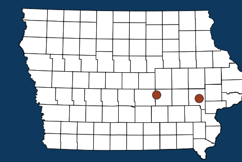
PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT



2019

Staff Contact
Liz Kolbe - (515) 232-5661
liz@practicalfarmers.org

Organic Control of Squash Vine Borer in Winter Squash

Cooperators

Mark Quee
Scattergood Farm, West Branch
Julia Slocum
Lacewing Acres, Ames

Funding

Ceres Trust

In a Nutshell:

- Julia Slocum and Mark Quee compared organic methods to control squash vine borer in susceptible varieties of winter squash.

Key Findings:

- Row cover was the most effective control practice, keeping more plants alive and producing higher yields.
- Bt injections were also effective at Quee's but were much more labor-intensive than row cover.

BACKGROUND

Squash vine borer can be a devastating pest to cucurbit crops and are difficult to control with organic methods. In this trial, two organic farms who have both struggled with vine borers undertook a trial comparing five methods of organic control. "The vine borers on my farm have seriously limited my ability to grow cucurbits - primarily winter squash - which are a really important end-of-season piece of the CSA spread, as well as one of my favorite crop groups to grow," said Julia Slocum, farmer at Lacewing Acres in Ames. Mark Quee's sentiments at the outset of the trial were similar: "Vine borer damage has been increasing the past 4 years and I need to figure out a way to control them. There are a variety of control methods and I'm seeking the easiest and most efficient way to control them." Quee is the farm manager at Scattergood Farm in West Branch.

Blue Hubbard squash harvested on Sept. 24, 2019 at Scattergood Farm.

METHODS

Both farmers planted a randomized, replicated trial with three replications of four or five treatments to control vine borer on their preferred winter squash variety. Production practices and trial design are noted in **Table 1**. At Quee's, Blue Hubbard squash were treated with either: control (no treatment), Bt injection, gauze stem collars, Spinosad spraying, or row cover (**Table 2**). At Slocum's, Red Kuri squash plants were treated with either: control (no treatment), newspaper stem collar, Bt injection, or row cover (**Table 3**).

Farmers collected data on vine borer damage, plant survival and yield. Quee scouted and counted living plants weekly, beginning six weeks after transplant and continuing for four weeks. Quee's activities by week for the trial are shown in **Table 2**.

TABLE 1. Planting and trial design at each farm.		
FARM	QUEE	SLOCUM
Winter squash variety	Blue Hubbard	Red Kuri
Seeding; transplant dates	June 5; June 14-15	May 5; June 15
Plants per plot	8	5
In-row spacing	30 in.	24 in.
Between-row spacing	8 ft	5 ft
Irrigation	Drip	Drip
Bed configuration notes	Reps 1 and 2 planted June 14; Rep 3 planted June 15 in drier, and more favorable, soil conditions.	N/A

The final plant count was the number of plants remaining at harvest. All non-surviving squash plants were considered killed by vine borer. Quee also collected yield data (fruit weight and fruit count) by plot.

Slocum also scouted and counted living plants beginning six weeks after transplanting. By her next data collection during week 8, all remaining plants had severe borer damage and visible entry points, so treatments were discontinued. Slocum's trial activities by week are shown in **Table 3**. At the final check during week 11, no marketable squash were able to be harvested from the trial.

To determine the effect of squash vine borer control practices on plant survival and squash yield, we calculated Tukey's least significant difference (LSD). If the difference in plant survival or yield measurements for any of the practices was greater than or equal to the LSD, we confirm that practice had a statistically significant effect. On the other hand, if the difference in plant survival or yield measurements was less than the LSD, we consider the practices to be statistically similar. We used a 90% confidence level to calculate the LSDs, which means that we would expect our rankings to occur 9 times out of 10. We could make these statistical calculations because the farmers' experimental designs involved replication and randomization of the practices (**Figure A1**).

TABLE 2. Field activities by treatment at Quee's.

FIELD WEEK	DATE	BT	CONTROL	GAUZE	ROW COVER	SPINOSAD
1	June 14, 15	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted
2	June 27	Injected	.	Wrapped	Covered	Sprayed
3	July 4	Injected	.	Re-wrapped	.	Sprayed
4	July 13	Injected	.	Re-wrapped	.	Sprayed
5	July 16	.	.	.	Uncovered	.
6	July 23	Injected	.	Re-wrapped	.	Sprayed
7	July 30	Injected	.	Re-wrapped	.	Sprayed
8	Aug. 8	Injected	.	Re-wrapped	.	Sprayed

All plants were started on June 5. Reps 1 and 2 were transplanted on June 14. Rep 3 was transplanted on June 15.

First signs of vine borer damage was July 16.

Squash was harvested on Sept. 15.

TABLE 3. Field activities by treatment at Slocum's.

FIELD WEEK	DATE	BT	CONTROL	NEWSPAPER	ROW COVER	SPINOSAD
1	June 15	Transplanted	Transplanted	Transplanted; Collar applied	Transplanted; Covered	Transplanted
4	July 10	Sprayed	.	.	.	Sprayed
6	July 21	Sprayed	.	.	.	Sprayed
6	July 24	.	.	.	Uncovered	Sprayed

All plants were started on May 5 and transplanted on June 15.

Bt was applied as DiPel, using backpack sprayer.

Newspaper collar was a 2 in. strip, wrapped three times around the stem and secured with masking tape.

Row Cover was Agribon medium weight, held down by soil.

RESULTS AND DISCUSSION

Quee, West Branch

In Quee's trial, row covers provided the best protection to Blue Hubbard squash plants from vine borers (**Table 4**). By week eight after transplanting, plots with the row cover treatment had significantly more surviving plants than the control and Bt injection treatments (all mortality was due to vine borer). Though the plant survival rate was not statistically different among row cover, gauze collar, and Spinosad treatments, Quee found the gauze collars too tedious to repeat, and the Spinosad was more labor intensive for the results it provided (requiring weekly applications).

TABLE 4. Plants survival and yield of Blue Hubbard squash at Quee's.

TREATMENT	WK 8 LIVING PLANTS (OF 8)	WEEK 8 SURVIVAL RATE (%)	PLOT YIELD (LB/PLOT)	FRUIT COUNT/PLOT
Bt	1.7 b	21 b	9.10	1.33 b
Control	2.0 b	25 b	9.17	1.33 b
Gauze	2.3 ab	29 ab	14.83	2.33 ab
Row Cover	5.7 a	71 a	21.40	4.33 a
Spinosad	2.7 ab	33 ab	13.63	1.67 ab
LSD	*3.7*	*46*	*14.38*	*2.91*

Plot size was 8 plants on 30-in. spacing, 8-ft between rows (160 ft^2).

Within columns, values that differ by more than the least significant difference (LSD) are followed by different letters and are considered statistically different with 90% certainty. Where letters are the same or no letters are reported, yields were statistically similar.

Photos from Quee's Farm: Top row, from left to right: Squash vine borer found inside a squash stem on July 23; Row cover being secured on June 27. Bottom row, from left to right: Gauze collar treatment on June 27; Bt injection on June 27.

Slocum, Ames

By the end of the trial at Slocum's, all Red Kuri squash plants in the trial were killed by vine borer; no marketable fruits were harvested. At week 6, however, the row cover treatment had statistically higher plant survival than the paper collar and control plots (**Table 5**). Plants under row cover, though, suffered from stunted blooms, delayed blooms and stunted plants, likely from the row cover being too tight over the plants. Plants with the paper collars had vine borer damage both below and above the collars.

TABLE 5. Red Kuri squash plant survival (until week 6) at Slocum's.

TREATMENT	WK 6 LIVING PLANTS (OF 8)	WEEK 6 SURVIVAL RATE (%)
Bt	**3.8 ab**	**75 ab**
Newspaper Collar	**1.5 c**	**30 c**
Control	**2.5 bc**	**50 bc**
Row Cover	**4.8 a**	**95 a**
LSD	***2.0***	***40***

Plot size was 5 plants on 24-in. spacing, 5-ft between rows (50 ft^2).

No marketable fruits were harvested at Slocum's due to plant mortality from vine borer.

Within columns, values that differ by more than the least significant difference (LSD) are followed by different letters and are considered statistically different with 90% certainty.

CONCLUSIONS AND NEXT STEPS

On both farms, row cover provided better control of squash vine borer than any other method in the trial. For Quee, this meant a larger harvest from those plots with less work; all other treatments required weekly applications and were not as effective, while the row cover was applied and then left alone until mid-July when it was removed permanently. For Slocum, the result of the trial was less immediately useful. Though the row cover kept plants alive longer than the other treatments, all plants in her trial eventually were killed by squash vine borers prior to any harvest. However, she learned that at this time she does not have an effective control strategy for squash vine borer, and that her CSA is better served by partnering with another farmer to provide squash for her boxes.

In 2020, two different farmers are continuing trials with row covers in winter squash. Their objective is to determine the optimal time to remove row covers to achieve sufficient pollination and effective protection against squash bugs.

From top to bottom: Squash seedling stems were wrapped with paper collars in one of the treatments; Freshly transplanted trial replications in the field at Slocum's; Squash stem cut open, revealing squash vine borer larva and its damage at Slocum's.

APPENDIX - TRIAL DESIGN AND WEATHER CONDITIONS

REP1	REP2	REP3	REP4
Collar	Row Cover	Bt	Control
Control	Collar	Row Cover	Bt
Bt	Control	Collar	Row Cover
Row Cover	Bt	Control	Collar

FIGURE A1. Example of experimental design used by farmers in the trial, which included randomized, replicated plots of the vine borer control practices. This design allowed for statistical analysis of the results.

TABLE A1. Climate data for 2019 and historical averages.

	Slocum: Ames				Quee: Iowa City			
	Growing Degree Days (base 50°F)		Rainfall (in.)		Growing Degree Days (base 50°F)		Rainfall (in.)	
Month	2019	Avg.	2019	Avg.	2019	Avg.	2019	Avg.
May	339	416	**8.3**	**4.7**	344	430	**9.6**	**4.4**
June	623	619	4.0	4.9	621	646	3.4	5.1
July	774	721	4.6	4.5	843	753	**1.0**	**4.0**
August	638	660	**1.3**	**5.1**	711	699	4.7	4.3
September	**610**	**479**	4.6	3.5	**629**	**486**	**7.5**	**3.1**

Monthly growing degree days and monthly rainfall for the current year and historical averages are reported from the nearest weather station. Climate data were accessed from the Ames and Iowa City weather stations.[1] Historical data include years 1985-2018.) Where rainfall in 2019 was more than two inches different than the average, values are displayed in bold.

REFERENCES

1. Iowa Environmental Mesonet. 2019. Iowa Environmental Mesonet. Iowa State University Department of Agronomy. http://mesonet.agron.iastate.edu/ (accessed September 2020).

PRACTICAL FARMERS of Iowa

PFI COOPERATORS' PROGRAM

PFI's Cooperators' Program helps farmers find practical answers and make informed decisions through on-farm research projects. The Cooperators' Program began in 1987 with farmers looking to save money through more judicious use of inputs. If you are interested in conducting an on-farm trial contact Stefan Gailans @ 515-232-5661 or stefan@practicalfarmers.org.