Evaluation of multi-row covers and support structure for cantaloupe and summer squash

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Abstract
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Sagging cover material over time suggested limiting distance between single supports to 2 m or less. Tennis balls atop single supports avoided cover damage better than rebar caps. Spunbond polypropylene had more tears and damage than polyethylene mesh during use. Wire hoops centered over the row, spaced 2.3 m along the row avoided cover damage while keeping material off the crop.

Keywords
Cucurbit, disease, horticulture, insects, supports, tunnels

Disciplines
Agriculture | Bioresource and Agricultural Engineering

Comments
Evaluation of multi-row covers and support structure for cantaloupe and summer squash

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Abstract. Covers excluding insects are an alternative to pesticide control on cantaloupe and squash. Tests evaluated support structure and two types of cover material (spunbond polypropylene and polyethylene mesh) during mid-summer field conditions.

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Introduction

About 41,000 growers in the eastern half of the U.S. produce $1.02 billion in value from cucurbit crops such as cantaloupe and summer squash on 374,000 acres (USDA-NASS, 2008). A major challenge for growers is feeding on the plants by cucumber beetle (Acalymma vittatum and Diabrotica undecimpunctata howardi) and squash bug (Anasa tristis). In addition to direct feeding, these insects also transmit bacterial wilt (Erwinia tracheiphila). Bacterial wilt can reduce cantaloupe and cucumber production by 80% and also impact pumpkin, winter squash, and zucchini (Latin, 1993; McGrath 2001). The disease costs eastern U.S. growers $18.9 million annually (Adams and Riley, 1997). Pesticide strategies require frequent re-application, can be costly, and are not an option for organic growers.

A proven method of improving production of horticultural row crops such as melons and squash (cucurbits), is covering them with some sort of row cover (Rojas et al., 2011). A row cover can extend the season and allow for a slightly earlier or later planting time and also helps prevent damage from insects such as the cucumber beetle. A potential means for mechanically covering single rows is using a tunnel layer implement (Hanna et al., 2014).

Horticulturalists have suggested that covering multiple rows may offer increased efficiency in row cover deployment and removal. However, existing equipment is designed to only cover one row at a time, so a different approach may be needed to cover multiple rows.

Objective

The objective of this research was to evaluate support structures and material that cover more than one row during mid-summer wind and sun conditions in Iowa. In selection of structural support materials, consideration was given to cost, labor requirements, potential for future mechanization, and effectiveness of reliably supporting the cover.

Methods and materials

Field experiments were done in two field tests. Crop row spacing was 2.1 m (7 ft), similar to earlier tests with the mechanized tunnel layer. Treatments were replicated three times in the field without a growing crop underneath. Row cover materials were supported over individual plots 6.1 m (20 ft) long by two rows wide (4.3 m, 14 ft).

Test 1

Row cover supports that were included in the field tests included (1) concrete reinforcement bar (rebar, 13 mm (0.5 in.) diameter) and (2) plastic-covered hollow metal rod tomato stakes (13 mm (0.5 in.) diameter). Each support was cut to a length of 53 cm (21 in.) and inserted 13 cm (5 in.) into the soil leaving 41 cm (16 in.) of exposed height. Horizontal rebar (hemispherical) end caps were placed atop supports to provide a smoother and larger area contact surface for cover material. Each type of support (rebar, tomato stakes) was tested in both 1.5 m (5 ft) and 3 m (10 ft) spacing along the row direction.

Cover material used was spunbond polypropylene (Agribon® AG-30) in sheets 8 m (26 ft) wide by approximately 12 m (40 ft) long, mounted over a support structure spanning 9.1 m
(30 ft) along the row and two rows (4.3 m, 14 ft) wide. Three supports across two rows were on 2.1-m (7-ft) spacing. In addition to these four treatments, Agribon®, on either rebar or tomato stakes on 1.5 or 3 m (5 or 10 ft) spacing along the row, a fifth treatment used a polyethylene mesh (Proteknet® 60 g; Dubois Ag Innovation, St. Remi, Quebec, Canada). This cover material was only tested on rebar spaced 3 m (10 ft) along the row. Treatment names are shown in Table 1.

Table 1. Treatment names

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cover material</th>
<th>Supports</th>
<th>Support spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/T/10</td>
<td>Agribon®</td>
<td>Tomato stakes</td>
<td>3</td>
</tr>
<tr>
<td>A/T/5</td>
<td>Agribon®</td>
<td>Tomato stakes</td>
<td>1.5</td>
</tr>
<tr>
<td>A/R/10</td>
<td>Agribon®</td>
<td>Rebar</td>
<td>3</td>
</tr>
<tr>
<td>A/R/5</td>
<td>Agribon®</td>
<td>Rebar</td>
<td>1.5</td>
</tr>
<tr>
<td>P/R/10</td>
<td>Proteknet®</td>
<td>Rebar</td>
<td>3</td>
</tr>
</tbody>
</table>

Test 2

During the first test, supports on some of the Agribon® covered treatments were observed protruding through holes worn through the Agribon® in one day’s time. A small burr approximately 1 mm tall on the end caps (possibly from the plastic molding process was too abrasive, and were abrading through the Agribon (figure 1).
During test 2 the two treatments using tomato stakes were changed. Caps on treatment plots using tomato stakes on 3-m (10-ft) spacing were replaced with tennis balls and new Agribon® covers. A small slit was cut in the tennis ball and the tomato stake was inserted into the slit. Treatment plots that had used 1.5-m (5-ft) spacing of tomato stakes were changed to using wire hoops for a support method on 2.3 m (7.5 ft) spacing along the row and covered with a new sheet of Agribon®. This method had been used before on 1.4 m (4.5 ft) spacings along single row coverings but not multiple rows. Observations continued with the three treatments using rebar supports.

**Test 3**

Noticeable fatigue or abrasion of the cover material resting on tennis balls was not observed during test 2; however, the 3 m (10 ft) support distances that were used in an attempt to minimize materials cost, allowed the row cover material to sag midway between supports within 13 cm (5 in.) of the soil surface which could cause a problems of physical interactions between the row cover material and the plant architecture. During test 3, support distance in the tennis ball treatment was changed to 1.2 m (4 ft) along the row. This doubled the number of supports (three to six) along the 6 m (20 ft) nominal length of each plot.
Results and Discussion

Test 1

After the row covers were in place, treatments were evaluated using three criteria: 1) number of caps causing fatigue due to abrasion or visible wear on the row cover material, 2) number of caps completely wearing and poking through the material, and 3) number of caps wearing through the material and then falling off or somehow being removed from the stake. Data was taken one day after, two days after, and five days after application of the row covers over the support structures in the field. A cap causing fatigue on day 1, but still not poking through by day 2 or 5, it was still recorded each day as an occurrence of fatigue. After a cap or support top poked through material, it was recorded as “poked through” rather than simply a “fatigued” spot.

Average percentage of supports fatiguing and poking through cover material for each treatment is shown in figure 2 for observations one, two, and five days after establishing the plots. Percentage of supports causing damage is used because treatments with 1.5-m (5-ft) support spacing along the rows used 15 supports per plot compared with just 9 total supports used for treatments with 3-m (10-ft) support spacing along the rows.

For most treatments, the combined percentage of fatigued and poked through locations increased as time progressed. Some locations initially classified as fatigued later changed to poked through. Dynamic movement of cover material with ambient wind currents seemed to be the primary cause of material wear against plastic rebar caps covering the supports. In some locations supports poked through material overnight without prior evidence of fatigue.

An apparent anomaly occurs in some cases, notably for treatment A/R/10, when the number of locations with supports poking through do not compensate for the reduced number of fatigued spots. Two phenomena may have caused this. First, cover material that was tensioned across supports initially by small plastic stakes anchoring borders of the cover, became loose over time from dynamic movement of the cover by wind. If cover material loosely bunched up at the top of a support without direct contact, further abrasion was stopped and it was difficult to observe earlier small spots that may have been fatigued. Secondly, small fatigued spots near each other could combine into a larger single area that often ultimately allowed a single poked through location.
Figure 2. Percentage of supports either showing wear damage on cover material or poking through cover after one, two, or five days by treatment (Agribon or Proteknet/tomato stake or rebar/support spacing in ft).

For Proteknet®, in treatment P/R/10, fatigue was only observed one time, and it was only on one cap. The Proteknet® wasn’t as susceptible to fatigue. No instances of material failure were observed in the Proteknet® material.
Figure 3 shows the average number of caps per plot that had fallen off of the support stake for each separate treatment. Cap removal from the top of the support was likely due to wind elevating cover material up and down over the cap after it had poked through material, but could have been caused by wildlife or an unknown factor.

**Test 2**

Replacing plastic caps with tennis balls on top of supports or replacing single support stakes with wire hoops showed much more positive results. After two weeks, there was still no visual fatigue on the row cover material where it made contact with either the tennis ball or the wire hoop. Weeds growing underneath the row cover had grown considerably taller than they were in test 1. Taller weeds lifted the row cover in some places, relieving the pressure of the weight of the row cover on both the tennis balls and wire hoops in some locations. This may have been lessened damage potential.

**Test 3**

As expected reduced spacing between supports (3 m or 10 ft to 1.2 m or 4 ft) helped keep cover elevated over the row. The combination of the tennis ball caps and closer spacing seemed resulted in better degradation results as well. The tennis ball had a less abrasive surface and the closer supports helped to spread the weight and pressure.
Conclusions

Tests during summer field conditions in Iowa support the following conclusions:

- Spunbond polypropylene cover material (Agribon®) was rapidly torn and degraded at points of contact with plastic rebar caps.
- Polyethylene mesh cover material (Proteknet®) showed negligible degradation, but adds expense at three times the cost of spunbond polypropylene.
- Substituting tennis balls to protect polypropylene cover material resulted in negligible degradation, however distance between single support stakes needed to be reduced from 3 m to 1.2 m (10 ft to 4 ft) for cover material to maintain acceptable height for the crop.
- Using wire hoops for cover support across the row area, with 2.3 m (7.5 ft) along the row direction had negligible degradation to polypropylene cover material and maintained acceptable height for the crop over the center of the row.

Although installation and mechanization of single-stake supports may be less challenging than wire hoops, increased system cost for shorter spacing between supports suggests wire hoops may continue to be a better alternative.

Acknowledgements

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References


