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Organic Practices for the Production of Butternut Squash

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Abstract
Growers of organic squash need effective ways to manage insect and disease problems. The squash bug (Anasa tristis) sucks sap, causing leaves to wilt and turn black. The squash vine borer (Melittia cucurbitae) can devastate winter squash plantings. Burrowing by larvae into the base of the stem causes yellowing and wilting. Organic insecticides are expensive, have limited efficacy, require many applications, and some kill beneficial as well as target insects.

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Organic Practices for the Production of Butternut Squash

RFR-A1031

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Introduction

Growers of organic squash need effective ways to manage insect and disease problems. The squash bug (*Anasa tristis*) sucks sap, causing leaves to wilt and turn black. The squash vine borer (*Melittia cucurbitae*) can devastate winter squash plantings. Burrowing by larvae into the base of the stem causes yellowing and wilting. Organic insecticides are expensive, have limited efficacy, require many applications, and some kill beneficial as well as target insects.

Row covers are widely used to protect cucurbit crops from transplant until anthesis (start of bloom) because they accelerate crop development, protect against environmental extremes, and exclude pests. Once row covers are removed, insect pests can rapidly colonize and damage plants. Extended-duration row cover strategies, despite their major benefits, can restrict pollinator access to flowers. The fact that winter squash has relatively few harvests suggests that full-season row covers with purchased bumble bees may be feasible. Alternatively, opening row cover ends or removing covers at anthesis could allow pollination without bee boxes, but may risk squash bug and squash vine borer immigration.

Plant growth promoting rhizobacteria (PGPR) can enhance plant growth and yield while suppressing soil borne pathogens. A commercialized product, Kodiak® (*Bacillus subtilis* GB03 strain) is OMRI-approved and was tested to determine its efficacy in reducing beetle feeding and increasing yield.

Nutrient management can be challenging on organic farms, in part because organic N must undergo mineralization to become plant available. Preliminary evidence exists that integrating PGPRs with row covers and organic nutrient sources such as compost could improve plant nutrition.

This report focuses on first-year results of a 3-year multi-state effort, with University of Kentucky and Penn State University, to optimize organic growing practices that effectively manage insect and diseases, enhance pollination, and reduce fertilizer inputs for winter squash production.

Materials and Methods

Transitioning organic land was used for the experimental plot at the ISU Horticulture Research Station, Ames, IA. On June 10, 2010, 10 day-old organic transplants of Betternut 401 winter squash were planted 2 ft apart in black plastic mulch with drip irrigation and 9-ft row centers. Spunbond polypropylene row covers (Agribon® AG-30) were installed on wire hoops immediately after transplanting.

A split plot, randomized complete block experimental design was used to examine impacts of organic fertilizer treatments, use of PGPR, and differential timing of row cover removal. Main plots of fertilizer treatment (30 × 120 ft) were replicated three times. Fertilizer treatments for each plot were based on spring soil analysis and were disc incorporated into the soil: 1) organic bagged fertilizer–Fertrell® 5-1-1 (66 lb) and Fertrell® 3-4-7 (110 lb); 2) dairy-based compost assuming a 10 percent mineralization rate (3.0 cubic yards); and 3) dairy-based compost assuming a 30 percent mineralization rate (1.0 cubic yards).

Subplot treatments were randomly assigned within main plots. Pre-plant seed treatments with Kodiak® were randomly assigned to each of 12 rows. Four row cover treatments were compared as follows: 1) row covers applied at transplanting and removed at anthesis (start of bloom); 2) row covers applied at transplanting, with the ends opened at anthesis and row covers removed 10 days later; 3) row covers applied at transplanting; bumble-bee box placed under row covers at anthesis; row covers removed at first harvest; and 4) no row covers (control).

OMRI-registered insecticides and fungicides were applied on a rescue basis only, triggered by results of weekly monitoring. Entrust® (spinosad) was applied for squash vine borer. Microthiol® (sulfur) was applied to control powdery mildew and Champ 50WG® (copper hydroxide) was used to control cucurbit anthracnose, which is caused by the fungus *Colletotrichum orbiculare*. Weed management was achieved with 6 in. of chopped corn stalk mulch between rows and composted bark was placed around the opening in the plastic around each seedling before row cover placement.

Populations of insect pests were monitored weekly from transplant through the beginning of harvest using weekly visual counts on five randomly chosen plants. Disease incidence was monitored weekly. Squash were harvested by block, from September 20 to October 8. The number and weight of marketable and cull squash harvested from each subplot was recorded. Culls with a physiological disorder, in which the vine attaches to the underside of the fruit, were also noted.

Results and Discussion

Severe weather had a large impact on the growing season. Despite high winds of up to 70 mph in mid-July, row covers remained intact. Exposed plants suffered tattered leaves. Excessively wet soils in the eastern, lower-lying portion of the field reduced and delayed fruit ripening.

The most serious biotic threat was anthracnose, which was first observed in mid-June. The disease was effectively controlled by weekly sprays of copper hydroxide. No insecticide or fungicide sprays were applied to the season-long row-cover treatment. Five more Champ WG applications were applied to the no-row-cover treatments than in the row-cover-removed-at-anthesis treatment (Table 1). Reduced rain splash under the row covers may have slowed spread of anthracnose, thereby reducing the need for fungicide sprays. All treatments except for the season-long row-cover treatment received a single spray of sulfur and spinosad. Bacterial wilt was not detected.

Analysis of variance showed no interaction of fertilizer treatment, PGPR seed treatment, or row cover treatment. Therefore each treatment effect was analyzed separately. Average number of marketable fruit per subplot was highest for the season-long-row-cover treatment, indicating good pollination and plant health (Table 1). Marketable weight did not differ among row cover treatments except for the removal—10 days after anthesis treatment, which suggests lower pollination rates in the latter treatment.

The no-row-cover treatment had the highest marketable yield and also had half the percentage of culls due to vine attachment (Table 1) than the other three treatments with row covers. The absence of Kodiak also had a minor, but significant, contribution to culls due to vine attachment (Table 2).

Yield was highest for the Fertrell fertilizer treatment (Table 3). However, the higher rate of dairy compost (10 percent mineralization) did not differ significantly from the Fertrell treatment.

In conclusion, several factors must be considered when growers adopt row covers. The season-long row-cover treatments saved seven fungicide and one insecticide spray and had the highest yield. The added expense of the bee box must be considered, however. Poor performance of the 10-day-after-anthesis row-cover removal treatment suggests problems with pollinator access. The increase in vine attachment under row covers was unexpected and the mechanism for this physiological disorder is not understood.

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Table 1. Effect of row-cover treatment on yield, quality, and number of insecticide and fungicide sprays in butternut squash (cv. Betternut 401). Values are means per 15 plant subplot.

	Marketable fruit		Percent vine	No. of
Row cover treatment	Number	Weight (lb)	attachment	sprays
Removed at anthesis	35.9 b*	67.0 a	20.8 a	4
Removed 10 days after anthesis	30.5 c	53.2 b	23.6 a	3
Season long	40.5 a	71.3 a	22.0 a	0
No row cover	37.9 ab	75.1 a	9.9 b	8
LSD	4.52	9.7	4.4	

Table 2. Effect of Kodiak seed treatment on yield and quality in butternut squash (cv. Betternut 401). Values are means per 15 plant subplot.

	Marketable fruit		Percent vine
Seed treatment	Number	Weight (lb)	attachment
Kodiak +	35.7 a*	64.3 a	17.0 a
Kodiak -	36.7 a	68.8 a	21.2 b
LSD	3.2	6.8	3.1

Table 3. Effect of fertilizer on yield and quality in butternut squash (cv. Betternut 401). Values are means per 15 plant subplot.

	Marketable fruit		Percent vine
Fertilizer treatment	Number	Weight (lb)	attachment
Fertrell	38.9 a*	72.0 a	21.0 a
10% min. rate	36.3 ab	67.4 ab	19.5 a
30% min. rate	33.3 b	60.3 b	17.0 a
LSD	3.9	8.4	3.8

*Means followed by the same letter are not significantly different within row ($P \leq 0.05$).