Perimeter Trap Cropping Works in Butternut Squash

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The striped cucumber beetle, *Acalymma vittatum*, is the major insect pest on winter squash in New England. Typically, these beetles are managed with full-field pesticide sprays. This can be a costly and time consuming procedure for growers, and effectively timing the sprays is often difficult due to the speed with which beetles can infest a field and damage the young crop. In addition to direct feeding damage, cucumber beetles also vector the bacterium *Erwinia tracheiphila*, which causes bacterial wilt in cucurbits.

In the spring of 2003, we began looking at the effectiveness of using a perimeter trap cropping (PTC) system for butternut squash. Jude Boucher of the University of Connecticut had already shown that PTC reduced time, expense, and potential hazards and gave higher yields in cucumbers and summer squash with a blue hubbard border. PTC is based on the fact that many insect pests prefer one species or variety of plant over another, due to variations in plant chemistry, shape, or other factors. In a PTC system, the more attractive crop is planted around the outer edge of the main cash crop, surrounding it on all sides. This protects the cash crop from insects entering the field from any direction. Perimeter trap cropping works best against pests that colonize a field from the edges and work inwards. Striped cucumber beetles over-winter in the brushy edges surrounding fields, and move into a crop from the field margins in the early summer. This makes them a good candidate for this method of control.

In 2003 we set up field trials in commercial fields and small plots trials at the UMass Research Farm to test a butternut PTC system. We repeated our experiments in 2004, but this time we tested a systemic insecticide in addition to a spray treatment to the borders. In 2004 we also evaluated other potential trap crops for growers who wanted an alternative to blue hubbard.

Commercial butternut fields, 2003

Six butternut growers planted a blue hubbard border around fields that ranged in size from 2 to 6 acres. These six fields were compared to conventional butternut fields where beetles were controlled with full-field sprays of Sevin or with an Admire drench at planting. Fields were scouted twice weekly until first leaves, then weekly until flowering. Borders were sprayed at the first arrival of the beetles.

Our first year of field trials got off to a little bit of a shaky start. The spring weather was difficult even by New England standards, some of the borders suffered from tractor blight, planting skips, poor emergence, and other maladies resulting in large gaps in the border. The beetles came out virtually overnight and ate whole sections of some of the hubbard borders right down to the ground, at which point they stopped being 'borders'. Needless to say, the beetles eventually broke through and necessitated full-field sprays in some fields. Even with all these difficulties, it was clear that the system had a great deal of potential. We saw places where there were piles of literally hundreds of dead beetles under the hubbard plants in the border, with a mere fraction of that many

beetles in the main crops. We saw fields that held out for a week or more under beetle pressure that would likely have decimated the unsprayed main crop if the beetles hadn't been stopped at the field edge and concentrated in the borders, where they were killed. All in all we were encouraged that the system had potential, and we learned a great deal about how to implement it successfully. Our growers who participated in the experiment seemed to feel much the same way, and most of them were happy to try it again in 2004.

Research plots, 2003

In our small plot work at the UMass Research farm in 2003, we laid out four replicated treatments – all were 14'X30' blocks of unsprayed butternut squash, surrounded by different kinds of borders:

1. unsprayed butternut
2. butternut sprayed weekly with Sevin until flowering
3. unsprayed Blue Hubbard
4. hubbard sprayed weekly with Sevin until flowering

These blocks were separated by 50' fallow areas. Beetles piled up in the blue hubbard, which was about what we expected. On the main crop, somewhat unexpectedly, beetle numbers were low in *all* treatments. The 'unprotected' butternut with no trap crop and no sprays had the highest number of beetles, though the difference among main crop treatments was not statistically significant (Figure 1).

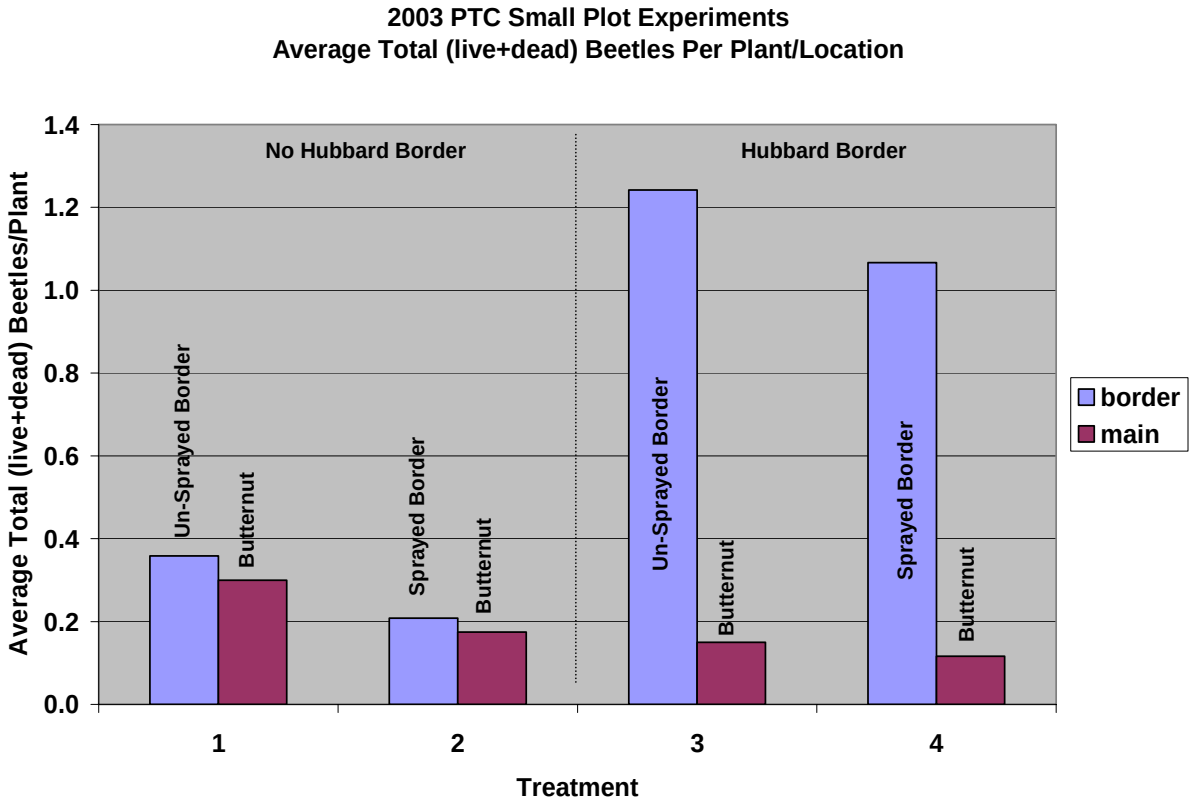

Figure 1. Results of 2003 PTC trials. Seasonal average of beetles (live + dead) per plant on borders and main crop of plots with and without blue hubbard border, with and without sprays on the border. Main crops were unsprayed. Hubbard borders had significantly greater numbers of beetles than butternut borders or main crops. There was no significant difference between main crops.

It seems likely that even with the 50' space between plots, the blue hubbard drew beetles away from butternut plots. Overall, beetle numbers were low compared to the commercial farm fields.

After the 2003 growing season a number of our growers expressed an interest in using the systemic insecticide imidacloprid (Admire) as a border treatment instead of foliar sprays of Sevin. This made a lot of sense, because they could apply it in the same operation as planting –saving a trip to the field – and plants would be protected from emergence, reducing the chance that borders would be decimated and overrun because a spray was delayed. To that end, we modified our experiments in 2004 to include Admire treated blue hubbard borders in both the field trials and the small plot work. Some growers also wanted to know if there was anything other than blue hubbard that they could use as a trap crop – after all, how much hubbard do you need? So we set up variety trials at the research farm to test the relative attractiveness of other winter squash and pumpkins.

Commercial butternut fields, 2004

Our 2004 trials went remarkably well. Borders were planted just right, everything came up when it was supposed to, and even the beetles cooperated. The borders held up throughout the season in all of the PTC fields and none of the main crops required a spray. The Admire drench worked as well as Sevin sprays on the borders. One grower was able to spray the border of his 3-acre field with a single tankfull in his backpack sprayer – thus avoiding the need to drive a sprayer to the field. The number of beetles and the damage in all of the PTC main crops was equal to the damage and beetle numbers in the control fields (where growers used their standard practices) – even though the control fields were sprayed (some of them several times) and the PTC butternut was never sprayed. Not having to spray over 90% of your field obviously saves a great deal of time and money. The beetles, as expected, piled up in the blue hubbard – we found more beetles in the hubbard than we did in any of the butternut.

We also noticed that during the critical initial colonization of the field – in other words, when the beetles first find the field and begin to spread out through it – the relative distribution of the beetles was different in the PTC fields from the conventional fields. In the conventional fields the beetles spread out through the field almost immediately. Beetle numbers were the same in field edges as in the center. In the PTC fields, most of the beetles stayed in the borders – on the hubbard. This means that during the time when the plants are the most sensitive, at the young seedling stage, there were actually LESS beetles on the butternut protected by a PTC system than there were on the conventional butternut. After the conventional fields were sprayed, the beetle numbers between the PTC butternut and the regular butternut evened out, but that initial protection can be critical not only for direct damage but also for infection with wilt.

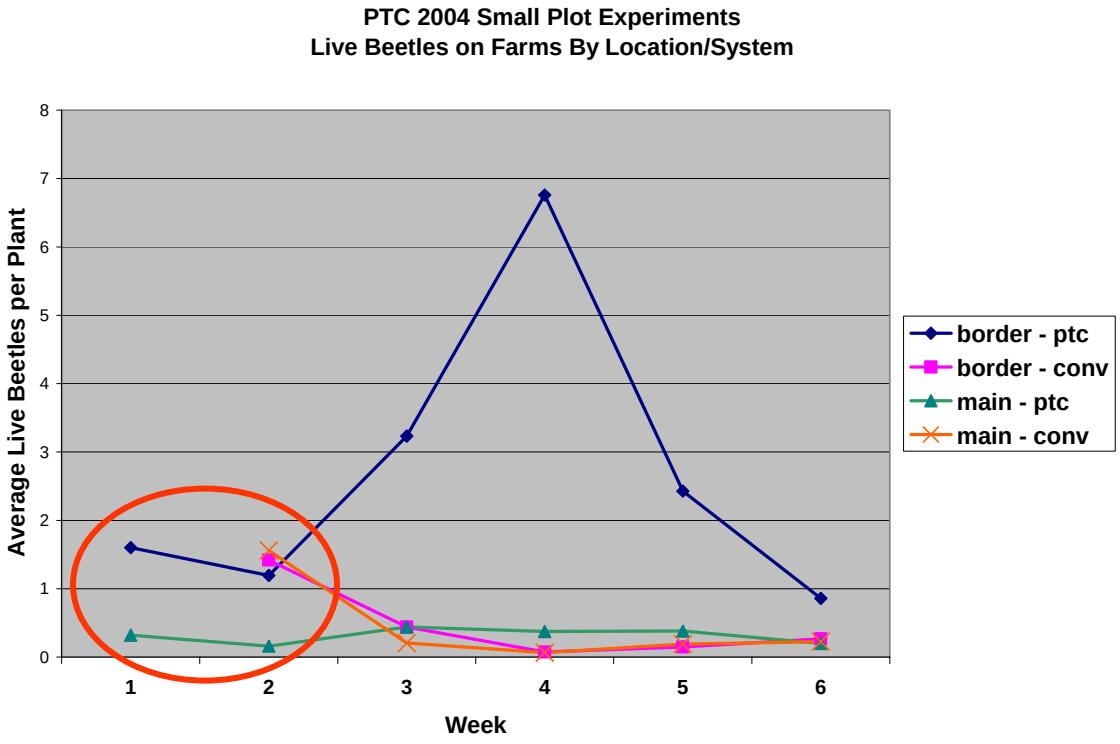

Figure 2

- Red Circle: initial colonization of the field by beetles.
- In the PTC fields, the pressure was initially much higher in the border than in the center.
- In the conventional fields, the pressure in the border and in the center was roughly equal.
- Beetle numbers were as low in the main crop of PTC as in conventional fields, even though no insecticides were applied to the main crop.

Research plots, 2004

The small plots were much the same as the previous year. There were more beetles in the hubbard than anywhere else and no differences between the main crops, regardless of whether or not the border was treated with Admire, sprayed with Sevin, or just left alone.

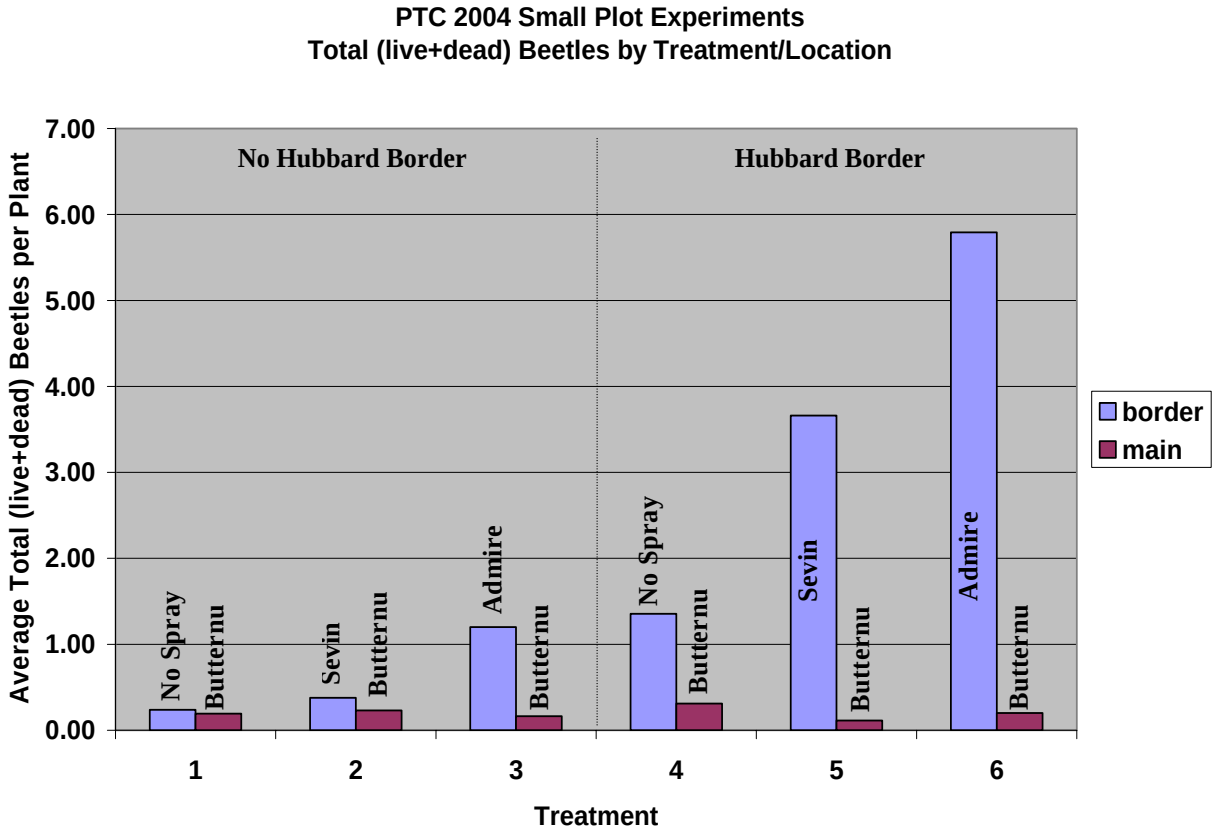

Figure 3 Results of 2004 PTC trials. Seasonal average of beetles (live + dead) per plant in borders and main crop of plots with and without blue hubbard border, with and without pesticide treatments on the border. Main crops were unsprayed. Hubbard borders had significantly greater numbers of beetles than butternut borders or main crops. There was no significant difference between main crops.

Again, this could be either because of a lack of beetles or because the hubbard drew them away from butternut plots.

Borders beyond hubbard?

We planted out two trials, each of them with eight different crops or cultivars, spanning three species of *Cucurbitacae.* The goal of these experiments was to evaluate some other potential trap crop/ main crop combinations. Trial one focused mostly on pumpkin types, and trial two focused mostly on winter squash types (Tables 1 and 2). Both trials included blue hubbard, as that has so far been our standard trap crop.

Variety Trial I: Pumpkins

Cultivar	Type	Species
Prizewinner	giant pumpkin	*Cucurbita maxima*
Valenciano	white pumpkin	*Cucurbita maxima*
Speckled Swan gourd	large gourd	*Lageneria siceraria*
Blue Hubbard	hubbard	*Cucurbita maxima*
Rocket	mid-sized pumpkin	*Cucurbita pepo*
Cinderella	specialty pumpkin	*Cucurbita maxima*
Big Max	giant pumpkin	*Cucurbita maxima*
Magic Lantern	mid to large sized pumpkin	*Cucurbita pepo*

Table 1

Variety Trial II: Winter Squash

Variety	Type	Species
Red Kuri	hubbard	*Cucurbita maxima*
Blue Hubbard	hubbard	*Cucurbita maxima*
Ambercup	buttercup	*Cucurbita maxima*
Waltham Butternut	butternut	*Cucurbita moschata*
Table Ace	acorn	*Cucurbita pepo*
Delicata	delicata	*Cucurbita pepo*
Calabaza	Latino pumpkin	*Cucurbita moschata*
Gourd	standard gourd	*Cucurbita pepo*

Table 2

In both trials, the *Cucurbita maxima* species had the most beetles and the worst defoliation, significantly more than either *C. pepo* or *C. moshchata*. There was some variation in terms of beetle counts within the *maxima* species – Red Kuri being the highest and Blue Hubbard being the lowest – but overall the beetles liked the C. *maxima species* much better than any of the species. None of the *maxima* cultivars we looked at were any more or less susceptible to wilt than blue hubbard, which is good because you don't want to plant a disease reservoir around your main crop. This means that any of the varieties of *Cucurbita maxima* that we tested – Prizewinner, Big Max, Valenciano, Cinderella pumpkins, Blue Hubbard, Red Kuri, or Ambercup winter squash - could be used as trap crops around any of the other varieties we tested. It should also be possible to use a mixed planting of different *maxima* cultivars around a planting of one or more of the other species.

Other crops in commercial fields

In addition to these formal experiments, we had one grower who used PTC around his pumpkins, with Prizewinner as the trap crop in 2003 and blue hubbard in 2004. Both worked equally well, but he found the hubbard easier to sell at his farmstand.

In 2004 a cucumber grower came to us with the following problem: His cucumber plantings were large and his fields were far apart, so getting them sprayed at the right time was expensive and difficult. Using Admire at planting would be simpler, but his cucumbers were so closely spaced (30 inches between rows) that the cost was prohibitive. We suggested that he try using a blue hubbard PTC system with admire treated borders, so he would only have to treat a small portion of his field. Beetle pressure was relatively low in his field and they piled up in the hubbard and were killed there. He plans to expand his use of PTC to more fields in 2005.

One organic farmer also tested the blue hubbard/butternut PTC system, without using any border sprays. In 2003, beetles were concentrated in the border, and populations were low enough that this provided sufficient control. In 2004, he used a reverse leaf blower to suction beetles off the trap crop on a weekly basis. This also provided satisfactory control.

What do the growers say?

We surveyed our MA growers, along with some folks in CT who had been using the Blue Hubbard/ butternut PTC system and this is what they had to say:

- 100% of surveyed growers found the PTC system and training to be good or excellent overall.
- Eight out of ten said that using PTC saved them money. The other two said it cost about the same.
- Eight out of the ten growers we surveyed were very satisfied or thrilled with the way PTC worked for them. The remaining two growers were satisfied and would continue using PTC.
- 100% said using PTC took less or the same amount of time as using conventional methods.
- 100% said they used less pesticide.

- Seven growers said that using PTC was simpler or much simpler than conventional pest control strategies. One thought it was about even. The other two found it a little more complex.
- Nine out of ten growers said they will certainly use PTC again. The tenth grower said that he probably would as well.

If you would like to try PTC in 2005….

In the 2005 growing season, we will continue to advise and train growers who want to use PTC systems as part of their pest management strategy. The PTC system also works in other crops, including brassicas, peppers and eggplant, as well as in other cucurbits such as summer squash and cantaloupe. If anyone would like more information about what PTC can do for them please contact Andy Cavanagh at (413) 577-3976 email: acavanagh@psis.umass.edu; or Ruth Hazzard at (413) 545-3696.