

2009 Field Study on Organic Control of Cucurbit Pests Tewksbury Grace Farm

From 2007 through 2009, in cooperation with the PA Association for Sustainable Agriculture (PASA) and Penn State Cooperative Extension, we conducted 3 seasons' trials of organic control of cucurbit pests in field cucumbers and winter squash. Methods of control were fairly simple, basically using hoops and barrier cloths (Agribon 19 or Enviromesh) to keep out unwanted pests, namely squash bugs, striped and spotted cucumber beetles, and squash borers. A hive of purchased bumblebees was placed under each crop "tunnel" to pollinate flowers. We also conducted an ancillary field trial on the organic control of flea beetles on eggplants, using essentially the same techniques as mentioned above.

Some background: during the second trial season (2008), we sought a new material to replace the Agribon 19 because we found it trapped excessive heat in the low tunnels, and during the height of summer, these very hot conditions caused chronic stress on the plants. Tunnel ends had been screened to provide venting, but did little to alleviate trapped heat. We also for found that Agribon was easily subject to wind damage and disturbance. Though adequately bricked down, the material acted like a kite, and several times came completely undone, thus potentially exposing plants to pests as well as creating tedious labor to reinstall. Finally, the Agribon was significantly tattered after two hailstorms in the '07 season, thus allowing the possibility for unwanted pests to access the plants and also our bumblebee pollinators to exit. After some research, our group decided on a promising material, Enviromesh (also called Proteknet in the ag supply industry), that was supposed to be durable and non-ripping, and not trap heat, since it is a screen-like material. Further discussion of this material is found in each section.

Cucumbers

In each trial season, we planted 3 succession crops of cukes in a 4' w x 75' l raised bed, the first transplants planted in late May, the second round in mid-June, and the final round in late June/early July. We planted 1/3 of the bed at each time, with 24" spacing, 2 transplants offset down the row. Roughly 10 varieties of cukes were interplanted, including white, Asian, and traditional (e.g., Marketmore) style fruits.

After transplants were planted, a heavy layer of straw mulch was applied to the bed. Then, the bed was hooped with 9-gauge wire, covered in Enviromesh (2008 and 2009), and bricked down on all edges. A bumblebee hive was placed under the low tunnel during the last week or two of June (as flowering began). During harvest time, we closed off the hive, which allows bees in, but prevents exiting, so that when we removed the cover to harvest, bees did not escape. The hive is re-opened after every harvest.

We have had great success with this method, and found the Enviromesh to perform well, though we noticed that plant tendrils would latch on to the mesh and create small openings. However, no striped or spotted cucumber beetles were seen inside or outside the material. We definitely plan to use these control methods in the future.

Due to severe drought in 2007, yields were fair, at 450 lbs. 2008 cuke harvest was excellent, yielding 908 lbs from June 27 to Aug 18, and bearing unblemished fruit. 2009 cuke harvest began on July 13, and plants look very healthy.

Winter Squash

During the first year of this study (2007), we used Agribon 19 floating row cover as a barrier cloth. We planted over a dozen varieties of winter squash in a 4' x 75' raised bed, using 24-inch spacing, with 2 plants offset down the row. Heavy straw mulch was applied after planting. Using 9-gauge wire hoops and flexible 10' pieces of 1/2" PVC piping inserted over rebar, we covered a 16' w x 75' l section with Agribon 19. A hive of bumblebees was placed under the tunnel in late June. Despite an excessively hot, droughty 2007 season, this bed yielded **561** lbs of unblemished winter squash, as no squash bugs or cucumber beetles penetrated under the cloth to damage plants.

However, we had trouble with excessive heat, wind ripping the cover off, and significant hail damage on the Agribon cloth, so in **2008**, we switched to the aforementioned Enviromesh material, which seemed promising. Instead of a single 4' x 75' raised bed, we planted two "sister" 4' x 75' beds (side by side), so we could use one large piece of Enviromesh over both, and hope to double our yields. Plant growth was robust with lots of vining and formed fruit. We noticed squash bugs on the exterior of the Enviromesh material by late June. As the squash plants grew, leaves pressed against the material, and we observed squash bugs feeding and laying eggs on the leaves through the material (note: squash bugs were unable to do this through Agribon, which is a spun material, rather than woven screen). As with the cukes, squash tendrils attached to the Enviromesh and created small openings. This material is not knit, so if it is snagged in any way, it tends to open and unravel. Also, after installation we noticed about a 4-inch opening along a center seam, apparently missed during the custom sewing.

Despite seeing some squash bugs on the exterior, all was well until we pulled the cloth off to inspect plants in late July when we found widespread squash bug infestation (eggs and nymphs) throughout the patch. We hand groomed plants as best as possible. In early August, we inspected again, and found continued infestation, also observing a few striped and spotted cucumber beetles under the material. Unfortunately, the **2008** crop crashed due to heavy squash bug pressure, and our harvest suffered a significant impact from the pest damage. Two 4' x 75' beds covered in Enviromesh yielded 393 lbs of moderately to severely blemished fruits, compared to 2007's one 4' x 75' Agribon 19-covered bed's yield of 561 lbs of unblemished fruits.

We cannot determine how such a severe infestation occurred – it is as if there was no barrier cover on at all. The few scattered holes did not seem sufficiently large and accessible enough to allow such a severe infestation. Also, there were no cucurbits on these beds prior to 2008.

So, in 2009, we decided to use the Agribon 19 again as the barrier cloth, since the Enviromesh was unable to prevent pest damage on winter squash. We planted only one 4' x 75' raised bed (with a barrier cloth spanning 16' across to cover vine sprawl) this year, again planting a dozen winter squash varieties. One hive of bumblebees was placed under the low tunnel in early July. We resolved the problems with wind pick-up by placing tie-downs over the floating row cover to keep it in place; so far, this simple method is working. Excessive heat is still a potential issue, as is hail damage but Agribon does appear to keep squash bugs off of plants. By late June we began spotting squash bugs on the screen exterior that covers each end of the bed. Initially, 12 to 15 bugs a day, down to just one or two daily. We cannot observe any under the Agribon, and will not take cover off for inspection until later in the season. So far, plants look vigorous.

Enviromesh

Pros

- Absolutely no problem with wind pick up, as wind moves through screen and creates no resistance
- No problems with heat trapping
- Strong material despite some drawbacks. Should be able to be reused.

Cons

- Not available in the U.S.
- If cucurbit plants can reach material, tendrils latch on and create holes.
- Squash bugs can feed and lay eggs on leaves if touching material.
- Apparently unable to keep squash bugs out adequately to prevent infestation.
- Expensive

In a final experiment, we asked PASA if we could conduct a field study on the organic control of flea beetles on eggplants, again using the same barrier techniques and captive bumblebee pollinators.

Eggplants

Prior to 2008, we had hooped and covered eggplants with Agribon 19 until plants flowered, at which time the Agribon was removed for pollination. Flea beetle damage would still occur and cause plant stress.

In both 2008 and 2009, in early June, we transplanted into a 4' w x 75' l raised bed, at 22-inch spacing, with two plants offset down the row. We hooped with half inch, 10' long flexible PVC piping, set into rebar every 4 feet on the bed sides. The piping was braced by running twine as a "backbone" down the hooped row, to create a 5' high tunnel. We covered the tunnel with Agribon 19 (since eggplants are not stressed by higher temps from heat trapping), instead of the more expensive Enviromesh (inadequate as a barrier material since its screen had holes large enough to allow flea beetle access) and screened ends for ventilation. A bumblebee hive was placed under the tunnel as soon as plants began to flower. It is important that screened ends are tightly secured as bees will seek to exit and will get fatally trapped in loose edges of material. During harvest time, we close off the hive, which allows bees in, but prevents exiting, so that when we remove the cover to harvest, bees do not escape. The hive is re-opened after every harvest.

Both years, we observed robust growth and minimal flea beetle damage, in contrast to the severe beetle damage to control plants outside the tunnel. There is some ongoing Colorado potato beetle damage, though not significant, and usually pests have been controlled with hand grooming. In 2008, we noticed fairly heavy aphid infestation on several plants in early August. By Aug 14, the infestation had spread and was more severe. We determined that the Agribon cover was creating a greenhouse effect, as the aphids had no predators and were beginning to cause significant stress to the plants. We decided to remove the Agribon at this time, and the problem was naturally resolved within a few days. In the future, lady beetles could be introduced as a control measure. Plants currently are robust and producing fruit.

Conclusion

After 3 seasons of trialing the barrier cloth and captive pollinator application to control cucurbit pests and flea beetles organically, we find the materials that work best for us include:

Winter squash: we will use Agribon 19 floating row cover over the entire crop, with screened ends for heat venting. Typically, we will intensively plant a 4' x 75' raised bed with a variety of squash that will be covered the entire season and pollinated by a quad of

bumblebees kept under the tunnel. The floating row cover will be cross-tied to prevent wind pick-up. We will use standard 9-gauge wire hoops over the bed, as well as some 10' PVC piping to allow for vine sprawl.

Cucumbers: we will use Enviromesh over the entire crop, with a quad of bumblebees under the netting for pollination. Typically, we will succession plant a 4' x 75' raised bed with a variety of cucumbers. No crossties needed, as wind is not an issue with this material. We will use standard 9-gauge wire hoops over the bed.

Eggplant: we will use Agribon 19 floating row cover over the entire crop, with screened ends for heat venting, and a quad of bumblebees under the tunnel for pollination. Typically, we will intensively plant a 4' x 75' raised bed with a variety of eggplants. We will use 5-foot tall PVC pipe hoops for hoop support. We plan to look into obtaining flea beetle-resistant netting, similar to Enviromesh, but with a tighter weave, for future barrier protection, as this type of netting resolves problems with wind pick-up.

Cost Considerations

Initial costs include barrier material, hoops, bumblebee hives, stakes (e.g., rebar), ½" PVC pipes, twine, and screen material. The Enviromesh material and Agribon floating row cover can be used several seasons if cared for properly. After the initial investment, the only recurring cost is the annual purchase of bumblebee hives.

Agribon floating row cover is fairly inexpensive and widely used. The Enviromesh is difficult to obtain locally, and is pricey, costing roughly \$0.07/sq. foot, though it is supposed to last a minimum of 10 years. Bumblebee hives cost \$ /quad.

Though there are increased costs associated with growing these crops, we believe they are worthwhile investments, since we definitely want to offer these crops to our customers (and ourselves), and prior to using these pest controls, we had experienced yearly crop failure from heavy insect pressure.