

**ORGANIC
FARMING
RESEARCH
FOUNDATION**

P.O. Box 440
Santa Cruz, CA 95061

tel ~ (831) 426-6606
fax ~ (831) 426-6670

email ~ research@ofrrf.org
web ~ www.ofrrf.org

Organic farming research project report submitted to the Organic Farming Research Foundation:

Project Title:

Development of a trapping system for cucumber beetles in cucurbits

FINAL PROJECT REPORT

Principal investigators:

Michael Hoffman
Dept. of Entomology
Cornell University
Ithaca, NY 14853

Co-investigators

Jonathan Kirkwyland, Department of Entomology, Cornell University, Ithaca, NY
Rachael Freeman, University of California Cooperative Extension, Woodland, CA
Richard Smith, University of California Cooperative Extension, Hollister, CA

Cooperating growers:

Lou Johns & Robin Ostfeld, Blue Heron Farm, Lodi, NY.
Carol & Robert Stull, CRS Growers, Lansing, NY.

Funding provided by OFRF: \$4,940

Awarded: Spring 1993

Project period: 1993

Report submitted: April 1994

Goal: To develop a system of mass trapping using traps baited with attractive volatile plant extracts to control cucumber beetles in cucurbits.

Background and Rationale: Cucumber beetles are among the most important insect pests of cucurbits (cucumber, melon, squash, and pumpkin) throughout the U.S. Direct feeding by cucumber beetles can destroy young cucurbit plants and it is known that some beetle species vector bacterial wilt. In California, the western spotted (*Diabrotica undecimpunctata*) and the western striped (*Acalymma trivittatum*) cucumber beetles infest cucurbits. The importance of these two pests in organic production systems was confirmed in two recently conducted surveys. In the needs assessment survey conducted by OFRF and the 1991-1992 CCOF growing practices survey, cucumber beetles are mentioned as a major pest for organic growers. In the northeast and across much of the U.S., the spotted cucumber beetle (*D. undecimpunctata howardi*) and/or the striped cucumber beetle (*A. vitattum*) plague conventional and organic growers alike. At the Annual New York State Vegetable Conference growers have indicated repeatedly that improving control of cucumber beetles is an important goal. In addition, adults of the western and northern corn rootworms (*D. virgifera virgifera* and *D. barberi*, respectively) infest cucurbits in the northern and central U.S. Western corn rootworm populations become especially large in the late summer and adults feed extensively on blossoms, leaves, and small fruit, though their economic importance is not yet known.

Organic growers have few options available for the control of cucumber beetles. Some growers receive a measure of protection from the use of row covers, but in most cases the row covers must be removed to allow pollination, thus exposing the plants to beetle attack. Many growers rely upon repeated applications of botanical insecticides such as pyrethrum, rotenone, ryania, or sabadilla. While these insecticides may be effective at temporarily reducing beetle populations, some may pose risks similar to many synthetic, petroleum-based insecticides. Thus there is a need to develop more ecologically-sensitive control measures for cucumber beetles.

Initial attempts to identify biological control agents have been disappointing. We have made extensive collections of adult cucumber beetles in upstate New York in the last two years in an effort to recover naturally-occurring parasitoids and pathogens. Our results show that indigenous natural enemies have very little impact on adult beetle populations. We have also evaluated entomopathogenic nematodes for use in controlling immature cucumber beetles, again with little success (Zitter et al. 1993). While it is possible that an exotic natural enemy or a different species of nematode may be more effective in controlling beetles, we have placed emphasis on the use of baited traps.

Volatile cucurbit floral extracts have been used successfully to monitor corn rootworm adults in corn in the midwest (Levine & Metcalf 1988). We have tested a mixture of these extracts known as TIC (trimethoxybenzene, indole, and trans-cinnamaldehyde) and found them to be effective in monitoring populations of cucumber beetles and corn rootworm adults in cucumbers, winter and summer squash, and pumpkins in New York. Using a trap which consisted of a 16 oz., yellow plastic cup coated with adhesive (Tangletrap) and a lure impregnated with mineral oil and TIC, we made an initial effort at mass trapping in cucumbers. We found that the traps were able to capture a large proportion of beetles that invaded the plots during the first few weeks of beetle colonization. That proportion declined as the beetle population increased. As in other trials, we observed that the sticky traps quickly become saturated with beetles, reducing their effectiveness. Nevertheless, our results indicate that a different type of baited trap, one that does not quickly saturate, could be effective in trapping cucumber beetles.

The TIC attractant has not yet been tested with the beetle species found in California. It is likely that western spotted and western striped cucumber beetles will respond to TIC, as they are closely related to the species found in the northeast.

Objectives:

1. Determine the effectiveness of volatile cucurbit extracts in attracting and trapping western spotted and western striped cucumber beetles in California.
2. Identify a trap design which will capture substantially greater number of cucumber beetles than the current model.
3. Determine the number of traps required per unit area for effective control.

Procedures: Objective 1. The ability of TIC lures to attract western striped and western spotted cucumber beetles was evaluated in replicated trials conducted on organic farms in San Benito and Yolo Counties, California. The trials were timed to coincide with periods of cucumber beetle infestation. In the first set of trials, yellow and white sticky traps, with and without TIC lures were compared. In Yolo County, two trials were conducted, one in a dry bean field, the other in a sunflower field. In San Benito County, trials were conducted in zucchini and melon plantings. There were four replications of each treatment. Traps were placed within crop rows, with at least 10 meters separating each trap. The traps and lures were changed daily for a period of four days, except in the dry bean field in Yolo Co., where traps and lures were changed every other day for a period of eight days. Also, the location of treatments within a repetition was rotated to compensate for differences in beetle population due to location. Data analysis was performed on the total number of beetles captured by each of the four color/lure combinations.

In addition, a trial was conducted to test the effect of TIC dose on trap catch in an organic cantaloupe field in San Benito Co. Treatments consisted of yellow sticky traps with lures containing 0, 10, 20, 40, 80, or 120 mg TIC. Placement of traps, lure and trap rotation and replacement was as described for the color/lure trials.

Objective 2. Sufficient numbers of beetles were not available early in the season to conduct preliminary greenhouse evaluations of different trap designs as planned. Field tests were conducted to determine the effect of trap size on the number of beetles captured. Yellow sticky traps of 4 sizes were made from white paper cans painted yellow and covered with TangleTrap adhesive. The traps were placed within the rows of an organic planting of delicata squash, such that the traps were separated by at least 10 meters. A lure containing 100 mg of TIC was affixed to each trap. The traps were removed after 48 hours and the number of beetles on each trap was recorded. The experiment was repeated a second time; in the second trial the traps remained in the field for a total of 6 days before being removed. In both trials, the location of the traps within a replicate was changed on a daily basis.

Objective 3. A field trial was conducted at the Entomology Research Farm in Freeville, NY, in order to determine the effect of trap density upon beetle abundance and damage to plants. Cucumber was direct seeded on 3 June in plots 1/16 acre in size and separated by at least 30 meters.

Yellow sticky traps with 100 mg TIC lures were installed at plant emergence (14 June). Each plot received a different number of traps, ranging from 1 to 5 (corresponding to a range of 16 to 80 traps/acre). The traps were replaced twice a week and the lures changed weekly. In addition, visual searches of cucumber plants were made 1-2 times per week. In each plot, all plants within 20 1-meter sections of row were inspected and the number of beetles recorded. Estimates of feeding damage were made also at the time of plant searches.

Results: Objective 1. The effect of trap color and TIC lure varied according to beetle species and crop (Tables 1 & 2). There was no measurable effect of trap color on catches of western striped cucumber beetle, except in the sunflower trial, where the yellow traps caught significantly more beetles than the white traps. In dry beans and sunflowers, there appeared to be no effect of the TIC lure upon the striped beetles, whereas, in the cucurbits, significantly greater numbers were captured by traps with lures. In all four crops, spotted cucumber beetles were attracted in greater numbers to the yellow traps compared to the white traps. The TIC lure increased trap catches of spotted beetles only in dry beans and cantaloupe. The response of these two species to trap color and lure differs from the response of the cucumber beetles and corn rootworm adults found in New York, where we have found that both yellow color and attractant lure significantly increase trap effectiveness.

The response of western striped and spotted beetles to increasing dose of TIC attractant is depicted in Figure 1. For striped beetles, there was a clear relationship between lure dose and trap catch. The trap catches increased in direct proportion to the logarithm of the lure dose. A similar trend was observed for spotted cucumber beetle, though spotted beetles showed a much more variable response to dose than did the striped beetles. This is consistent with the results from the trap color/lure trials.

Objective 2. The response of trap catch to increasing trap size is depicted in Figure 2. The response was similar for the 2 day trial and the 6 day trial, hence the trap catches shown represent the total number of beetles captured during the two trials. Trap catches appeared to increase at a constant rate with increasing trap size. The effect was similar for the three beetle species and statistically significant in all cases: for striped cucumber, beetle p -value <0.05 ; for spotted cucumber beetle and western corn rootworm, p -value <0.01 .

Objective 3. The effect of sticky trap density on beetle capture is presented in Table 3. For all four species, the proportion of the total estimated beetle population captured on traps increased with increasing number of traps. The trends were similar for striped and spotted beetles, though the maximum proportion of beetles captured was greater for striped than spotted beetles (100% and 44 %, respectively). The extremely low densities of striped cucumber beetles observed in 1993 may have been responsible for the relatively high proportion of trap catches. The high proportion of western corn rootworm beetles captured on sticky traps (65 - 90% of total estimated population) was not an artifact of low beetle densities. Western corn rootworm populations were an order of magnitude greater than populations of the other beetle species, which makes the high trap catches all the more noteworthy.

Observations on damage by beetle feeding were made during the early growth stages of the cucumber crop, when the plant is thought to be more susceptible to defoliation. Due to the abnormally low densities of striped cucumber beetles at that time, very little damage was recorded and we were unable to determine the impact of trap density on feeding damage.

Discussion: Though the response to trap color and lure *differed for* the two western cucumber beetle species, the results suggest that a yellow trap with lure would be most effective *for* capturing both species. The data from the dose response trial corroborate the evidence from trials conducted in New York, which indicate that there is little measurable increase in trap catch with doses above 100 mg TIC.

The results from the trap size trial indicate that trap catch is primarily a function of the trap surface area available. We had suspected that a larger trap might be more visible and thus attract proportionately larger numbers of beetles, but our data do not support that hypothesis. As noted above, beetle abundance was relatively low during the trials. It is possible that with higher beetle population densities, the smaller traps may become saturated more quickly than the larger traps. In that case, the large traps would capture a larger number of beetles per surface area of trap than the small traps.

Though the trap density trial also was affected by low beetle densities, it was particularly noteworthy that the one species that was relatively abundant, western corn rootworm, was captured in large proportions, even at trap densities as low as 40 traps per acre. Traps may be somewhat less effective when beetles are not abundant, especially at lower trap densities, because beetles tend to be aggregated in clumps rather than dispersed evenly throughout a field. While we now have evidence that traps can capture a large number (and proportion) of beetles, to fully evaluate the effectiveness of the traps, we need to relate trap catches to the amount of damage caused by the beetles and, eventually, to crop yield.

References:

- Kirkwyland, J. J. and M. P. Hoffmann. 1991. Development of trapping system for cucumber beetles. pp. 127-132. *In* Proceedings, 53rd Annual New York State Pest Management Conference. November 11-14, Ithaca, NY.
- Levine, E. and R. L. Metcalf. 1988. Sticky attractant traps for monitoring corn rootworm beetles. The Illinois Natural History Survey Reports No. 279.
- Zitter, T. A., M. M. Kyle, M. P. Hoffmann and M. T. McGrath. 1993. Management of cucurbit diseases and cucumber beetles in cucurbits and its impact on marketability and storage. *In* 1992 Reports: IPM Research, Development, and Implementation Projects - Vegetables. NY State IPM Program.

Table 1. Effect of trap color and attractant lure on trap catches of western striped and western spotted cucumber beetles in four crops.

Treatment	Mean Number of Beetles Per Trap							
	Dry Beans		Sunflower		Zucchini		Cantaloupe ¹	
	Striped	Spotted	Striped	Spotted	Striped	Spotted	Striped	Spotted
White - Lure	11.5	7.5	9.8	10.0	1.8	62.3	6.8	20.4
Yellow - Lure	10.0	12.8	57.8	32.3	3.8	206.3	11.3	105.4
White + Lure	10.8	14.8	11.8	14.5	11.8	88.5	88.5	43.2
Yellow + Lure	15.0	18.3	39.0	66.5	12.3	209.0	91.0	139.0

¹ Means based on log transformation ($\log_{10} n+1$) of raw data.

Table 2. Significance level (p-value) of single degree of freedom contrasts for the effects of trap color and TIC lure on trap catches of western striped and western spotted cucumber beetles in four crops.

Contrast	Significance Level (p-value) ¹							
	Dry Beans		Sunflower		Zucchini		Cantaloupe	
	Striped	Spotted	Striped	Spotted	Striped	Spotted	Striped	Spotted
White vs Yellow	NS	0.0116	0.0108	0.0168	NS	0.0001	NS	0.0001
TIC vs No TIC	NS	0.0013	NS	NS	0.0003	NS	0.0001	0.0003
Color x TIC Interaction	NS	NS	NS	NS	NS	NS	NS	0.0319

¹ NS indicates that contrast was not significant, $p > 0.05$.

Table 3. Effect of trap density on capture of striped (STCB) and spotted (SPCB) cucumber beetles and western (WCR) and northern (NCR) corn rootworm beetles with semiochemical-baited sticky traps, August 13-20, Freeville, NY, 1993.

Trap Density (traps/A)	Mean Proportion ¹ Trap Catch/Tot Population				Mean Number/A ² Cumulative Trap Catch			
	STCB	SPCB	WCR	NCR	STCB	SPCB	WCR	NCR
20	0.27	0.09	0.65	0.07	194	93	2993	100
40	0.53	0.25	0.83	0.21	307	93	7998	53
80	0.55	0.26	0.90	0.33	206	253	3607	93
160	1.00	0.44	0.86	0.56	220	540	7600	293

¹ Total population = total trap catch + estimated beetles/plot (based on visual searches of 20 1-meter sections of row/plot). Values are means of three repetitions.

² Values represent total number of beetles captured on sticky traps during the period August 13-20, expressed on a per acre basis. Values are means of three repetitions.

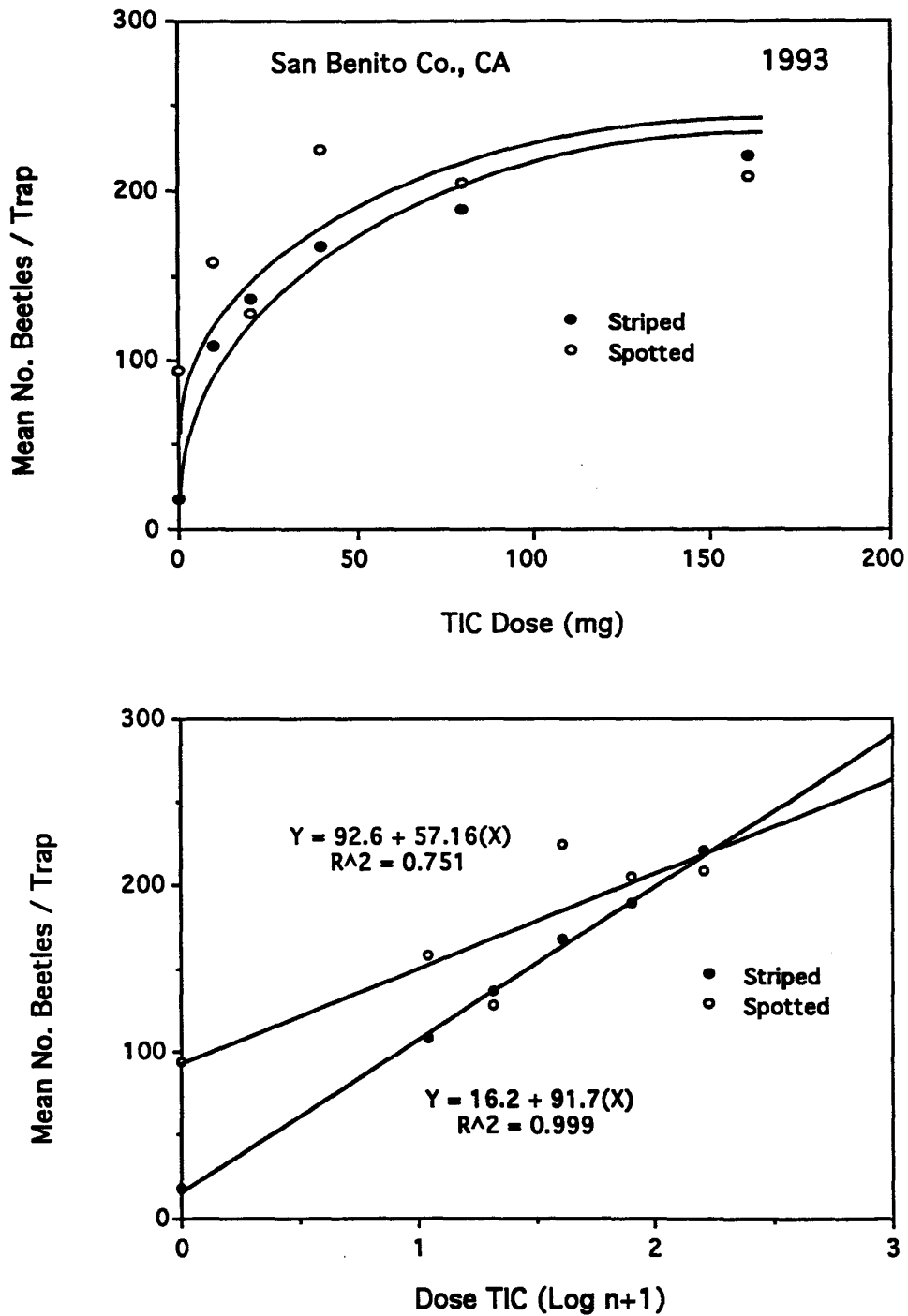


Figure 1. The regression of trap catches of western striped and western spotted cucumber beetle on TIC lure dose and log10 dose in squash, San Benito Co., CA, 1993.

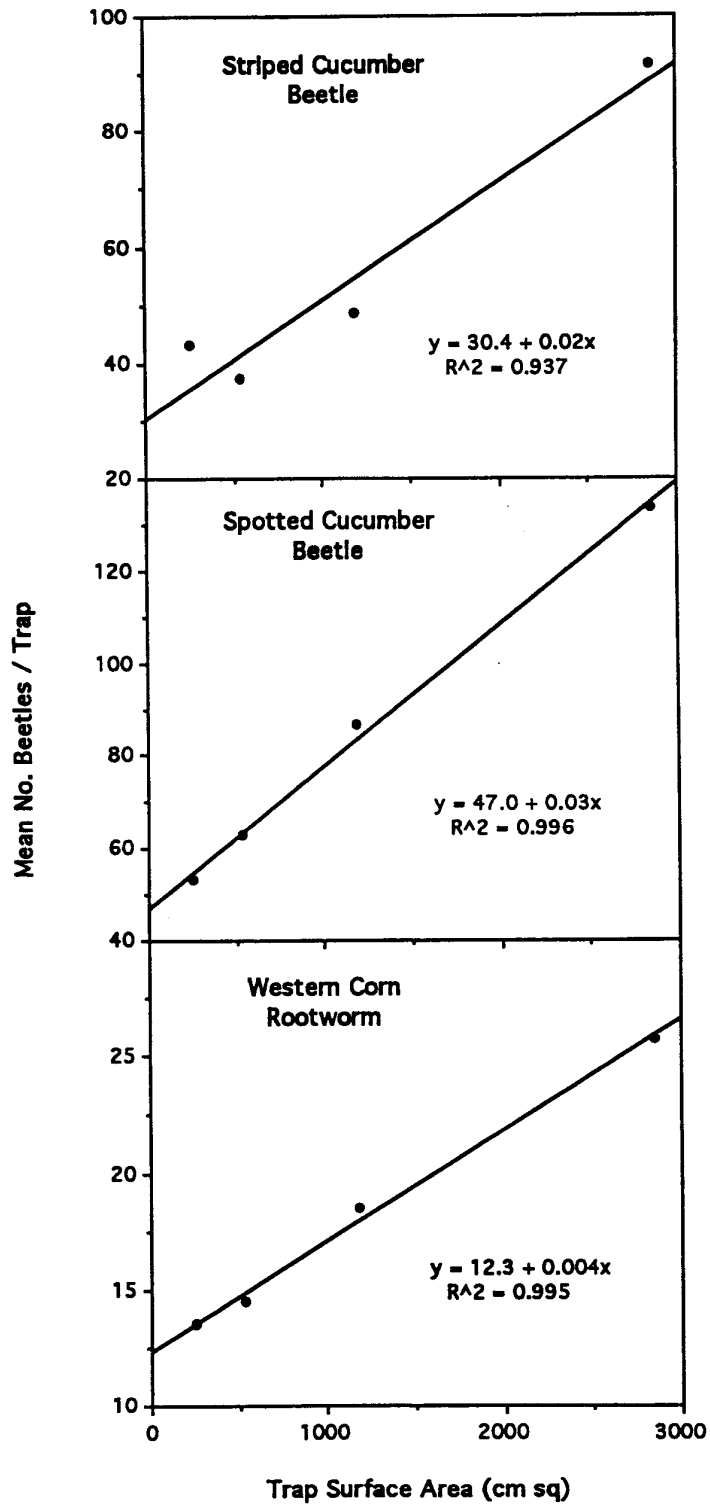


Figure 2. Effect of trap size (surface area) on beetle trap catch, in delicata winter squash, Seneca Co., NY, 1993.