Improving Row Cover Systems for Organic Management of Bacterial Wilt in Muskmelon and Squash—Year 1

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Introduction

Bacterial wilt is a devastating disease of cucurbit crops (melon, cucumber, squash, pumpkin) in Iowa. Striped and spotted cucumber beetles transmit the bacteria (*Erwinia tracheiphila*) to cucurbit plants when their infected frass comes in contact with feeding wounds and floral nectaries. Infected plants usually wilt and die within two weeks.

Organic growers often use spunbond polypropylene row covers (Agribon™, Reemay®) as a barrier to protect the crops during the early part of the growing season. At transplanting, row covers are suspended 1.5 ft above the soil on wire hoops and edges are secured with soil. Row covers are removed when female flowers start to appear to allow for pollination, and insecticides are used for the remainder of the season to control cucumber beetles, squash bugs, and other pests.

However, these "low tunnel" row cover systems have some practical limitations. The tunnels are too small to cover the plants all season, and plants can suffer heat damage if the covers are left on during hot weather. Once the plants are uncovered, they are vulnerable to pest and disease damage, and organic insecticides are weak against cucumber beetles and squash bugs. Another limitation is that the polypropylene is too dense to see through, so the edges have to be pulled up to scout for flowers or pests.

A goal of this study was to overcome some of these limitations by redesigning row covers and tunnels for full-season crop protection. A new row cover material (ProtekNet) was tested in 3-row-wide plots with tall (3.5 ft) hoops made of 1-in. galvanized conduit. ProtekNet is a nylon mesh insect netting with holes small enough to exclude cucumber beetles and squash bugs. The material allows for greater air movement than traditional row covers, and fungicides can be sprayed through the material.

Materials and Methods

Experimental design was a split plot randomized complete block, with acorn squash (cv. Table Ace) and muskmelon (cv. Athena) as the split plots. Treatment subplots were three rows wide and 30 ft long, with four replications of each treatment. Treatments included: standard-practice row cover approach—spunbond row covers on wire hoops removed at anthesis (ARA); ProtekNet row covers on conduit hoops with covers removed at the start of flowering and replaced two weeks later (POFO); full-season ProtekNet row covers on conduit hoops with bumble bees placed under the row cover at the start of flowering (PFS); and a non-covered control (NRC).

Three weeks prior to transplanting, fields were tilled. One week later, organic compost was applied according to compost test results and fields were tilled a second time. Commercial organic fertilizer was applied by hand along rows according to soil test results, and then drip tape and black plastic mulch were laid. One week before transplanting, soil between rows was cultivated and covered with a 6-in.-thick layer of corn stover mulch.

Ten-ft lengths of 1-in. galvanized conduit pipe were bent using a QuickHoops™ 4 ft x 4 ft Low Tunnel Bender (Johnny's Selected Seeds). Class C Natupol hives containing bumblebees (*Bombus terrestris*) were purchased from Koppert Biological and placed under row covers in PFS subplots at the start of flowering. Laundry baskets were placed over the hives to protect them from rain and direct sun.

On June 1, 2016, 3-wk-old muskmelon and squash seedlings were transplanted 2 ft apart on 6-ft row centers. Row cover treatments were applied the same day of transplanting. ProtekNet row covers were secured with rock bags, and soil was used to secure Agribon row covers.

Scouting for cucumber beetles and squash bugs occurred only when plants were not under row covers, and was done twice weekly until plants had six fully formed leaves, then once per week thereafter. One pheromone trap was placed at plant height near the squash field and scouted weekly for the presence of squash vine borer moths. A tank mix of Surround® WP, neem oil, and pyrethrins was applied when scouting thresholds were reached for cucumber beetles or squash bugs (Table 1). Bt was sprayed to the bases of squash plants if a single squash vine borer moth was found. The economic threshold for cucumber beetles was 0.5 beetles/plant prior to 6-leaf stage, and 1 beetle/plant thereafter. The threshold for squash bugs was one squash bug nymph, egg mass, or adult/plant throughout the season.

Scouting for bacterial wilt occurred once weekly, and a final incidence (% wilted plants) was noted in each subplot immediately prior to harvest (Table 1). Yield data were taken on the center row of each subplot. Number and weight of marketable fruit, insect culls, disease culls, and other culls were recorded (Table 1).

Results and Discussion

Muskmelon. The full-season ProtekNet treatment (PFS) had significantly more marketable fruit and a higher weight of marketable fruit than any other treatment. PFS and the non-covered control treatment (NRC) had fewer culled fruit due to insect damage than the other treatments. However, the NRC treatment required six total insecticide sprays compared with none for the PFS treatment. Mean percent bacterial wilt incidence in PFS was significantly lower than in the NRC and ARA treatments, but did not differ significantly from the ProtekNet on-off-on (POFO) treatment. Significantly more fruit were culled in ARA than in PFS, NRC, and POFO.

Acorn squash. The full-season ProtekNet treatment (PFS) yielded significantly higher number and weight of marketable fruit than the non-covered control (NRC), but did not significantly outperform other row cover treatments (ARA and POFO) in marketable yield. Treatments on squash did not differ significantly in their effects on insect or total damage to fruit, or in mean percent bacterial wilt incidence. PFS required no insecticide sprays, while POFO required three, ARA required eight, and NRC required 14 insecticide sprays (Table 1).

These results show excellent promise for the adoption of a full-season Protek-Net system, especially in muskmelon.

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Table 1. Bacterial wilt incidence, number of insecticide sprays, and yield data for four organic row cover treatments in muskmelon (cv. Athena) and acorn squash (cv. Table Ace) in 2016 at the Iowa State University Horticulture Research Station, Ames, IA.

			Insecticide sprays[3]		Marketable yield[4]		Insect culls[5]		Total culls[6]
Crop	Trtment[1]	Mean % bacterial wilt incidence[2]	Cucumber beetle or squash bug	Squash vine borer	Mean number	Mean weight	Mean number	Mean weight	Mean number
Muskmelon	PFS	0 a	0	n/a	88.5 a	414.1 a	33.8 a	161.9 a	72.8 a
	POFO	12 ab	1*	n/a	27.0 b	120.8 b	78.0 b	327.1 b	112.1 a
	ARA	35 b	2	n/a	16.5 b	67.2 b	89.3 b	340.9 b	159.0 b
	NRC	42 b	6**	n/a	8.3 b	34.5 b	22.5 a	106.5 a	106.5 a
Acorn squash	PFS	0 a	0	0	105.8 a	205.0 a	0.8 a	1.4 a	129.0 a
	POFO	0 a	1*	2	80.3 ab	146.0 ab	3.0 a	6.2 a	89.3 a
	ARA	8 a	3	5	66.8 ab	114.3 ab	7.5 a	11.1 a	135.8 a
	NRC	5 a	8**	6	50.3 b	92.4 b	11.3 a	16.8 a	138.8 a

*On July 1, muskmelon POFO subplots were mistakenly sprayed for cucumber beetle control despite not reaching threshold. On the same date, squash POFO subplots reached threshold and should have been sprayed but were not.
**The first two sprays of the season (applied to NRC subplots for cucumber beetle control) consisted of Entrust mixed with pyrethrin and kaolin clay. Entrust was replaced with neem oil for all later sprays.
[1]Treatments are full-season ProtekNet (PFS), ProtekNet removed for two weeks at the start of flowering (POFO), Agribon removed at anthesis (ARA), and no row cover (NRC). Treatments were arranged in a split plot, randomized complete block design with four subplots/treatment. Muskmelon and acorn squash data were analyzed separately.
[2]Means in a column followed by the same letter do not differ significantly ($P < 0.05$) based on Tukey's honestly significant difference critical values.
[3]Values represent total number of sprays for each pest group. Uncovered treatments were scouted for cucumber beetles and squash bugs and sprayed with a combination of kaolin clay, neem oil, and pyrethrins upon reaching economic threshold for either or both pests. A pheromone trap was scouted weekly for squash vine borer moths and all uncovered squash subplots were sprayed with Bt upon reaching economic threshold.
[4,5]Values are treatment averages of number or weight of fruit per 90 row-ft. Weight is measured in pounds.
[6]Values are treatment averages of number of culls per 90 row-ft. Includes fruit culled due to any combination of insect damage, disease, poor pollination, small size, sunscald, rodent damage, irregular netting, and other deformities.