Squash Bug and Squash Vine Borer: Organic Controls

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Squash bug and squash vine borer are major pests among cucurbits. This publication addresses organic control methods for these pests. The life cycles and characteristics of each pest are presented. Various levels and types of organically sanctioned controls are discussed. Row covers, cultural methods, and physical practices are also covered. Experimental controls, biological controls, and alternative insecticides are also discussed and a case study is presented. A list of references follows the narrative.

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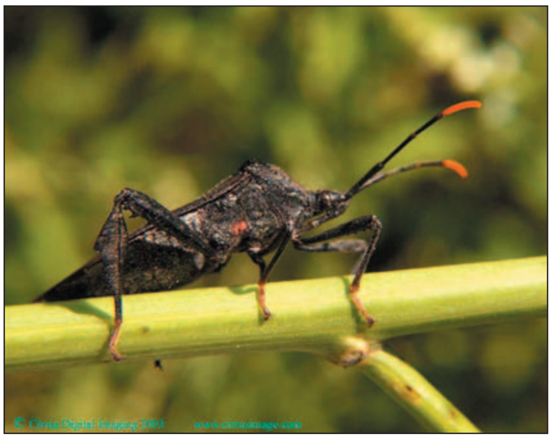

Squash bug.
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Squash vine borer.
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Introduction

Squash bug and squash vine borer are among a trio of serious cucurbit pests. Striped cucumber beetle is another. For control measures for striped cucumber beetle on squashes in organic production, see the ATTRA publication *Cucumber Beetles: Organic and Biorational IPM.*

Squash bug (*Anasa tristis* Hemiptera: Coreidae) is the most serious pest of squash and pumpkins in the U.S. and is a potential problem for all cucurbits. Squash bugs (found only in the Western Hemisphere) range widely from the east to west coasts and north to south from Canada to South America. (1) Adults and nymphs of squash bugs damage plants by sucking plant juices from the leaves. Further, they inject a toxin that causes the plants to wilt, blacken, and die back. Certain species and varieties of pumpkins, watermelons, and squash are more susceptible than others. Plants are most susceptible to damage when they are small.

Squash vine borer (*Melittia satyriniformis* Lepidoptera: Ageiriidae) is a pest in the eastern half of the United States. Squash vine borer is native to a large area from east of the Rocky Mountains to the Atlantic Coast and from Canada to South America. (2) In the U.S. it can cause significant crop losses east of a line that roughly parallels Interstate 35. (3) The larvae of squash vine borer damage plants by destroying tissue in the stem and causing anything beyond that point to die—either the whole plant or a runner.

Some of the same controls have recently been found to work well for both pests in commercial-scale organic production, even though the two pests come from different orders/families of insects, and their different developmental stages do damage to different parts of the squash plants. (4, 5) Preventive management practices consist of destroying crop residues and debris that provide shelter for overwintering adults and excluding entry using a row covering strategy between the time of planting and flowering.

Life Cycle and Characteristics: Squash Bug

Adult squash bugs pass the winter under whatever shelter is available—including leaves, boards, stones, and other debris. The adult bugs re-emerge as soon as the weather warms, and mate soon thereafter. Squash bugs lay eggs in masses of a dozen or more on the underside of leaves, usually in the vein axils. Eggs hatch in 10 to 14 days. The nymphs pass through five instars over a period of four to six weeks to reach maturity. Since the overwintering adults lay eggs well into midsummer, all stages of the pest's lifecycle can be observed in the field throughout most of the season. (6) Two generations may occur in the South.

Squash bug adults are easy to identify. They are approximately 5/8-inch long, dark brown or mottled, and hard-shelled. Being true bugs, they have a long, shield-like shape and membranous-looking wing tips. They give off a disagreeable odor in large numbers or when crushed. Nymphs are delicate, with bright orangish-red heads, legs, and antennae; the abdomen is green. As the nymphs age, they become grayish-white with dark legs. (6) They range in size from 1/10 to 2/5 of an inch.

Squash bug eggs are easy to identify. The orange-yellow eggs are each about 1/16-inch in length. Eggs appear in neatly ordered rows on the underside of host-plant leaves. They gradually change to a bronze color as hatch nears. (1)

Life Cycle and Characteristics: Squash Vine Borer

Squash vine borers overwinter as larvae or pupae in the soil. Adult moths emerge in the spring and deposit eggs on a host plant. Disk-shaped, dark-reddish-brown eggs are laid singly on the plant near the base. (7) After hatching, the larvae penetrate the plant stem and burrow toward the base. An individual adult can lay from 150 to 250 eggs, and (theoretically at least) as few as 10 moths can cause 100 percent infestation on a single acre of squash-family plants. (8) Occasionally, small borers may also enter leaf stems. The burrowing larvae destroy the internal vascular tissue and cause the whole plant or the invaded runner to wilt and die. Feeding may continue for four to six weeks. A sticky gob of excrement (*frass*)—which resembles wet sawdust—typically marks the entrance site. (9, 10) If a vine dies before the borer has completed its larval cycle, the larva can migrate to a neighboring plant and resume feeding there. (8)

The squash vine borer larvae are whitish, wrinkled, brown-headed worms that can grow to about 1 inch in length. The adult moth, a member of the clear-winged moth family, has translucent wings (wing expanse of about 1.5 inches) with metallic green-black and orange colors on the body and wing fringes. The moth is a day flier, often mistaken for a wasp.

Generally, only one generation per year is produced in northern states, two generations in many southern states.

Planning for Control

Planning for control of squash bug in organic production must begin before a single seed or seedling is planted. Recent research has identified squash bug as a vector for the newly named Cucurbit Yellow Vine Disease (CYVD). Once squash plants start to yellow from infection with this virus, there is very little that can be done. The viral disease, which shows up soon after transplanting, has been reported in Kentucky, Oklahoma, and Texas, and is

Related ATTRA Publications

Organic Pumpkin and Winter Squash Production

Farmscaping to Enhance Biological Control

Season Extension Techniques for Market Gardeners [hoophouses and row covers]

NCAT's Organic Crops Workbook

Cucumber Beetles: Organic and Biorational IPM

Overview of Cover Crops and Green Manures suspected in Ohio. The organism has been identified as *Serratia marcescens*. (11)

Planning for squash vine borer control is likewise very important, since a very small population of borers can be highly destructive. Feeding within the plant stem, a single borer can kill a whole plant or a large runner vine.

Levels of Control in Certified Organic Production

The National Organic Program, administered by the U.S. Department of Agriculture (USDA), has set standards for pest management. The Crop Pest, Weed, and Disease Management Practice Standard (Section 205.206) requires that producers use a three-level hierarchical approach in deciding how to deal with pest management problems.

Management levels 1, 2, and 3 in the following discussion describe three tiers of pest management. See also the interpretation of the National Organic Standards found in *NCAT's Organic Crops Workbook: A Guide to Sustainable and Allowed Practices*, p. 22.

Systems-based practices (level 1)

Cultural practices such as timing of plantings, choice of cultivars, and field sanitation practices are examples of first-line, systemic strategies for pest management. Mulches are known to harbor squash bugs. Helpful sanitation measures include removal of plant debris, soil incorporation of cucurbit crop residue, and removal of old boards and other overwintering sites. These practices can prevent squash bug infestations.

Field sanitation techniques have both positive and negative consequences in organic production. Some types of mulches used for weed control appear to attract more squash bugs than other types of mulches. (12) Removal of plant residues can be contrary to good organic practice, unless a winter cover crop replaces the organic matter.

Annual rotation to non-curcubit crops is a primary step toward cultural control of squash vine borer and the squash bug. However, producers should be aware that the squash vine borer adults are strong fliers and have been known to find squash fields as far as one-half mile from their emergence site in another field. (8)

Field sanitation procedures are recommended as a measure of control of the squash vine borer, as well. Vine residues should be destroyed as soon as possible after harvest to prevent late larvae from completing their lifecycle. (9, 10) Fall tillage exposes cocoons (pupae) to predation and deep incorporation in early spring further helps to keep populations suppressed. (10) On the other hand, fall sanitation procedures that leave the ground bare for extended periods are contrary to good organic agriculture practice. Consider planting cover crops or other measures that minimize the risks of erosion or compaction of bare soil.

A very small population of squash vine borers can be highly destructive.

Mechanical and physical practices (level 2)

After cultural practices, mechanical and physical practices provide a second line of defense against pests. Such practices include the use of barriers and nonsynthetic lures, traps, and repellents such as kaolin clay products. Level 2 practices also include developing habitat for beneficial predators and parasites.

Iowa State University Organics Research Program conducted trials of various control methods for squash bug and squash vine borer. Researchers found that mulching with newspaper and hay, combined with tightly secured row covers on the plots (a level 2 control), provided very effective control of both weeds and squash bugs in pumpkin (*C. pepo*)—especially in the wet season of 2002. (4, 5) The row covers apparently excluded squash bugs, preventing them from entering to lay eggs.

Gauze row covers (e.g., Reemay™, Agriforce™, Agribon™, Tufbell™) [Section 205.206(b)(1),(2),(3)] physically exclude pests and prevent them from reaching the plants in large numbers. Preventive strategies have become more important with recognition of *A. tristis* as a probable disease vector.

Hand picking and trapping of *A. tristis*, or slitting each vine to remove the larva, in the case of *M. satyriniformis*, represent attempts to control pests after they have begun rearing another generation in numbers sufficient to cause economic damage and pest build-up. Such labor-intensive controls may be uneconomical for large plantings.

Material (level 3)

Level 3 strategies include the wider use of biologicals and botanicals to control pests. Organic producers also have the option to use materials included on the National List under Section 205.206(e)—"Synthetic substances allowed for use in organic crop production."

Some products acceptable in organic vegetable production that are effective against squash bugs include diatomaceous earth, sabodilla, and neem oil. Growers that anticipate using materials to control heavy pest infestations must list these materials and the circumstances for their use in their organic systems plan. This plan must be submitted to and approved by the organic certifier before the producer uses any material.

Botanicals and biorationals are discussed below in **Alternative Insecticides**. Organic advisors strongly encourage early cultural and other controls, rather than relying on product applications after populations have been allowed to reach economic threshold levels. *www.ipm.ucdavis.edu/PMG/r116301111.html* According to Cornell University Extension, "application of

National Organic Standards Rule

Section 205.206 Crop pest, weed, and disease management practice standard.

a. The producer must use management practices to prevent crop pests, weeds, and diseases including but not limited to:
    1. Crop rotation and soil and crop nutrient management practices, as provided for in sections 205.203 and 205.205;
    2. Sanitation measures to remove disease vectors, weed seeds, and habitat for pest organisms; and
    3. Cultural practices that enhance crop health, including selection of plant species and varieties with regard to suitability to site-specific conditions and resistance to prevalent pests, weeds, and diseases.
b. Pest problems may be controlled through mechanical or physical methods including but not limited to:
    1. Augmentation or introduction of predators or parasites of the pest species;
    2. Development of habitat for natural enemies of pests;
    3. Nonsynthetic controls such as lures, traps, and repellents.
c. Weed problems may be controlled through:
    1. Mulching with fully biodegradable materials;
    2. Mowing;
    3. Livestock grazing;
    4. Hand weeding and mechanical cultivation;
    5. Flame, heat, or electrical means; or
    6. Plastic or other synthetic mulches: **Provided**, That, they are removed from the field at the end of the growing or harvest season.
d. Disease problems may be controlled through:
    1. Management practices which suppress the spread of disease organisms; or
    2. Application of nonsynthetic biological, botanical, or mineral inputs.
e. When the practices provided for in paragraphs (a) through (d) of this section are insufficient to prevent or control crop pests, weeds, and diseases, a biological or botanical substance or a substance included on the National List of synthetic substances allowed for use in organic crop production may be applied to prevent, suppress, or control pests, weeds, or diseases: **Provided**, That the conditions for using the substance are documented in the organic system plan.

approved products is not currently a viable management option" for squash vine borer. *www.nysaes.cornell.edu/pp/resourceguide*

Iowa State Organic Research (Gerber trials)

In 2002 Kathleen Delate, Organic Crops Specialist at Iowa State University, began comparative field trials on methods of insect control in organic production of winter squash, four zucchinis (representing summer squash, usually sold as fresh produce, rather than processed), and pumpkins. This first trial included specific squash and pumpkin cultivars—many of them bush, rather than vining types. It is unclear why the specific cultivars listed in the Abbe Farm profiles (below) were selected for the initial trial; according to Ashworth, the named cultivars represent three distinct squash species—*C. moschata*, *C. maxima*, and *C. pepo*. Production was destined for the organic baby food market. With two cooperating farmers, Delate established sites to evaluate how three methods of pest management affected plant health and crop yields. Subsequent trials in 2002 and 2003 narrowed the cultivar range to *C. moschata* varieties for which squash bug and squash vine borer show inverse preferences.

In the first year, the three methods consisted of:

- A kaolin clay product applied bi-weekly from plant emergence until a month before harvest
- Interplanting of buckwheat to supply food for a fly parasite (tachnid fly) of the squash bug, and
- Reemay™ row cover, a gauze-like fabric used to prevent colonization by the pests.

After the second year, project results indicate a slight preference for row covers as the most effective method to control both squash bug and squash vine borer. Varieties of *C. moschata* were the only cultivars trialed after the first year. (4)

Row Covers

A two-year organic squash and pumpkin variety trial from West Virginia found benefits for row covers comparable to the Iowa State work. (13) Row covers must be tightly secured to be effective in excluding insects. Especially in areas with high winds, row covers have to be securely anchored to the ground. Row covers are removed just before female blossoms appear, to facilitate pollination. For more information on use of row covers, see ATTRA's *Season Extension Techniques for Market Gardeners*.

Host Preference and Genetic Resistance

It is important to use scientific nomenclature when discussing cucurbit crops, in order to identify species and subspecies correctly. The terms *squash* and *pumpkin* are used in the produce industry and among home gardeners to refer to a confusing variety of cucurbits. Scientifically, there are either five or six recognized species: *C. pepo*, *C. moschata*, *C. mixta*, *C. maxima* (the four types commonly found in U.S. markets)—plus *C. ficifolia* (known as chilacayote in Mexico and commonly used in candies) and *C. foetidissima* (the foul-smelling wild "Buffalo Gourd," sometimes employed as a source of seeds pressed for oil). These species were established and defined by the fact that members do not cross when planted near each other. However, evidence

Row covers must be tightly secured to be effective in excluding insects.

Regionality

The results of the Iowa and West Virginia pest management trials are preliminary and regional. For instance, squash vine borer is not a significant problem in the West (west of Interstate 35). In general, organic growers need to be guided primarily by research done in their own regions. The University of California IPM Web site, however, presents very similar recommendations to what these research studies suggest: field sanitation and crop rotation to break pest cycles in the field, and use of row covers to prevent infestation from nearby pest hatching sites. *www.ipm.ucdavis.edu/PMG/r116301111.html* Research remains to be done—region by region and under weather conditions that may differ markedly from year to year—on the best organic methods to control insect pests on all varieties and market types of *Cucurbita*.

suggests that *C. mixta* may cross with *C. moschata* under certain conditions. (14)

C. pepo includes all the "summer squash"—i.e., preferred culinary use is before maturity—most "pumpkins," and hard-shell keepers like acorn, as well as novelties such as spaghetti squash. However, "Cushaw pumpkins" are *C. moschata*, and some "white pumpkins" are *C. maxima*. Sometimes giant orange varieties, such as *C. maxima*, are marketed as pumpkins.

A 1990 study at Oklahoma State University of ovipositional preference by squash bugs found a decided preference for yellow straightneck and crookneck (*C. pepo*), as compared with zucchini, acorn, spaghetti (all *C. pepo*), and butternut (*C. moschata*). (15) Other studies have found a squash bug preference for *C. maxima* and *C. mixta* over some types of *C. pepo*. Acorn squash and all the *C. moschatas* are quite tolerant of squash bug damage. (16, 17) Cocozelle (*C. pepo*) has been identified as an extremely susceptible sub-type of zucchini. A research study in Texas found *C. foetidissima* extremely distasteful to squash bugs, as well as to humans. (18)

The bottom line is that any organic grower who wishes to raise squashes and pumpkins must grow varieties preferred by the customers, and cannot rely on "host preference and genetic resistance" to deter squash bugs.

The University of Illinois rated the susceptibility of twelve varieties (types) of squash on degree of resistance to squash vine borer attack. The list corresponds almost exactly to the four sub-types of squashes cultivated in the U.S. A rating of 1 indicates most resistant to vine borer; a rating of 5, least resistant. (19)

Pumpkin.

Also, see the ATTRA publication *Organic Pumpkin and Winter Squash Production.*

Investigation into host preferences of squash bug and squash vine borer and inferred genetic resistance, while not an objective of the Iowa State trials, has been carried on elsewhere and could account for some of the Iowa State results as a "missing variable." Feeding preferences have been studied primarily in the context of cultural management of cucumber beetle through the use of trap crops. (20, 21) (See the ATTRA publication *Cucumber Beetles: Organic and Biorational IPM.*)

Cultivar Preference of Squash Vine Borer

Variety or Type	Rating	Scientific name
Blue Hubbard (Hubbard type)	5	*C. maxima*
Boston Marrow (Hubbard type)	4	*C. maxima*
Golden Delicious (Hubbard type)	4	*C. maxima*
Connecticut Field pumpkin (ornam.)	4	*C. pepo*
Small Sugar pumpkin (ornamental)	4	*C. pepo*
Zucchini	4	*C. pepo*
White Bush Scallop	3	*C. pepo*
Acorn	3	*C. pepo*
Summer crookneck	2	*C. pepo*
Dickenson pumpkin	2	*C. moschata*
Green striped cushaw	1	*C. mixta*
Butternut	1	*C. moschata*

When applied to squash bug and squash vine borer control, research on feeding preferences does not address market preferences. The bottom line is that any organic grower who wishes to raise squashes and pumpkins must grow varieties preferred by the customers, and cannot rely on "host preference and genetic resistance" to deter squash bugs. Squash bug control in pumpkins cannot be achieved by simply substituting 'Cushaw' for the jack-o-lantern, nor can patty pan be considered a substitute for the 'Prolific straightneck' or the highly desirable fresh market 'Cocozelle.' (16) A winter squash producer having a

Farm Profile: Abbe Hills Farm, Mt. Vernon, Iowa

Abbe Hills Farm, managed by ISU farmer cooperator Laura Krause, was one of two farms participating in a two-year trial of pest control methods in certified organic squash production intended for Gerber Products, Inc. The project evaluated methods of pest management in terms of pest suppression and crop yields, in addition to the productivity (plant performance and health) of organically raised squash. Other heirloom vegetables were raised as part of the trial, as well, and processed at the Iowa State University Food Science Department according to Gerber specifications for baby food.

Heirloom squashes raised in 2001 in the trial plots at Abbe Hills included the following. No other cucurbits were grown.

Winter squash		
Table Queen	(*C. pepo*)	
Early Butternut	(*C. moschata*)	hybrid
Burgess Buttercup	(*C. maxima*)	
Heart of Gold	(*C. pepo*) [sweet dumpling acorn type]	hybrid
Sweet Dumpling	(*C. pepo*) [sweet dumpling acorn type]	
Cream of the Crop (semi-bush)	(*C. pepo*)	hybrid
Table Ace (semi-bush)	(*C. pepo*)	hybrid
Summer squash		
Zucchinis Costata Romanesco, Nimba, Aristocrat (hybrid), Cocozelle (hybrid), Black	(*C. pepo*)	
Pumpkins		
Ghost Rider	(*C. pepo*)	
Howden	(*C. pepo*)	
Orange Smoothie	(*C. pepo*)	hybrid
Racer	(*C. pepo*)	hybrid

Findings reported after two years clearly showed row covers to be a superior method of pest management, based on yields, plant health, and absence of squash bugs in all stages of development.

problem with vine borers will undoubtedly find it easier and more cost-effective to take different measures to control the pest than to convince the marketplace to accept butternut as a substitute for 'Giant Blue Hubbard.'

Other Cultural and Physical Controls

Research can be useful to show what is not effective, as well as what does work. A 2005 Cornell University guide for organic insect and disease management comments on "possible organic controls that lack efficacy." (22) Some are discussed below.

Delayed planting has sometimes been suggested as a means to control both squash bug and squash vine borer. Conditions for success seem to limit its use rather narrowly.

- A moderately long growing season
- No neighbors growing any of the cucurbits

Delayed planting has sometimes been suggested as a means to control both squash bug and squash vine borer.

- No wild cucurbits to serve as hosts

A method in use to control squash vine borer is syringe injection of the bacterial insecticide Bt (*Bacillus thuringiensis*) into each vine by hand. In home gardens or small market gardens, growers often try to control squash bugs by hand picking or placing wooden boards near the plants, where squash bugs will congregate for hand collection and disposal. For squash vine borer, small growers are advised to slit each vine showing frass (the insect excrement) and extract the larva before the vine is irreparably damaged. Such methods are not suitable for commercial production of three or four acres because of the hand labor involved.

Among the successful strategies to suppress squash bugs on a larger scale are field sanitation techniques.

Experimental, creative approaches

Eero Ruuttila, an organic farmer from New Hampshire, has observed that squash bug oviposition on vines tends to take place disproportionately on the growing ends of mid-season offshoots. He harvests one-third of the young vines in July and August, before the eggs hatch, and sells the harvested offshoots in ethnic markets. (23) Harvesting a marketable alternative crop for a specialty market is a creative way to avoid—rather than solve—pest problems.

An experimental technique for squash bug control is companion planting with repellant plants—catnip, tansy, (16) radishes, nasturtiums, or marigolds, (6) beebalm, (24) or mints. (25) For more information on such strategies, ask for ATTRA's *Companion Planting* publication.

Marigold.

Recommended strategies

Among the successful strategies to suppress squash bugs on a larger scale are field sanitation techniques. The use of postharvest tillage—routinely recommended to destroy overwintering sites and to bury the adults—has worked well to control both squash bug and squash vine borer.

Sanitation procedures that remove crop residues by burning or high-temperature composting are also successful. (1, 11, 15) It is helpful to clear adjacent areas of litter, leaf piles, and (especially) cucurbitaceous weeds, as well. Burning crop residues is permitted as an exception to Organic Standard Section 205.203c(3) for the express purpose of disease suppression. High-temperature composting would be preferable. These strategies, when approved by a certifying agent, should be viewed as stopgap measures and not be employed as part of a long-term crop management plan.

Fall tillage and cover cropping is the norm in organic squash production. Research from Oklahoma State found that plastic mulch provided squash bugs with more shelter from sprayed insecticides than did other types of mulch. (20) Mulch used in the Iowa State study (first year) consisted of newspaper and hay, which provided good weed control. (4)

National Organic Standards Rule

Section 205.203 Soil fertility and crop nutrient management practice standard.

e. The producer must not use (3) burning as a means of disposal for crop residues produced on the operation: Except, that burning may be used to suppress the spread of disease or to stimulate seed germination.

Crop rotation is a recommended production practice that reduces squash pests within a field. Rotation can contribute to pest suppression by delaying population build-up early in the season. Rotation does not, however, provide complete, reliable control of either pest because adults can move easily between fields. Sustaining vigorous plant growth is a very important part of a borer control strategy. Supplemental fertilization may be necessary to promote the vigorously growing plants that can tolerate one or two borers and still produce a crop through additional rooting along the stem. (10)

Biological Control

Biological control was part of the Iowa State Study. Buckwheat was interplanted to attract the tachinid fly parasitoid, *Trichopoda pennipes*, of *A. tristis*. *T. pennipes* deposits its eggs on large nymph and adult squash bugs. After hatching, tachinid fly larvae feed on the squash bug, eventually killing it. Unfortunately, the victim may continue to feed and lay eggs for a while after it has been parasitized. Therefore, even parasitism levels as high as 80 percent may not prevent measurable economic damage. (26) The Iowa State study found that planting a buckwheat intercrop to enhance tachinid fly parasitism consistently outperformed applications of kaolin clay in reducing squash bug infestations. However, squash yields in the buckwheat intercrop plots were reduced by a factor of at least six at Abbe Hills Farm and a factor of three at Pratt Farm, when compared with the row-cover trial plots.

***Tachinid fly** (Trichopoda pennipes).*

The "Results and Discussion" section of the report noted: "The number of squash per plot and yields were significantly less in the squash plots intercropped with buckwheat." (4) (See **Table 2**.)

Table 1. Squash harvest parameters. Pratt Farm, 2001 (5)

Treatment	Yield (lbs)/acre ± SE	Fruit/acre ± SE
Control	2,472.9 ± 663.3	1,375.0 ± 291.7
Surround™ [kaolin clay]	3,580.8 ± 2246.1	1,708.3 ± 718.1
Buckwheat intercrop	1,901.7 ± 986.9	1,000.0 ± 343.6
LSDO.05	nsd	nsd

Table 2. Squash harvest parameters. Abbe Hills Farm, 2001 (5)

Treatment	Yield (lbs)/acre ± SE	Fruit/acre ± SE
Control	13,812.5 ± 1,226.4	6,437.5 ± 437.5
Surround™	12,750.0 ± 4,165.8	5,625.0 ± 1,419.7
Buckwheat intercrop	2,000.0 ± 639.4	1,062.5 ± 213.5
Row cover	13,937.5 ± 2,303.5	6,562.5 ± 868.3
LSDO.05	7,637.2	2,671.4
(5)		

Populations of squash bug can also be suppressed by the presence of other natural predators. Limiting pesticide use is a most important step in protecting these beneficials in agricultural systems. They can be further encouraged through the use of beneficial habitats, or refugia, in the form of cover crops, strip plantings of diverse crops, and maintenance of desirable non-crop border areas. For more information on creating habitat for beneficials (refugia), see the ATTRA publication *Farmscaping to Enhance Biological Control*, *www.attra.org/attra-pubs/farmscape.html*, also available in print upon request. For squash bugs, generalist predators include spiders, predatory mites, disease organisms, and a number of beneficial insect species—especially ground beetles and robber flies. At least one egg parasitoid of squash vine borer has been identified that helps to keep its numbers under control (8, 9, 23). Parasitic nematodes can be effective predators. Cornell Extension points out that soil treatments will not reliably control squash vine borer, as adults are strong flyers.

Because a single borer can be so highly destructive, **biological controls have not been considered a key strategy in managing the squash vine borer**. (9)

Kaolin Clay

Comparison of Kaolin Clay (Surround™) treatment with other physical and mechanical pest control methods in the second-year Iowa State study showed "no significant difference" in populations of squash bug and squash vine borer or in populations of beneficials among the three pest management treatments. It should be noted that this trial involved only *C. moschata*—next to *C. foetidissima*, the type least preferred by squash bugs. (4, 5)

In 2003 and 2004, further trials were held at Iowa State, comparing two different Kaolin Clay formulations—Surround-WP and Surround-XP—on Waltham Butternut Squash (*C. moschata*) at the Nerely-Kinyon Research Farm, Greenfield, Iowa. Nine rows were treated with Surround-WP, applied on a bi-weekly basis from plant establishment until plant leaf senescence; nine rows, with Surround-XP, applied the same. A control plot received no treatment. There was no significant difference found among the three plots in yields (measured by count and individual squash weights) or presence of insects. (27)

Alternative Insecticides

Organic growers have traditionally used botanical insecticides such as sabadilla, ryania, rotenone, or various blends of these to control squash bug. However, most botanicals have generally proven to be a bit expensive and only marginally effective. For information on what to use, see "What can I use in organic production?" on page 20 and Chapter VIII, Pest and Disease Management, pages 25–29, in *NCAT's Organic Crops Workbook*. Also consult the Organic Materials Review Institute (OMRI) for more information on insecticides permitted in organic squash production (*www.omri.org*).

In all cases where pesticides—natural or synthetic—are used, timing is critical. Application should coincide with maximum egg hatch, because the nymph stage is most vulnerable. Timing can be judged by frequent and careful field scouting. In organic farming, there is no substitute for the eye of the farmer. Monitoring squash bug emergence is not difficult, as the egg clusters are easy to find and identify. Egg placement and hatch occur on the undersides of leaves, and the nymphs tend to remain there. Therefore, to be effective, pesticide sprays or dusts must reach these areas and blanket them thoroughly. Since hatching occurs continually throughout the season, subsequent treatments will be required to assure sufficient control. (28)

All pesticides pose known and potential risks. When applying any pesticide, be certain to follow label instructions and use appropriate protective gear. Some natural substances used in organic production as pesticides can have significant toxic effects. The decision to use any pesticide should be made only when other approaches to pest management fail to provide adequate protection, and after plans for application have been included in the organic system plan that has been approved by the organic certifier.

References

1. McKinlay, Roderick G. 1992. Vegetable Crop Pests. CRC Press, Boston, MA. p. 143.

2. Sorensen, Kenneth A. 1994. The squash vine borer. Cooperative Extension, North Carolina State University, Raleigh, NC. *www.ces.ncsu.edu/depts/ent/notes/Vegetables/veg20.html*

3. Anon. No date. Squash vine borer. Lane Agricultural Experiment Station, Oklahoma State University, Lane, OK. *www.lane-ag.org/*

4. Delate, Kathleen. 2002. Progress Report to Gerber Products, Inc.: Organic Squash Pest Management Trials and Heirloom Vegetables. January 9. Iowa State University, Ames, IA. 6 p. *http://extension.agron.iastate.edu/organicag/researchreports/gerber.pdf*

5. Delate, Kathleen. 2003. Progress Report to Gerber Products, Inc.: Organic Squash Trials. February 12. Iowa State University, Ames, IA. *http://extension.agron.iastate.edu/organicag/*

6. Bessin, Ric. 2004. Squash Vine Borer and Squash Bug. *www.uky.edu/Ag/Entomology/entfacts/veg/ef314.htm*

7. Friend, R.B. 1931. The Squash Vine Borer. Bulletin 328. Connecticut Agricultural Experiment Station, University of Connecticut, New Haven, CT. 25 p.

8. Worthley, Harlan N. 1923. The Control of the Squash Vine Borer in Massachusetts, Bulletin No. 218. Massachusetts Agricultural Experiment Station, Amherst, MA. 80 p.

9. Sorensen, Kenneth A., and James R. Baker. 1983. Insect and Related Pests of Vegetables:

Some Important, Common, and Potential Pests in the Southeastern United States. Pub. AG-295. North Carolina State University, Raleigh, NC. 173 p.

10. Metcalf, Robert L. and Robert A. Metcalf. 1993. Destructive and Useful Insects: Their Habits and Control. McGraw-Hill, Inc., New York, NY. p. 14.38–14.39.

11. Bruton, B.D., et al. 2003. *Serratia marcescens*, a Phloem-Colonizing, Squash Bug-Transmitted Bacterium: Causal Agent of Cucurbit Yellow Vine Disease. Plant Dis. 87:937-944. *www.apsnet.org/pd/abstracts/2003/dau03ab.htm*

12. Staff. 1990. Mulch attracts squash bugs. HortIdeas. November. p. 126.

13. Van Tine, Melissa, and Sven Verlinden. 2003. Managing Insects and Disease Damage under an Organic System. West Virginia Extension, Morgantown, WV. 3 p. *www.wvu.edu/%7Eagexten/farmman2/organic/insects.pdf*

14. Ashworth, Suzanne. 2002. Seed to Seed. Seed Saver Publications, Decorah, IA.

15. Bonjour, E.L., W.S. Fargo, and P.E. Rensner. 1990. Ovipositional preference of squash bugs (Heteroptera: Coreidae) among cucurbits in Oklahoma. Journal of the Entomological Society of America. Vol. 83, No. 3. p. 943–947.

16. Ellis, Barbara W., and Fern Marshall Bradley. 1992. The Organic Gardener's Handbook of Natural Insect and Disease Control. Rodale Press. Emmaus, PA. 534 p.

17. Davidson, Ralph H., and William F. Lyon. 1987. Insect Pests of Farm, Garden and Orchard, 8th ed. John Wiley & Sons. New York, NY. p. 302–303.

18. Paige, J. et al. 1989. Ovipositional host association of Anasa Tristis (DeGeer) and various Cucurbita cultivars on the Texas High Plains. Journal of Agricultural Entomology. Vol. 6, No. 1. p. 5–8.
Note: For an assessment of C. foetidissema *potential in biodiesel production, see the ATTRA publication* Biodiesel: The Sustainability Dimensions.

19. Grupp, Susan M. No date. The bug review: Squash vine borer. Cooperative Extension, University of Illinois, Urbana, IL. *www.urbanext.uiuc.edu/bugreview/squashvineborer.html*

20. Palumbo, John C. 1988. Innovative methods of coping with squash bugs on cucurbits. Proceedings of the 7th Annual Oklahoma Horticulture Industries Show. p. 152–155.

21. Naegely, Stella K. 1997. Faking out bugs. American Vegetable Grower. August. p. 38–39.

22. Cornell University. 2005. Resource Guide for Organic Insect and Disease Management. *www.nysaes.cornell.edu/pp/resourceguide/cmp/cucurbit.php*

23. Stoner, Kimberly A. (ed.) 1998. Proceedings: Alternatives to Insecticides Conference. Abstracts: Cucurbit crops. Connecticut Agricultural Experiment Station (CAES), New Haven. 2 p. *www.caes.state.ct.us/AlternativestoInsecticides/Abstracts/abstractcucurbit.htm*

24. Garrett, J.H. 1993. J. Howard Garrett's Organic Manual. The Summit Group. Fort Worth, TX. p. 114, 121.

25. Patterson, Peg. 2000. Peppermint defeats those nasty squash bugs. Organic Gardening. Vol. 48, No. 2. p. 70–71.

26. Hoffman, Michael P., and Anne C. Frodsham. 1993. Natural Enemies of Vegetable Insect Pests. Cornell University Cooperative Extension. Ithaca, NY. 63 p.

27. Delate, Kathleen, and A. McKern. 2004. An examination of Kaolin Particle Film for Insect Pest Management in Organic Winter Squash. *www.organicaginfo/upload/Gerber_2004_squash_report.doc*

28. Bishop, Beth A. 2000. The Vegetable Growers News. Vol. 34, No. 7. p. 6–7.

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