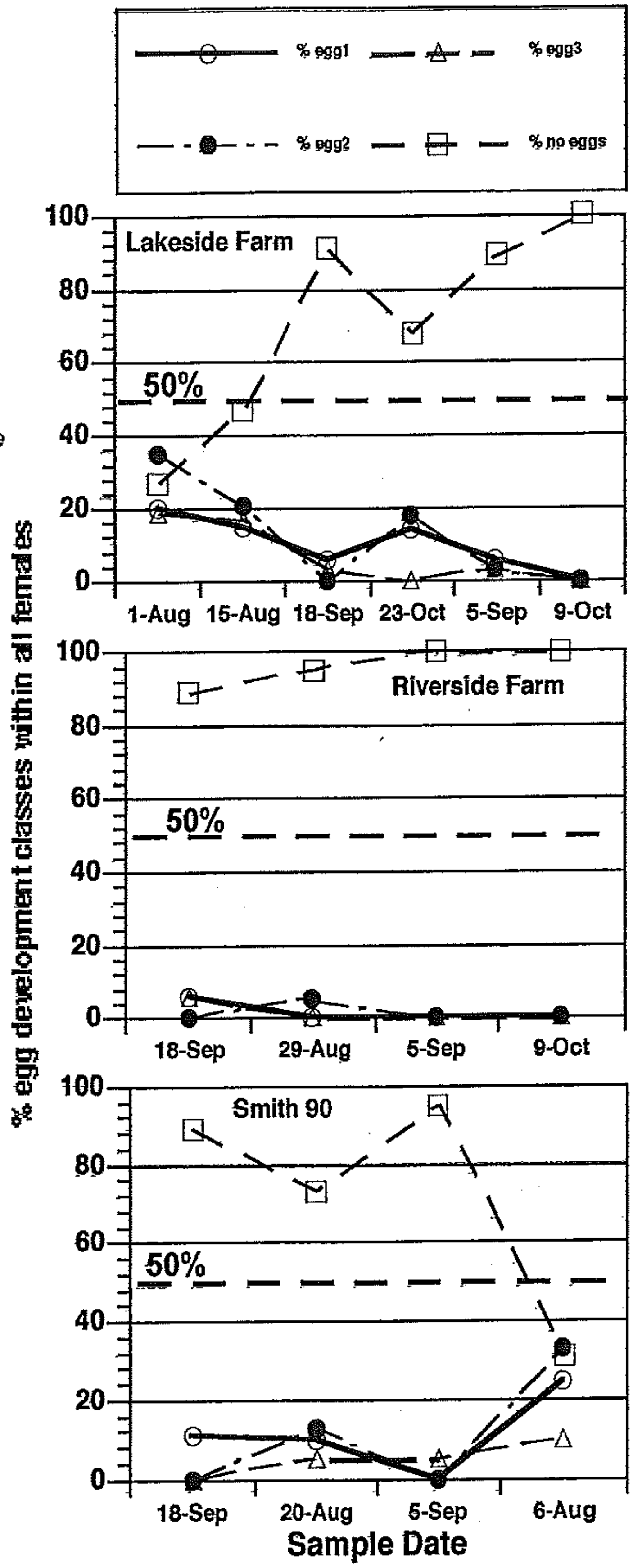

Fig. 3. Percent of females with varying stages of egg development (1= barely developed; 2 = moderately developed, and 3 = fully developed eggs.

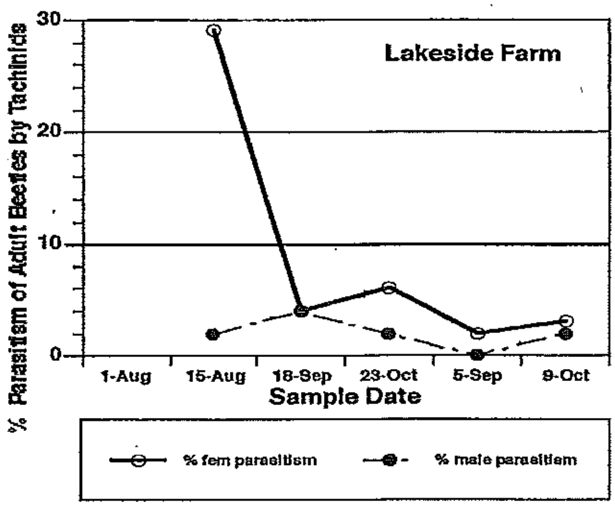

Fig. 4. Percent parasitism of adult beetles by Tachinid parasitods.

Fig. 7. Layout of wingtraps in "trap line" to detect movement of beetles into field from borders.

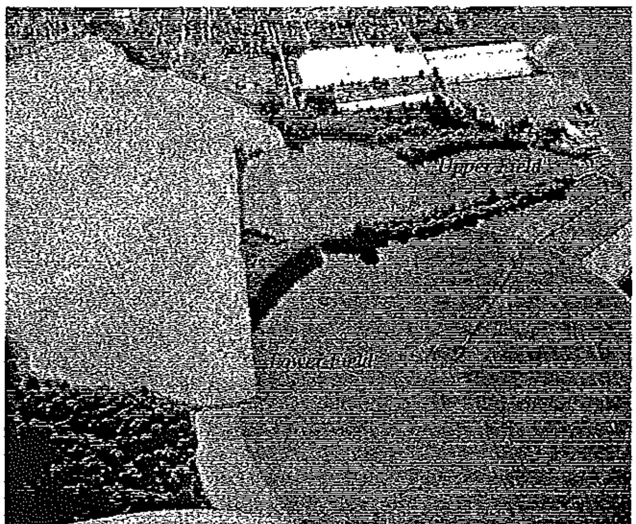

Fig. 5. Location of beetle landscape-level movement studies at Kenagy Family Farm, west of Albany, OR.

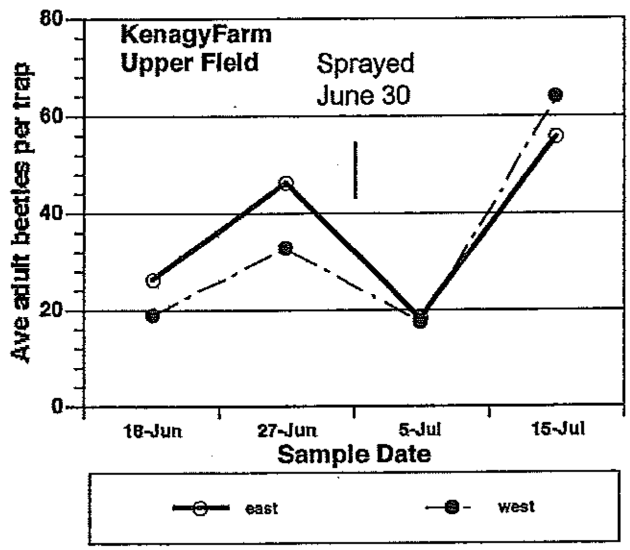

Fig. 8. Movement of adult beetles into the Kenagy Upper field from the east.

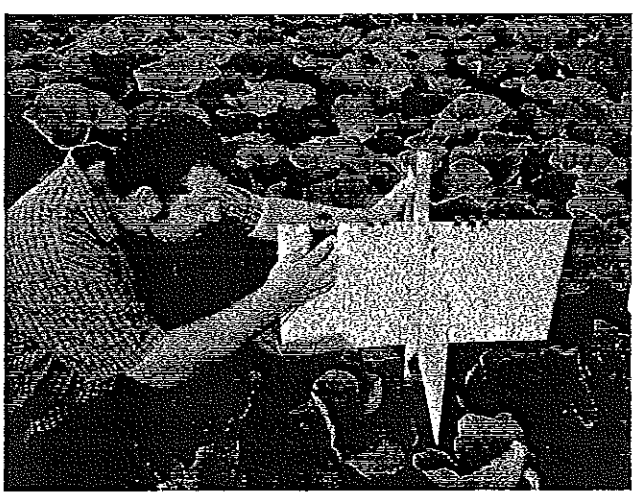

Fig.6. Traps were alligned on a true N-S axis using a hand-bearing compass.

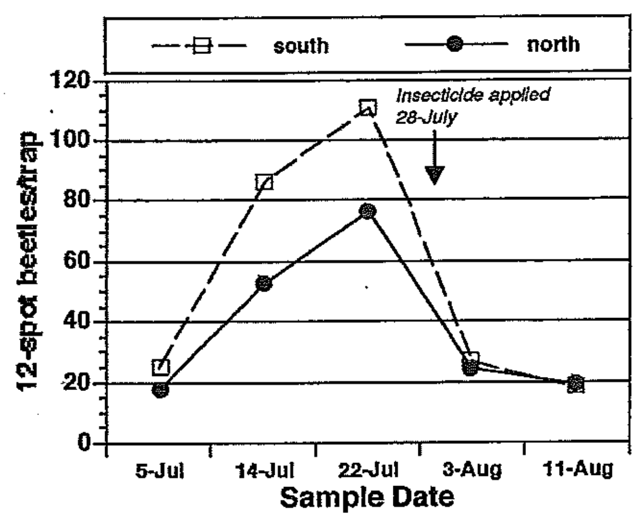

Fig. 9. Movement of adult beetles into the Kenagy Lower bean field from the south.

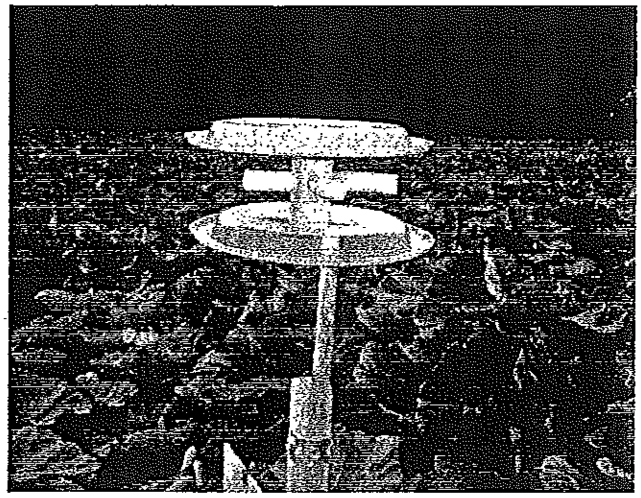

Fig. 10. New 4-direction kairomone dispenser, used in first rate experiment, 0 - 400 mg/trap.

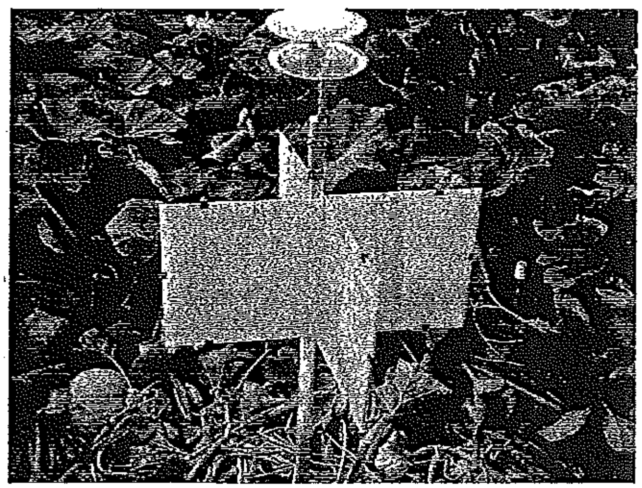

Fig. 11. Kairomone dispenser attached to wing traps for evaluating optimum kairomone rate.

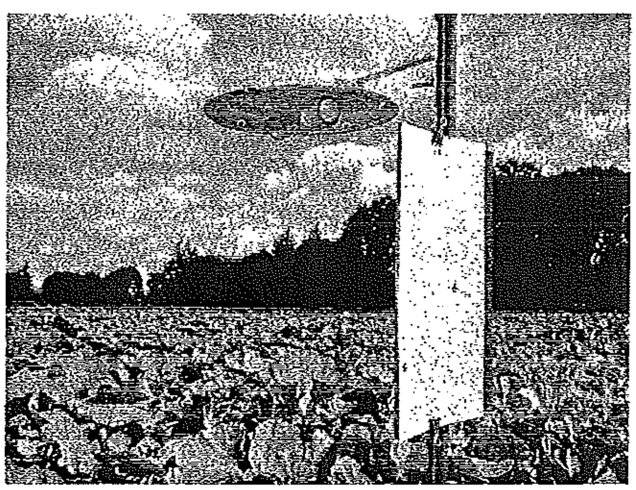

Fig. 12. Single-tube kairomone dispense used in the 0-1200 mg/trap optimum rate study.

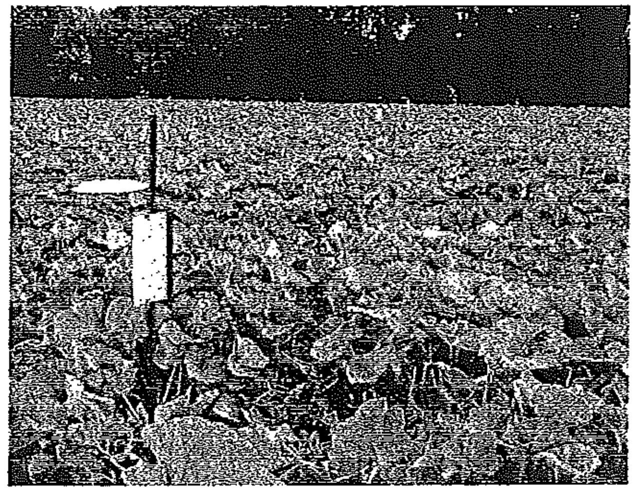

Fig. 13. Arrangement of kairomone-baited traps in lines with traps 90' apart.

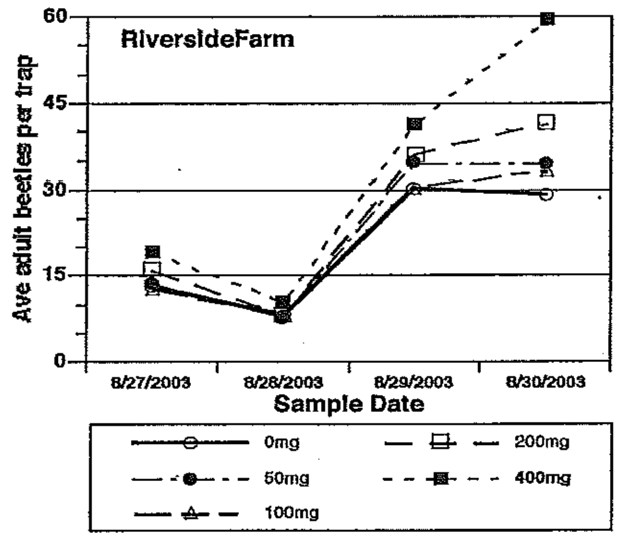

Fig. 14. Effect of kairomone (0-400 mg/trap) on catch of adult beetles on yellow sticky traps.

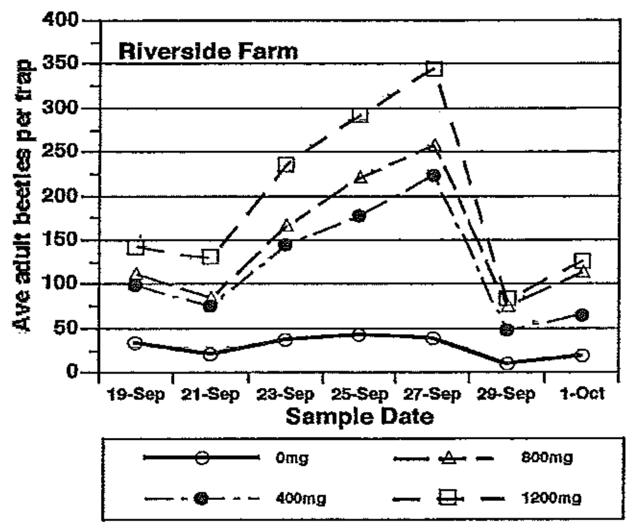

Fig. 15. Effects of kairomone rate (0 - 1200 mg/trap on adult beetle catch in yellow sticky traps