Optimizing Pollination of Acorn Squash in Organic Mesotunnel Systems

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Introduction

In the Midwest, squash production can be affected by insect pests such as cucumber beetles (*Acalymma vittatum* and *Diabrotica undecimpunctata*) and squash bug (*Anasa tristis*), which spread the pathogenic bacteria *Erwinia tracheiphila* (causal agent of bacterial wilt) and *Serratia marcescens* (causal agent of cucurbit yellow vine disease), respectively. These insects are difficult to control under organic systems because of the lack of effective insecticides. An alternative approach is the use of physical barriers such as low tunnels or mesotunnels. Mesotunnels are 3.5-ft-high tunnels covered with a nylon mesh fabric. Mesotunnels can protect marketable yield better than low tunnels, mainly because they can be used for longer periods than low tunnels. Despite their potential advantages, mesotunnels must accommodate the bees that pollinate cucurbit crops. Therefore, the objective of this research is to optimize pollination in mesotunnel systems.

Materials and Methods

Acorn squash (cv. Table Ace) seedlings were transplanted into subplots of three 150-ft-long rows. Rows were spaced 6 ft apart with 2 ft between plants in each row. Each row was drip irrigated and covered with a black plastic mulch. A randomized complete block design included three treatments: 1) full-season mesotunnels with one bumblebee hive (Koppert Biological Systems) in the middle of the center row (full season); 2) nets removed at bloom for two weeks to allow natural pollination, then reinstalled (on-off-on); 3) both ends of the mesotunnels were open for two weeks at bloom, then resealed (open ends). Visual observations of bees and cucumber beetles were made twice a week for two weeks during bloom. Observations were conducted in 45-second intervals at three locations/subplot by two observers simultaneously, then averaged. At harvest, the number and weight of fruit were taken from the entire center row of each subplot.

Results and Discussion

On-off-on had the highest marketable yield with 20,708 lb/acre, followed by Open ends with 19,033 lb/acre. The lowest producing treatment was full season with 16,854 lb/acre. The only significant ($P < .05$) difference was between on-off-on and one hive (Table 1). More bees also visited the on-off-on plants than in the other treatments (Table 2). Cucumber beetle density (Table 3) was lower in the one hive treatment, followed by open ends and on-off-on treatments. The presence of cucumber beetles may not significantly affect yield because the *E. tracheiphila* strain that is pathogenic to squash is not known to be established in Iowa.

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Table 1. Effect of pollination treatments on marketable yield under mesotunnels.

Treatments[1]	Marketable yield[2]	Non-marketable yield[2]
On-off-on	20,709 A	3,291 A
Open ends	19,033 AB	2,014 B
Full season	16,854 B	2,741 AB

[1]On-off-on: nets were removed for two weeks at bloom, then reinstalled. Open ends: both ends of the mesotunnels were opened at bloom for two weeks, then resealed. Full season: tunnels in place all season, one bumblebee hive was installed in the middle of the center row.
[2]Fruit weight in lb/acre. Means followed by the same letter are not statistically different ($P < 0.05$); means were separated using Tukey LSD.

Table 2. Effect of treatments on bee density July 14.

Treatments[1]	Number of bees observed/location[2]
On-off-on	1.7 A
Open ends	1.5 A
Full season	0.7 B

[1]On-off-on: nets were removed for two weeks at bloom, then reinstalled. Open ends: both ends of the mesotunnels were opened at bloom for two weeks, then resealed. Full season: tunnels in place all season, one bumblebee hive was installed in the middle of the center row.
[2]Total number of bees observed in a three-plant subsection of outer row July 14 (two days prior to mesotunnels closing). Means followed by the same letter are not statistically different ($P < 0.05$); means were separated using Tukey LSD.

Table 3. Effect of treatments on cucumber beetle density July 14.

Treatments[1]	Number of cucumber beetles observed/location point[2]
On-off-on	2.1 A
Open ends	0.7 B
Full season	0.3 B

[1]On-off-on: nets were removed for two weeks at bloom, then reinstalled. Open ends: both ends of the mesotunnels were opened at bloom for two weeks, then resealed. Full season: tunnels in place all season, one bumblebee hive was installed in the middle of the center row.
[2]Total number of cucumber beetles observed in a three-plant subsection of outer row July 14 (two days prior to mesotunnels closing). Means followed by the same letter are not statistically different ($P < 0.05$); means were separated using Tukey LSD.