SARE Farmer /Grower Grant Report
"Winter Squash Perimeter Trap Cropping for the Organic Grower"

FNE06-574
Nancy Hanson
Manager
Community Supported Agriculture Program
Hampshire College Farm Center
893 West Street Amherst, MA 01002
413-559-5599
nhanson@hampshire.edu

Goals:

Our objective for this project was to develop an effective trap cropping system in winter squash using organic methods. We proposed using Blue Hubbard squash as a perimeter trap crop for the control of cucumber beetles in a Butternut squash main crop. We tested the efficacy of two methods of controlling cucumber beetle in the trap crop and one method to make the main crop less palatable to the beetles. The two trap crop control methods were as follows: Entrust, an organic formulation of Spinosad, was sprayed on the Blue Hubbard crops to kill cucumber beetles, or a reversed leaf blower was used to remove beetles from the trap crop. Surround, a kaolin clay coating treatment, was used on the main Butternut crop in an attempt to deter the cucumber beetles from feeding on the main crop.

Farm Profile:

As the manager of the Hampshire College Community Supported Agriculture Program I grow 14 acres of mixed vegetables using organic methods. The CSA is located at Hampshire College in Amherst MA. Crops are distributed to 210 shareholder households from September through November. The majority of shares are sold to students, staff and faculty of the Five colleges (Hampshire, Smith, Mt Holyoke, Amherst Colleges and the University of Massachusetts).

Participants:

Grower:
Nancy Hanson
Manager
Hampshire College CSA

Technical Advisor
Ruth Hazzard
Umass Extension
Role: Assistance with experimental development and design. Supplied information about previous experiments. Visited experiment several times to help with sampling techniques and results interpretation.

Cooperator:
Brian Schultz
Professor of Entomology
Hampshire College
Role: Assistance with sampling, experimental design and plot layout. Conducted statistical analysis.

Project Activities:

On 5/24 /06 Blue Hubbard and Butternut squash seeds were started in the greenhouse in plastic flats (BH in 48s BN in 72s) .
On 6/12/06 squash starts were transplanted into the field.

The experimental section of squash consisted of 31 rows by 165' long, with 20 plots along the edges, 5 treatments in 4 replicate randomized blocks with plots that were 24' x 30' each in size (either 6 rows x 24' along the edge field rows, or 5 rows by 30'at the end of the field rows, so that each plot had the same depth into the field). Each plot consisted of Butternut squash as the main plot variety, surrounded by Blue Hubbard as the perimeter trap crop (PTC) variety, all planted with 80" between rows and 36" between plants within rows. The Blue Hubbard was in one row along the edge of plots, and 1 plant deep at the ends of plot rows, to define each plot perimeter. This planting pattern allowed for mechanical cultivation along all the crop rows, and also gave 24 plants of the main variety inside of each plot for insect sampling. The portion of the field inside the experimental plots was planted with a number of other winter squash varieties and pumpkins. A map of the plot layout is attached (Figure 1).

The five treatments were:

1) PTC treated with Entrust but no main crop treatment;
2) PTC treated with Entrust plus the main crop treated with Surround;
3) PTC with vacuuming but no main crop treatment;
4) PTC with vacuuming plus the main crop treated with Surround;
5) PTC only with no other treatments, as the experimental control or check.

All applications of Surround were at a rate of 25lbs/ac.
All applications of Entrust were at a rate of 2.5oz/ac.
All spraying was done with a hand pump backpack sprayer.
Vacuuming was done with a reversed backpack leaf blower with a collection bag attached.

Plants treated with Surround were sprayed in the trays prior to transplantation on 6/12.
Surround was then reapplied to cover new growth or after rains had washed off any prior applications.
Surround was reapplied on the following dates: 6/19, 6/21, 6/27, 6/30, 7/6.
Entrust was applied and vacuuming was done when scouting showed a threshold of 1 cucumber beetle per plant in the border rows. Spraying and vacuuming was done on the following dates: 6/14, 6/15, 6/16, 6/19, 6/21, 6/27, 6/30.

Insect activity data was collected once prior to the start of treatments and then again each day following a treatment. Sampling was done on the following dates: 6/14, 6/15, 6/16, 6/19, 6/20, 6/22, 6/26, 6/30. A final sample was taken on 7/12. The first sampling on 6/14 was before border sprays were applied. Three plants along each border edge of each plot were randomly scouted and data collected on the number of live cucumber beetles and the number of dead cucumber beetles. A feeding damage estimate was also made using the following scale:

<u>% of leaf area damaged</u>

0- no damage
1- 1-10%
2- 11-25%
3- 25-50%
4- 50-75%
5- 75%-100%

The same data were then collected for 12 random Butternut plants in each main crop block.

Treatments and sampling was stopped during the second week of July because most beetles had moved into the squash flowers at that point. Spraying inside flowers was difficult and vacuuming the flowers was impossible without significant damage to the flowers.
Harvest data were collected on 11 September.

Data were analyzed by analysis of variance (anova) for randomized blocks, with ln(x+1) transforms for beetle counts, and linear orthogonal contrasts to separate the effects of Entrust vs. vacuuming or Surround vs. no Surround among the treatment combinations.

Results:

Beetles quickly accumulated in large numbers in the Blue Hubbard PTC plants at the beginning of the season, and though numbers subsequently also dropped rapidly in all PTCs, insect numbers and damage were always much higher in the PTC plants than in the main crop Butternut plants on the inside of each plot, including the check plots (Figure 2). There were some significant differences among treatments in beetle numbers and damage, mainly from the very first sampling days.

In the outer rows on 15 June, Entrust reduced the numbers of beetles somewhat more than vacuuming (Figure 2a; $F_{1,12} = 12.66$, $p = 0.004$; linear contrast for Entrust vs. vacuuming treatments; vacuuming actually did not differ from the checks). Entrust application was also easier than vacuuming.

On butternut squash within plots however (Figure 2b), the only effective treatments early on in reducing beetle numbers were those with Surround on the main crop ($F_{1,12} = 924$, $p = 0.010$; linear contrast for treatments with vs. without Surround, first sampling date).

The Entrust treatments also eventually reduced damage appearing in PTC plants (Figure 2c), while Surround treatments showed less damage on inner plants from the very start (Figure 2d; $F_{1,12} = 12.99$, $p = 0.004$; linear contrast for treatments with vs. without Surround). The appearance of damage on treatments was actually often worse than the check plots, especially later, and this appeared to be due to disturbance -- we noticed that high numbers of beetles sometimes occurred on or under plant leaves that had been trampled (which was more likely in plots with and after repeated applications of materials).

The Entrust killed beetles promptly enough that we found significant numbers of dead beetles in the single PTC rows of plants (Figure 3). We could also see the vacuum removing insects. It is possible that in these small plots, however, insects were able to move around enough that reductions by any treatments to PTC crops were so relatively temporary and small that beetles mostly returned to numbers in PTC vs. inner crops based almost solely on their squash variety preference and the presences or absence of Surround.

There were no significant differences in yield from the inner main crops (Figure 4; $F_{4,12} = 0.18$, $p = 0.943$), probably because all inner plot beetle numbers were far below economic thresholds whether treated or not.

One additional outcome we noted was that the number of beetles in PTC crops was about the same at all PTC locations around a given plot, even on PTC plants in rows back from the very edge of the whole field and within the main crops of the experiment (Figure 5; and see map), which could suggest that the additional trap crop plants could serve as an insect sink within a main crop field and not just as a perimeter trap.

In short, Entrust was somewhat more effective in reducing beetle numbers in PTC plants than vacuuming, and was also easier to use. However, only inner Surround treatments clearly reduced beetle numbers within the plots. One may only need Surround on the inside; if an organic PTC treatment seems needed (perhaps in larger plantings or other designs), it seems better to try Entrust rather than vacuuming. All beetle numbers within plots this year and/or this experiment were low, however, and there were no treatment differences in main crop yields. The small plots and disturbance due to treatment applications were possible confounding effects reducing apparent effects of the treatments in this experiment.

Conditions:

There were two field conditions that may have affected our results. One was the proximity of one side of the experimental field to a wooded area. It became very clear that the beetles were moving in from the east side of the field from over wintering sites in the adjacent wooded area. (See attached map). This should not have significantly affected our results, however, because our randomized block design scattered the different treatment types throughout the field.

There were heavy rains during the week of 6/25. Applying control treatments and sampling during that week were difficult because many of the squash leaves were buried in mud and the beetles had a tendency to congregate under the leaves.

Economics, Assessment and Adoption:

While it is difficult to directly connect these activities to overall CSA profitability, winter squash is an important part of the fall CSA crop mix. The reduction of cucumber beetle damage, especially while transplants are young, is imperative to good yields of winter squash.

At $400/lb, Entrust is a relatively expensive material. It was effective at small rates; however, several (almost daily) applications were required for the first few weeks after transplant while new beetles are moving into the field. Total cost of Entrust was $65/ac. Total labor cost to apply Entrust was $55/ac ($10/hr labor rate).

Surround is a much less costly material per pound but requires more material and labor because the entire main crop must be sprayed. Once per week applications were sufficient to cover new growth, however, total number of applications needed depended on rainfall. Because frequent rains did require extra applications of Surround, total cost of Surround was equivalent to $195/ac materials cost and $60/ac in labor costs. Surround is also somewhat messy to apply and difficult to clean out of spraying equipment.

Vacuuming was not a reasonable solution to cucumber beetle control. The unit was costly ($400), awkward and time consuming to use. The vacuum also caused significant damage to the squash plants. It was difficult not to suck the new transplants out of the ground and impossible to remove beetles once they had moved into the flowers. The noise of the vacuum also disturbed the beetles enough so they would fly away before the vacuum could remove them.

Without significant differences in yield data between treatments, it is hard to tell if these treatments were worth the cost. More experiments using larger plot sizes would be required to determine economic feasibility. In 2007, I plan to use a perimeter trap crop system around the entire squash field using Entrust to control beetles in the border rows. I also plan to apply Surround to the main crop prior to transplant for beetle deterrence at least for the vulnerable cotyledons. I may also try using another more marketable variety of squash (Buttercup) as the trap crop.

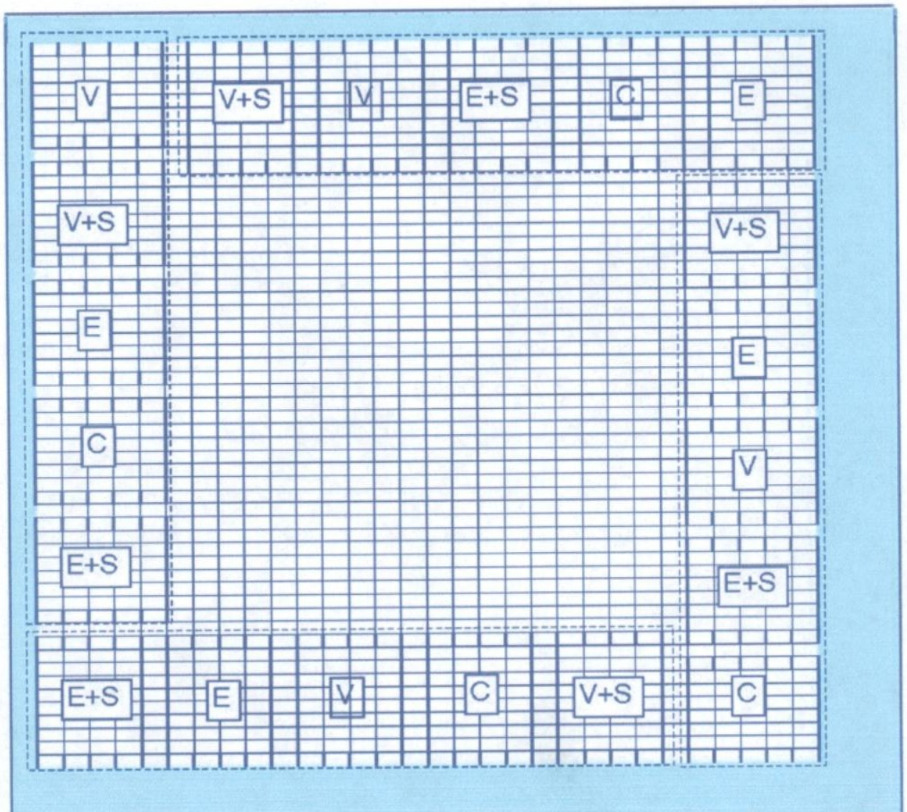
Outreach:

A tour of our experiment was conducted during the August Northeast Organic Growers conference. Twenty-five farmers were showed the PTC field layout, spraying techniques and sampling results. Results of this experiment will be published in Vegetable Notes (Umass extension) this spring.

Report Summary:

This project was designed to test organic perimeter trap cropping (PTC) methods in winter squash. We planted experimental plots with a Blue Hubbard squash as a PTC surrounding Butternut as a main crop. We trailed two organic methods of controlling cucumber beetles on the trap crop and one method designed to deter feeding on the main crop. We found that while Entrust killed beetles in the trap crop, it is difficult to say whether the use of Entrust is economically feasible. We found that although vacuuming removed beetles from the trap crop, it is an expensive and awkward control method and not recommended. We also found that spraying the main crop with Surround was an effective deterrent for cucumber beetle feeding on the main crop, however, we again could not determine the economic feasibility of this method. In the future, I would like to trail the use of Entrust and Surround on my entire squash crop using Blue Hubbard or perhaps Buttercup as the PTC.

Figure 1. Plan and map of the experimental design (PTC crops in bold; experimental plots are arrayed around the edges of a main crop). Wooded area is to the right of this map.



Experimental Design.

C = untreated Control plots;
E = Entrust applied to PTC borders; V = Vaccuuming of PTC borders
E+S = Entrust borders + Surround on inner main crop;
V+S = Vaccuuming borders + Surround on inner crop.

Notes.
- The field is 31 row (2m between rows) x 55m
- Plots are 8m x 10m (6 rows x 8m or 5 rows x 10m)
- Solid lines represent the Blue Hubbard trap crops
  - 1 row along squash planting rows or 1 m across rows
- Inside each plot is 24 row-m of butternuts squash as the main crop
- There are four blocks, each indicated by dotted lines

N
W + E
S

Figure 2. Mean (± se) live striped cucumber beetle numbers (SCB) on outer (PTC) rows (a) or on inner crop plants (b), or damage on outer rows (c) or inner plants (d) for each treatment: control (C), vaccuuming PTC only (V), Entrust on PTC only (E), vacuuming PTC plus surround on outer rows (V+S) or Entrust on PTC plus Surround on inner plants (E+S). First date counts on 14 June were before PTC treatments of E or V were applied. * indicates overall anova significance for that date.

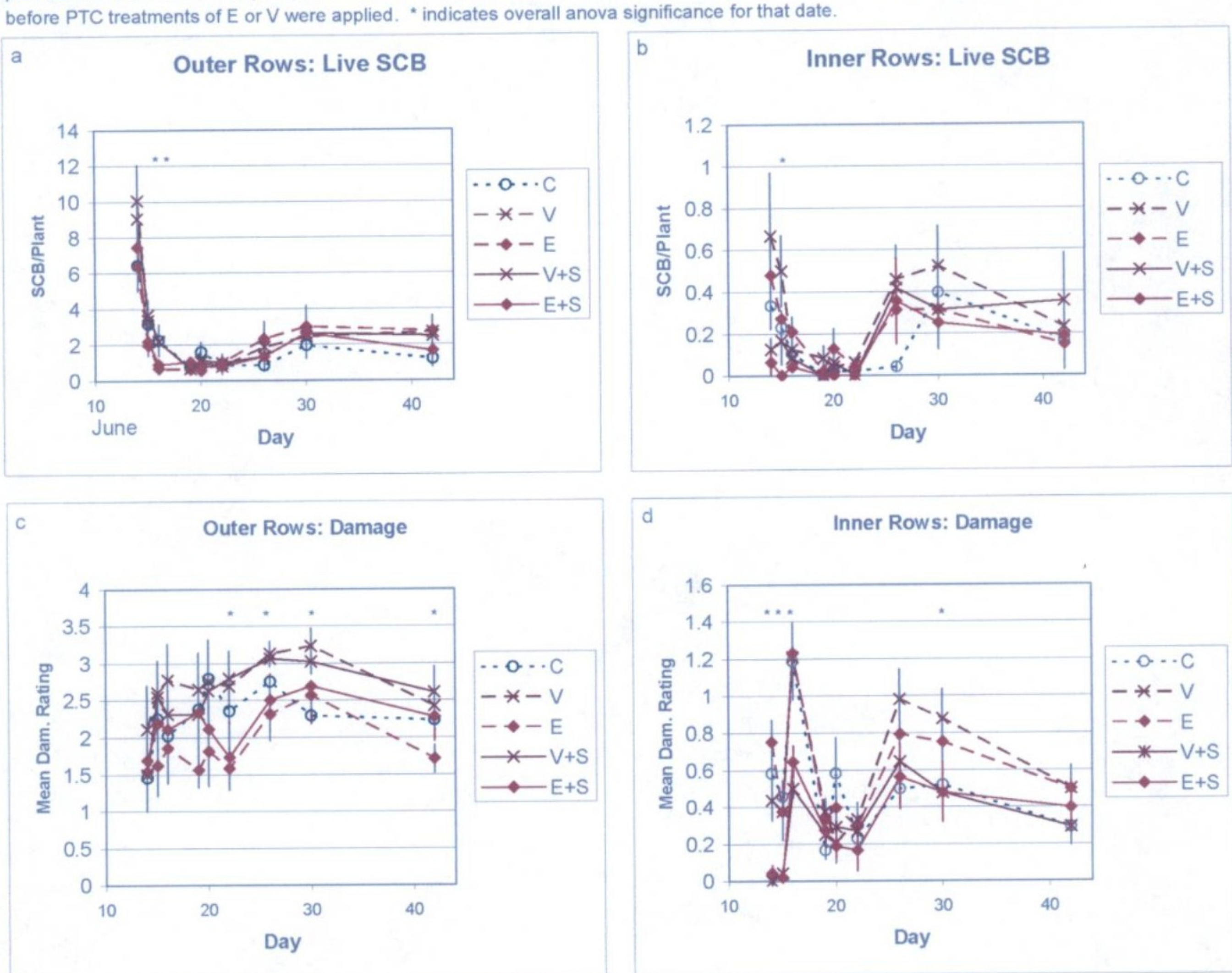


Figure 3. Dead SCB counts on PTC plants.

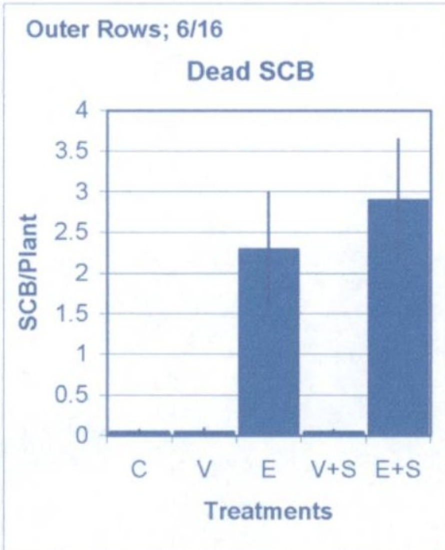


Figure 4. Main crop yields.

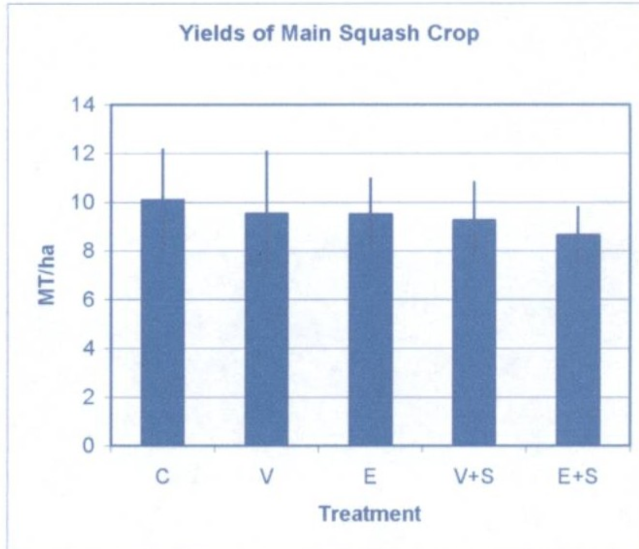


Figure 5. Numbers of live SCB found on PTC crops by location in experimental field (on field edge rows vs. PTC plot rows more inside whole field and within main crop plants; see design map).