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Demonstrating a Perimeter Trap Crop Approach to Pest Management on Summer Squash in New England

Abstract
Perimeter trap cropping (PTC) involves using a trap crop, and possibly other border defenses, to encircle and protect the main cash crop like fortress walls. Six growers in Connecticut used PTC to protect commercial summer squash plantings from cucumber beetles and bacterial wilt damage. Grower surveys were used to compare PTC program results to the conventional "multiple-full-field-spray" system formerly used on the farms. Most growers using PTC stated that this system improved and simplified pest control, reduced pesticide use (93%) and crop loss, and saved them time and money compared to their conventional program.

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Introduction

Many insects colonize crops from outside the field and exhibit preferences among varieties that can be exploited to arrest pest migration on a trap crop that completely encircles the main cash crop. The effectiveness of this trap crop spatial orientation can be further improved by adding other perimeter defenses, such as border sprays or biological, mechanical, and cultural controls to form a pest management system known as "perimeter trap cropping" (PTC). Perimeter trap cropping has led to a dramatic increase in trap crop efficacy over the past decade on a variety of pests and crops (Aluja et al., 1997; Boucher Ashley, Durgy, Sciabarrasi, & Calderwood, 2003; Brewer & Schmidt, 1995; Mitchell, Hu, & Johanowicz, 2000).

Perimeter trap cropping functions by intercepting pest migration, regardless of the direction of attack. It then concentrates the pest population(s) in the border area, where they can be controlled, thus preserving natural enemies in the main crop (Aluja et al., 1997; Boucher et al., 2003; Mitchell et al., 2000). Because many insect pests act as vectors of important crop diseases, reducing pest populations on the main crop may also reduce losses from diseases.

Perimeter trap cropping does not work on every pest or for every crop. However, it has the potential to improve and simplify pest management on a variety of crops grown on diversified vegetable farms. This article reflects the experiences of a group of commercial growers using PTC to manage cucumber beetles and bacterial wilt on summer squash in Connecticut.

Field Demonstrations

In 2002, four Connecticut growers surrounded a total of 6.5 acres of green and yellow summer squash with a "Blue Hubbard" trap crop, supplemented with border sprays. In 2003, six growers used the summer squash PTC system on a total of 17.25 acres. Because four of the growers participated in both years, and methods and survey results were nearly identical, only the results of the second year (2003) are presented. The six growers who volunteered for the program

represented a range of farms, from small retail operations to larger wholesale operations with up to 600 acres of vegetable crops.

Perimeter trap crop plantings ranged from 1/4 to 5 acres in size. All growers used a single row of trap crop along the length of the summer squash plantings, except for one who used a double-row along the woodland side of the field, where the heaviest pest pressure was expected. One to three Blue Hubbard plants were planted at both ends of each summer squash row, or the trap crop was seeded by machine across the ends of the rows, perpendicular to the main crop planting direction. The trap crop was planted at the same in- and between-row spacing as the main crop.

One grower used bare-ground culture to produce his squash, while the others used a plastic-mulched system of production, with either trickle or overhead irrigation. Two growers used transplants for both the main and trap crop, while most direct seeded the whole field. Two growers planted their summer squash on plastic and the Blue Hubbard on bare-ground beside the mulched area. One grower, who was not interested in marketing Blue Hubbard squash, pulled the trap crop plants when the main crop was in bloom to avoid interspecies competition.

This PTC system has the potential to reduce several insect and disease problems associated with squash, but was primarily designed to minimize direct damage from the striped cucumber beetle and from the bacterial wilt pathogen vectored by the beetle. Blue Hubbard squash was used as the trap crop in the system because it is highly attractive to cucumber beetles, squash vine borers, and squash bugs, but tends to experience a relatively low incidence of bacterial wilt infection compared with other potential trap crops tested (Boucher & Durgy, unpublished data). It is important that the trap crop does not act as a reservoir for bacterial wilt to help minimize disease spread and crop damage.

Prior to each season, Extension personnel met with growers and supplied them with trap crop seed, fact sheets on PTC, and advice to help them implement and maintain the system on their farms. Certain important concepts were emphasized with the growers prior to the start of the program:

1. Plant the trap crop on good ground, so that it remains healthy and completely encircles the main crop, without large gaps in the perimeter.

2. Apply a foliar insecticide application to the perimeter as soon as beetles are found or feeding begins on the trap crop. (Don't wait for a threshold level to be exceeded.)

3. Monitor the field continuously until harvest, and be prepared to make one or two additional perimeter or full-field applications, if necessary.

Repeat perimeter applications were considered justified if rain washed the insecticide from the plants prematurely or if any more live beetles were found in the trap crop prior to bloom. Full-field sprays were not to be applied unless pest pressure was excessive on a particular farm, causing a breach in the perimeter and substantial main crop infestation (>2 beetles/plant). Extension personnel helped growers monitor pest populations and time perimeter pesticide applications up until bloom. Most growers used backpack or boom sprayers to apply carbaryl, or one of several synthetic pyrethroids, to the trap crop row(s) only. One grower used his boom sprayer to apply perimeter sprays to the outer 25 feet of the block.

After the final harvest, growers were surveyed and asked to compare the results of using the summer squash PTC system to prior years using a conventional program that relied on full-field insecticide sprays. Growers provided the number of full-field or perimeter insecticide applications used based on their spray records or by estimation. This data was used to calculate the difference in insecticide use between the two systems. Growers were also asked to comment on PTC and to rate a list of possible benefits on a scale of zero (no benefit) to three (high benefit). They were also asked to rate the PTC program for simplicity/complexity, describe their overall satisfaction level with the system, and rate the training program overall.

Although grower surveys that compare pre- and post-program results represent an imperfect research tool that may rely on farm records and memories rather than objective observations, farmers' opinions may be among the best indicators of user satisfaction and whether new techniques may actually be adopted by industry.

Results of PTC User Surveys

All six (100%) of the growers stated that their pest control was much better using PTC than in previous years without a trap crop system. When asked "what percent of your crop was damaged by target pest(s) prior to using...and after using a trap crop," growers estimated that an average of 19% of their squash was damaged by the target pests using multiple full-field sprays, while only 1% was lost using PTC.

All respondents reported pesticide savings using the trap crop system. They applied an average of 1.9 insecticide sprays to the trap crop (only) using PTC, compared with 2.2 full-field sprays using their conventional program. The use of insecticide active ingredient was reduced by 1.6 pounds per acre (93%) using PTC. Potential insecticide savings are greater for larger plantings using PTC,

because the edge-to-area ratio decreases as field size increases. Square plantings have a shorter perimeter than long rectangular plantings of similar size (area). Square plantings also result in greater insecticide savings than long, narrow blocks or fields.

Eighty-three percent of the growers stated that they saved time and money using the PTC system compared to previous years. One of the producers said that PTC cost him about the same amount of money and took approximately the same amount of time as multiple full-field sprays. The five growers who said that PTC saved them money estimated their overall savings at $51 to $1,100 per acre. They attributed most of the savings to improved summer squash yield. The single grower who did not save money said that he tends to plant more squash than he needs, so the system did not result in increased sales. He stated that crop damage due to cucumber beetles and bacterial wilt was normally about 10%, but was eliminated using PTC.

Eighty-three percent of the growers rated the PTC system as simpler or much simpler to use than their traditional pest control program on squash, while one grower said that using a trap crop was a little more complex. All growers gave the following PTC benefits the highest possible rating (3): reduced spray time/expense, reduced risk from pest damage/improved crop quality, and easier/faster pest detection (improved monitoring) (Table 1). A majority of the program participants also gave the highest possible rating to these additional benefits: reduced pesticide use, easier harvesting schedules [reduced re-entry intervals (REI)/day-to-harvest restrictions (dh)], reduced potential for residues at harvest, reduced impact on the environment/land/water, and improved crop farm profitability (Table 1).

Table 1.
Grower Ratings for Possible PTC Benefits

Possible Benefit of Using PTC	Average Rating from 6 Growers*
Reduced pesticide use	2.83
Reduced use of harsh pesticides	2.83
Reduced spray time/expense	3.00
Easier picking/harvesting schedules (reduced REI/dh)	3.00 (2 N/A)
Reduced personal/personnel exposure to hazards	2.17
Reduced potential for chemical residues at harvest	2.67
Reduced risk from secondary pest outbreaks	2.33
Reduced risk from pest damage/improved crop quality	3.00
Reduced impact on the environment/land/water	2.67
Reduced liability exposure	2.17
Improved crop/farm profitability	2.75
Improved public perception/reduced condemnation	2.25 (2 N/A)

Easier/faster pest detection (improved monitoring)	3.00
*Rating: 0 = no benefit, 1 = low, 2 = medium, 3 = high, N/A = not applicable	

All program participants said that they were either very satisfied (67%) or thrilled (33%) with the overall performance of the trap crop system, and all final comments about PTC were positive. All growers rated the training program as excellent and stated that they would continue using the summer squash PTC system in the future.

Summary

Many integrated pest management (IPM) programs are too complex or time-intensive for busy producers to use and often require an entire book or manual to explain (Boucher & Ashley, 2001). Simpler pest management solutions capable of controlling multiple pests, reducing pesticide use, increasing farm profitability, and increasing IPM implementation are needed. Perimeter trap cropping represents a first step towards restructuring and simplifying the pest management system.

Connecticut growers who used PTC to protect commercial summer squash plantings found that the system succeeded in improving and simplifying pest management while providing numerous "hidden" benefits. These growers reduced insecticide use by 93% by switching to a perimeter trap crop, supplemented with border sprays. This technology is inexpensive, accessible, and applicable to farm operations of variable size on multiple crops.

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