

Development of an IPM Program for Western Spotted Cucumber Beetle in Vegetable Cropping Systems

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Background and Justification

There is currently strong interest among many vegetable growers and food processing companies in “environmental stewardship” marketing claims (i.e. Food Alliance certification). Norpac, a cooperatively owned Oregon food processing company, currently has a “Stewardship” program focused on linking sustainable farming practices to marketplace values.

Integrated pest management (IPM) strategies that can improve pest control while reducing pesticide inputs clearly offer economic and environmental advantages to farmers and society, IPM has long been considered a key component in sustainability of farming systems. The fate of insecticides in watersheds and their effects on non-target organisms has caused concerns to farmers, consumers and environmentalists.

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 cucurbit crops. 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.

Although an IPM program for WSCB in Oregon snap bean production (based on sampling methods and economic thresholds) was developed in the early 1980’s by OSU (Weinzierl et al. (1986, 1987), few Oregon bean growers currently use field scouting to make pesticide application decisions (D. McGrath, personal communication). Because of the relative simplicity of adding an insecticide to the “tank mix” of Ronilan fungicide being applied for white mold control, bean growers have achieved relatively effective control of the WSCB.



Fig. 1. Sweep net sampling was used by full-time field scouts to collect data on *Diabrotica* beetle abundance in bean fields.

Table 1. Participation in the IPM Pilot Project for snap beans, 2004-206.

Year	Farms	Plantings	Acres
2004	10	78	1,600
2005	10	125	2,100
2006	35	303	5,150

A “Pilot IPM Program” was initiated in 2004 to investigate the feasibility of using field scouting and economic thresholds to base pesticide decision making for control of the WSCB. This program involves seasonal field scouts who deliver “real-time” information to the participating growers on beetle densities in their fields. Participating growers used scouting data to make spray decisions for pest control.

We also continued development of “trap and kill” strategies as pest control alternatives that have been in progress for the past two years and continue to study landscape level movement and aggregation patterns of the beetle.

Project Objectives

1. Implement and evaluate a Pilot IPM scouting program for the WSCB in snap beans
2. Evaluate WSCB seasonal aggregation and movement patterns within diversified vegetable cropping systems
3. Evaluate the potential for “trap and kill” strategies as cultural control components of an IPM program for the WSCB

Objective 1. Implement and evaluate a pilot IPM scouting program for the WSCB in snap beans

This objective focused on evaluating risks and benefits associated with a seasonal IPM scouting program to sample bean fields for cucumber beetle adults, and deliver information to participating growers. In 2004, the first year of the project, ten vegetable growers participated in the program, with 78 bean plantings on 1,600 acres. In 2006, thirty-five growers participated in the program, with 303 bean plantings on 5,150 acres (Table 1). Field scouts used a standardized sweeping technique (10 sweeps per sample, 10 samples per field). In bean fields with margins next to cornfields, an additional five samples were taken along the edge of the field to identify aggregations (See Objective 2). After every farm visit, scouts delivered written reports to a designated site on each farm. These reports gave field-specific data on beetle densities, as well as data on aggregations along field margins next to cornfields. Information on action thresholds was also included on the reports to assist growers in making pesticide application decisions. Each week scouts entered data into the central database at OSU, and weekly, area-wide summaries were sent to all participating growers, industry, and Extension personnel. Field scouts tried to begin their first sampling of fields just prior to bloom, then continue on a weekly basis until beans were set and developing in the field. Because of the difficulty of sweeping bean fields with full bean set, as well as the difficulty of getting accurate sweep net beetle counts, scouting was discontinued after the beans were past the pin bean stage and were developing size.

All costs of operating the scouting program were recorded for an economic analysis of the program. Spray records and crop grade reports from most of the scouted fields were obtained to examine relationship of beetle density with damage to beans. Estimates of economic loss to WSCB feeding (“bean bite”) were derived from the Norpac grade sheets and average “payout” values to the growers. Although actual economic loss would depend on varying contract prices for specific cultivars of beans being grown, only one value, for Oregon 91G, was used in the calculations.

RESULTS:

Beetle Densities. Two full-time summer field scouts (with some help from the scout supervisor) made 632 individual field visits from June 21 to Aug. 10, 2006. Beetle densities were well below the 1987 economic threshold for insecticide application (3 beetles per 10 sweeps) in most fields sampled (Fig. 1.) However, 47% of the scouted bean fields were sprayed with insecticides to control WSCB.

Economic Impact. Complete data sets (spray records and grade reports) were obtained for 275 fields in the program. Economic loss to bean bite (in dollars per acre) was zero for 218 of the fields, less than \$4.00 per acre for 56 fields (Table 2, Fig. 3). One field however experienced economic loss of \$96.50 per acre (Fig. 4). Total loss to beetle damage in this 13-acre field was \$1,250. In further discussion, this field will be referred to as the

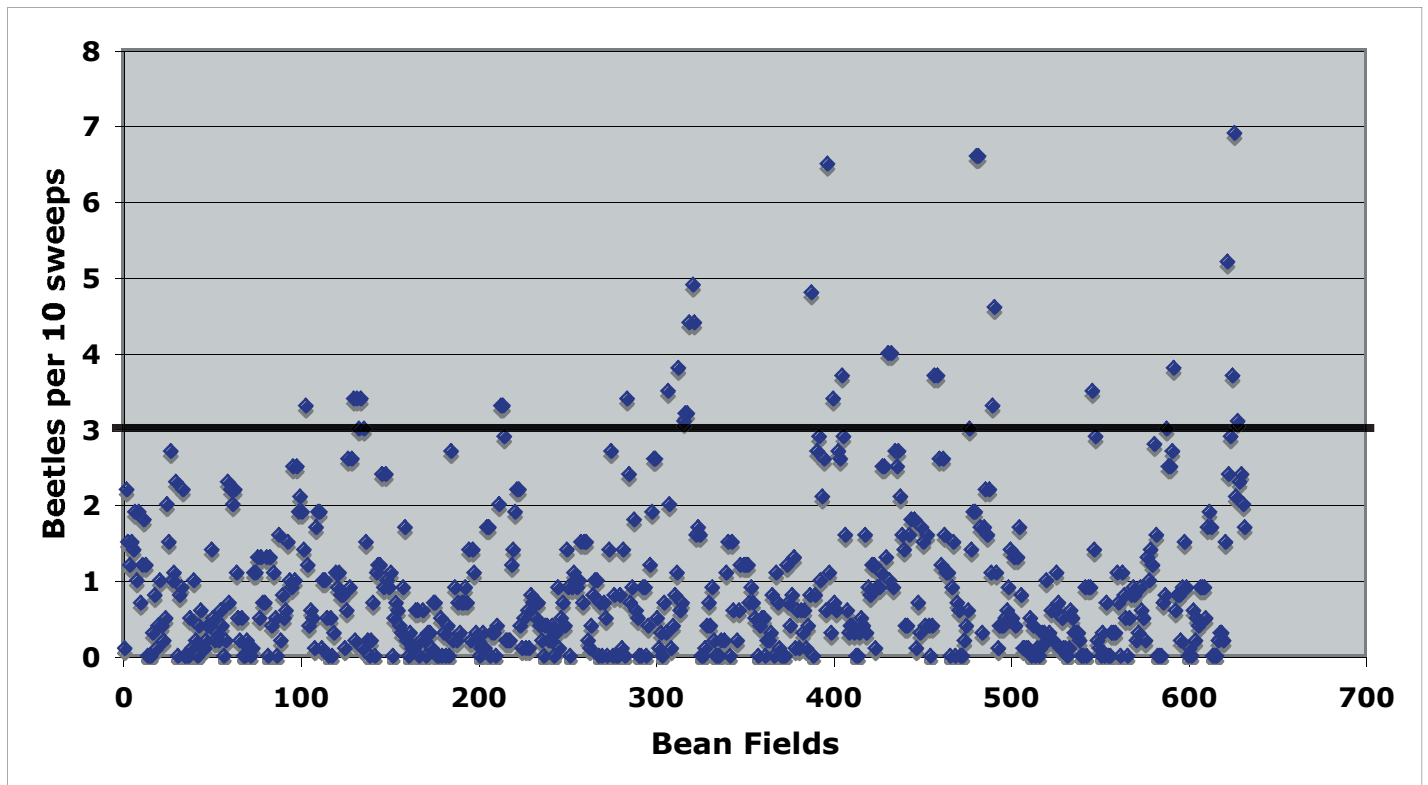


Figure 2. Diabrotica beetle abundance in scouted bean fields, 2006.

“high damage field” or “HDF.” Looking at average economic losses across the entire scouting program, including the HDF, losses were \$0.58 per acre. Excluding the HDF, average losses to bean bite were \$0.23 per acre.

When the HDF field was harvested, one truckload of beans (8,780 lbs) was rejected at the processing for containing excessive bean bite (7.4%). Additional truckloads of beans from this field also contained beetle damaged beans, but were accepted for processing. The last prior sampling of this field occurred on July 15, and the reported beetle counts were 1.3 beetles per 10 sweeps, well below the action threshold of three beetles per 10 sweeps. Beans were developing in the field on July 15, and sampling was discontinued, according to normal procedure (as described above). However, this lag between pod fill and harvest leaves a period of vulnerability in the scouting program in which beetles could colonize a field following the harvest of a nearby bean field. The landscape position of the HDF was interesting, in that it was completely surrounded by grass seed fields, with a cluster of bean fields approximately ½ mile away. Possibly beetles moved from a harvested bean field to the HDF after the last sweep net sampling. There is considerable anecdotal evidence of a relationship between grass seed fields and WSCB colonization of bean fields. Clearly, this needs more work to determine if a grass seed border effect exists. Clearly, by July 15, most grass fields had been harvested, but the harvest dates of the grass fields surrounding the HDF are not known. There is also a possibility that beetle numbers were already on the rise in the HDF by the July 15 sample date, since in one sample, the beetles count was five beetles/10 sweeps.

Following the breakdown of the scouting program with the undetected damaging populations of beetles in the HDF, we met with the field scouts

Table 2. Economic loss (dollar per acre) to pod feeding by the western spotted cucumber beetle in snap bean fields, 2006.

Dollar loss per acre	Number of Plantings
-0-	218
\$0.01 to \$1.00	34
\$1.01 to 2.00	15
\$2.01 to 3.00	7
\$3.01 to 4.00	0
\$4.01 to 5.00	1
\$96.50	1

to revise the sampling protocol for the remainder of the season. Sampling was intensified, especially along field margins, and if relatively high numbers (>4) appeared in a single sample, an additional sample was taken nearby to identify the existence of “hot spots.” An explanation of the situation with the HDF and the change in protocol was sent to all participating growers. Some growers decided to continue with the scouting program, while others decided to spray their remaining fields. No other fields were docked for excessive bean bite damage for the remainder of the season.

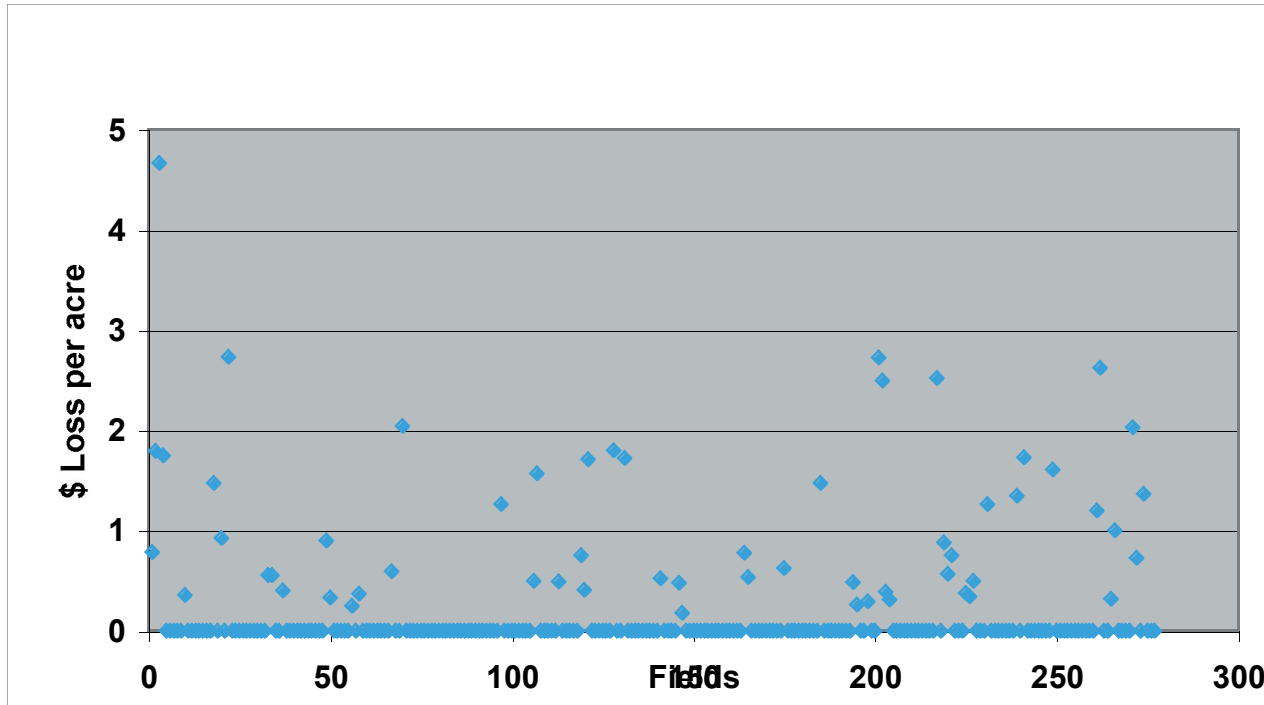


Fig.3 Economic loss (dollar per acre) to Diabrotica beetle for all bean plantings, except for one field with high levels of damage, 2006.

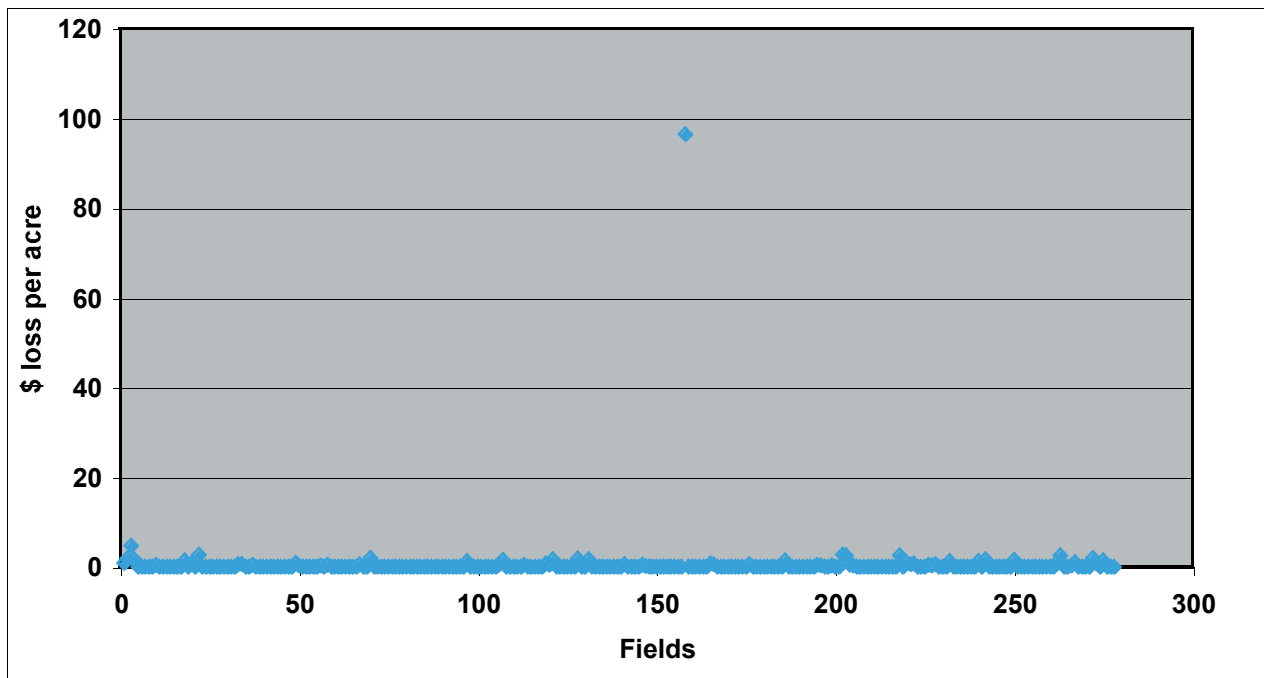


Fig.4. Economic loss (dollar per acre) to Diabrotica beetle for all bean plantings, 2006.

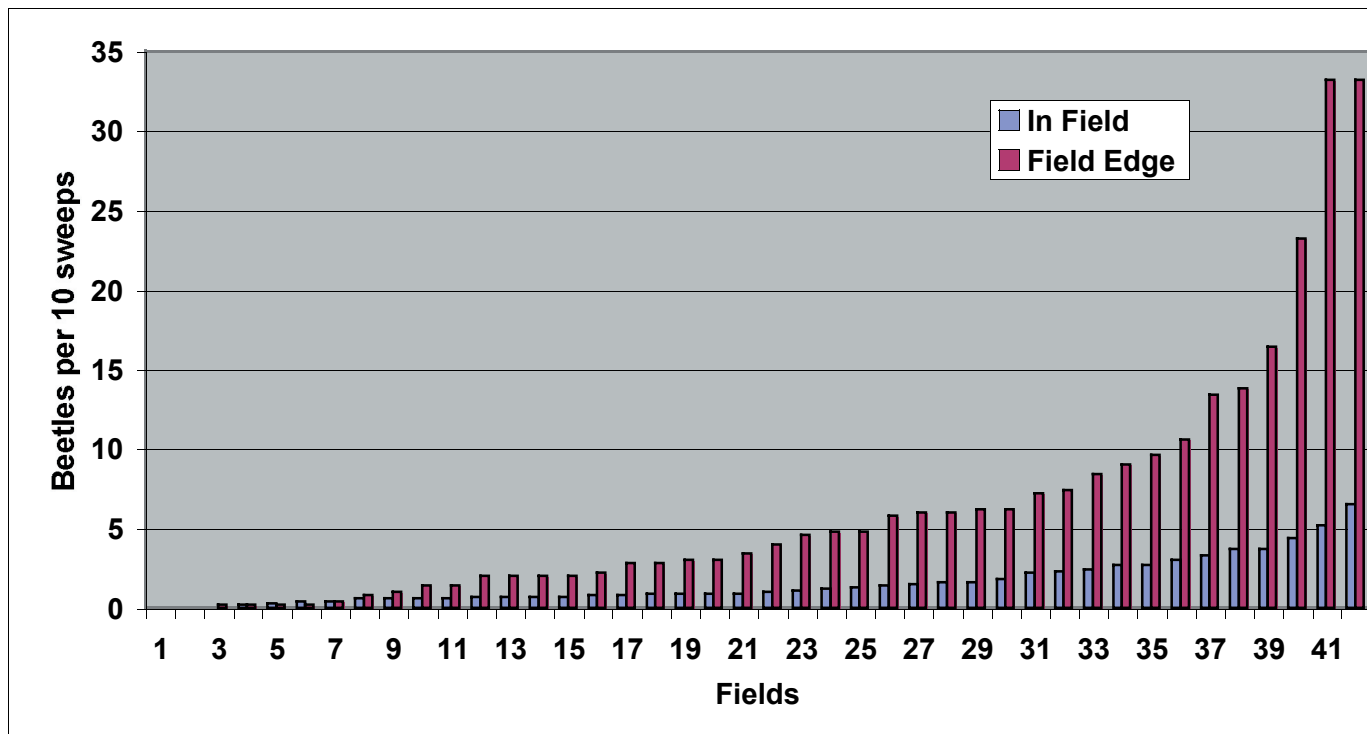


Fig. 5. Comparison of beetle counts in the field edges of beans next to corn (“Field Edge”)with beetle counts taken throughout the rest of the field (“In Field”). Note the exceptionally high beetle numbers in some of the aggregations.

Economic and Environmental Analysis. Total scouting costs were \$12,894, which included \$9,033 for wages and \$3,861 for mileage reimbursement. A total of 8,580 miles were driven by the field scouts. With a total of 5,200 acres scouted, the average scouting cost was \$2.48 per acre. One hundred sixty fields containing 2,480 acres were not sprayed for insect control. With only 47% of the acreage receiving insecticide applications, total savings in pesticides were estimated at \$11,145. Note: this estimate assumes all fields would otherwise have been sprayed, which is not the actual situation. Further analysis of the historical Norpac database of spray records will be necessary to determine insecticide application data prior to the introduction of the IPM Pilot Project. Total economic loss to dockage from bean bite was calculated for all fields in the program. This was \$2,367, and included the \$1,250 loss in the HDF.

Discussion. The results from the 2006 IPM scouting program present an interesting dilemma. For the 34 bean growers who did not suffer the economic loss of the HDF, the IPM scouting program reduces insecticide inputs and enables the growers and processors to make verifiable claims for environmental stewardship. With the movement of food processing companies to develop stewardship programs, the IPM program represents an information-intensive approach which promotes sustainability. However, for the one bean grower who farmed the HDF, the economic loss from beetle damage was clearly unacceptable.

Future Directions. Can the sampling protocols be redesigned to better detect field border invasions, or possibly close up the gap between last sampling and harvest? Is the probability of unacceptable loss ($1/275 = 0.0036$) simply too high a risk for growers to be interested in field scouting? Can the risks to individual growers be shared by the grower community? Further discussions with participating growers during early 2007 are planned to determine the next phase of this project.

Objective2. Evaluate WSCB seasonal aggregation and movement patterns within diversified vegetable cropping systems.

Previous work in this project has identified the common aggregation of female beetles in the margins of bean fields next to sweet corn fields. In 2006, field-scouting protocol was modified to allocate more samples along

the bean/corn interface to detect aggregations. Scouts took an additional five samples along the edges of bean fields next to corn. These data enabled growers to use border strip spraying of the aggregations, thereby reducing total acreage sprayed. Forty-two fields were sampled with bean/corn interfaces. In 18 of these fields, data from the field borders generated same “no spray” recommendations at the samples from the whole field. In seven of the fields, samples from both the whole field and field border indicated the need to spray. In 16 fields, however, higher beetle densities in the field margins triggered a spray decision that would not have occurred if only the whole field sampling method had been used (Fig. 5).



Fig. 6. Cucumber beetle trap: Yellow wing trap, containing Entrust and Hawkesbury melon bait suspended within the clear plastic container, with kairomone trap and rain cover on top of the post.

Objective 3. Evaluate the potential for “trap and kill” strategies as cultural control components of an IPM program for the WSCB

We continued to develop and evaluate a trap and kill technology for WSCB using a chemical kairomone attractant (Hongrakul 1997), and cucurbitacin-baited traps. During 2005, we grew ¼ acre of the mutant Hawkesbury watermelons, which contain high levels of cucurbitacin glycoside E, a feeding stimulant for the WSCB. We processed these melons and produced 200 gallons of pressed juice, and an equivalent amount of ground squash solids. This year we explored the use of the solids as a bait material containing spinosad, a biologically derived insecticide. The use of baits has been used widely in the Midwest to control the western corn rootworm (*Diabrotica virgifera*) (Weissling and Meinke, 1991). We also evaluated plastic trap design to increase trap catches of the WSCB.

We used a commercially available yellow wing trap (Japanese beetle trap), which has four yellow plastic vanes leading into a clear plastic container (Fig. 6). We cut out two 2-x 4-inch vent openings in the containers and covered the vents with plastic screen. We attached to the trap to a metal pole, with the clear container on top. A Petri dish “beetle feeding station” was suspended on a bolt, hanging within the plastic container. On this dish, we placed



Fig. 7. Cucumber beetle traps were spaced 90’ apart in a snap bean field south of Corvallis.

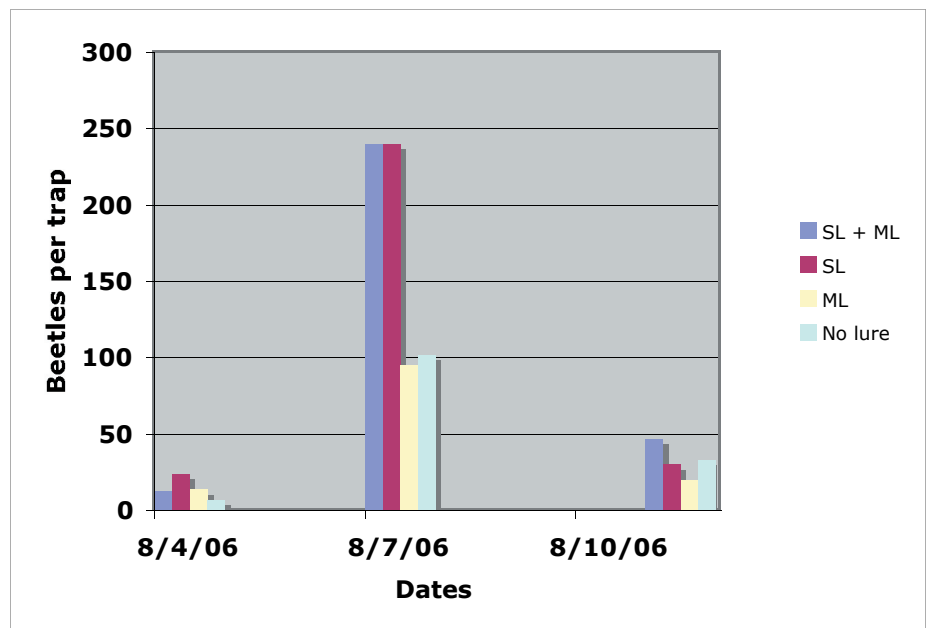


Fig. 8. Evaluation of kairomone lures for attracting cucumber beetles to “fatal feeding station” traps in a snap bean field.

our latest recipe for “Fatal Beetle Chow.” This is a mixture of 2 g of dried Hawkesbury melon pulp, 16 ml of Hawkesbury melon juice (thawed from 2005 frozen juice), and 0.1 g of Entrust® insecticide. In the laboratory, the Entrust® is blended with the melon juice, then the juice is used to rehydrate the dried melon pulp. Entrust®, manufactured by Dow AgroSciences, is similar to Success®, and is a microbially based insecticide with the common name of spinosad. While spinosad is quite effective against many lepidopteran pests, some flies and beetles, it has generally been shown to have weak efficacy against the *Diabrotica* beetles. However, if the material is ingested, it is quite toxic. We’ve previously documented the attractiveness of our IBb kairomone lure to both the WSCB and the striped cucumber beetle, *Acalymma trivittatum*. In these experiments, our objectives were: (1) Evaluate trap design and bait materials for trapping WSCB, and (2) Evaluate the value of adding a small kairomone lure within the trap to increase WSCB trapping rate.

The experiment was established in a 10 acre snap bean field south of Corvallis. Four treatments were used, (1) control--no kairomone lures, but traps contain the Hawkesbury bait (2) Standard lure on top of pole (SL), (3) “Mini-lure” inside the trap (ML), and (4) a combination of both lures (SL + ML). The “Standard” lure is made by soaking 9 cotton dental wicks in mineral oil, then inserting them into a 1 ¼ - in diameter PVC pipe approx. 3” long. Kairomone (1.0 ml of IBb) is added to the lure prior to installation in the field. The lure is mounted on a bracket on the top of a 3’ metal fence post. An aluminum pie pan is bolted over the top of the lure as a rain and irrigation shield. The mini-lures were ½” long pieces of cotton dental wicks, soaked with mineral oil, and placed into 3/8” diameter plastic tubes. Kairomone (0.01 ml of IBb) is added to the lure prior to installation in the field.

Traps were spaced 90” apart in rows, with the four treatments randomized with each of four replicated lines of traps. Trap lines were spaced 150’ apart. Three separate trap runs were made in early August. The bean field contained moderately low numbers of WSCB and had not surpassed the action threshold for insecticide sprays. Traps remained in the field for 2 or 3 days. All beetles found within the traps or on the ground below the trap were counted and the traps were removed from the poles until the next trapping interval.

Results. On the first trapping date (Aug. 4), all lure combinations increased catch over the control, with the Standard lure having the highest catch. On the second trap day, (Aug. 7) catches were much higher in all traps, with the SL and SL+ML having nearly identical catch, and the ML and control have similar, much lower catches. On the last sample date, the SL +ML had the highest catch rate, suggesting an additive effect, but with other treatments caught similar numbers of beetles. Results from the Aug. 7 date clearly indicate that the “mini-lure” is adding no value to the Standard lure. Data from the other two sample dates do not give clear treatment responses.

Future Work. This project has clearly shown the potential for trap and kill of WSCB, however more work is needed to improve the design of the trap. Particularly the bait “feeding station” needs to be redesigned. The current trap is difficult to service (empty beetles) as the tray is suspended within the trap and the beetles die in the pulp. New designs will need to facilitate quick and easy trap servicing. Optimum density and placement of traps all needs to be determined.

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