EXTENSION
UtahStateUniversity

Non-Chemical Control to Reduce Losses from Stink Bug and Beet Curly Top Virus in Commercial Tomato Production

Project Summary

In a 2018 survey, Utah vegetable producers reported that their main crop losses came from insects and related plant diseases. In Utah's commercial tomato production, fruit injury from stink bugs and beet curly top virus can cause significant economic loss. This project investigated the use of non-chemical control methods to reduce losses from these pests by conducting trials on both USU and commercial vegetable farms.

Objective 1

Determine whether a trap-cropping system using sorghum or sunflowers will reduce stink bug damage on tomatoes.

This objective was carried out on four commercial and two UAES research vegetable farms during the 2019 and 2020 growing seasons. The trial was replicated at the UAES-Greenville Farm in Cache County, UAES-Kaysville Farm in Davis County, Holmgren Farm in Box Elder County, Mortinson Farm in Salt Lake County, and Hatfield Farm in Utah County. Each farm used in the study reported having prior yield losses from stink bugs and beet curly top virus. Each farm site was set up with a control plot (Figs. 1 & 3) and a variable plot (Figs. 2 & 4). Production practices mimicked industry standards used by commercial farmers in the state. Each plot had tomatoes ('Sunbrite' variety) that were planted in 4 of the 10 rows. Rows were 11 ft long and spaced 3 ft apart. Individual plants were spaced 20 inches apart. In 2019, black plastic mulch was used for weed control, and in 2020 black weed barrier fabric was used. Drip line irrigation was used in both seasons. All sites in both seasons received the same type of fertilization, trellising, and maintenance.

In the 2019 trials, dwarf grain sorghum ('Bicolor' variety) was used as a trap crop in the 4 variable plots. Sorghum was selected after referencing studies from the University of Florida[1], Auburn University[2], and the USDA-ARS Crop Protection and Management Research Laboratory in Tifton, GA[3]. All reported sorghum as effective in attracting stink bugs and other Hemiptera species away from desired cash crops. In the 2020 trials, sunflowers (a mix of 'Zohar', Peredovik', and 'Sunny Smile' varieties) were used as a trap crop in the 4 variable plots. Sunflowers were selected based on studies from Pennsylvania State University[4] and Florida A&M University[5]. They reported sunflowers as effective in reducing hemiptera species in the desired cash crops. In both seasons, trap crops were planted at the appropriate time to reach maturity at the same time as the tomato crop. Trap crop effectiveness was monitored by weekly visual inspection for stink bugs by observing a random selection trap crops and tomato plants. At harvest, tomato fruit deemed unmarketable due to insect feeding damage was weighed separately as a measure of culled fruit.

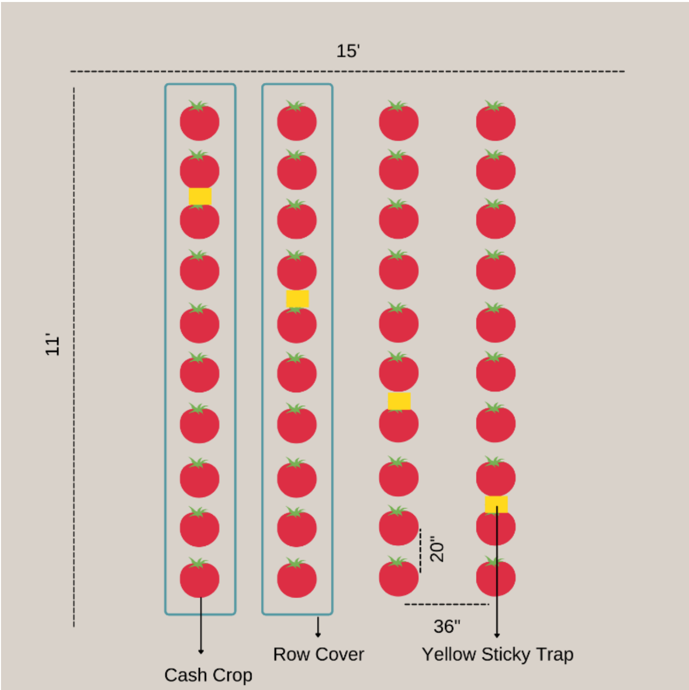

Fig. 1 Field experimental design used for control plots in 2019.

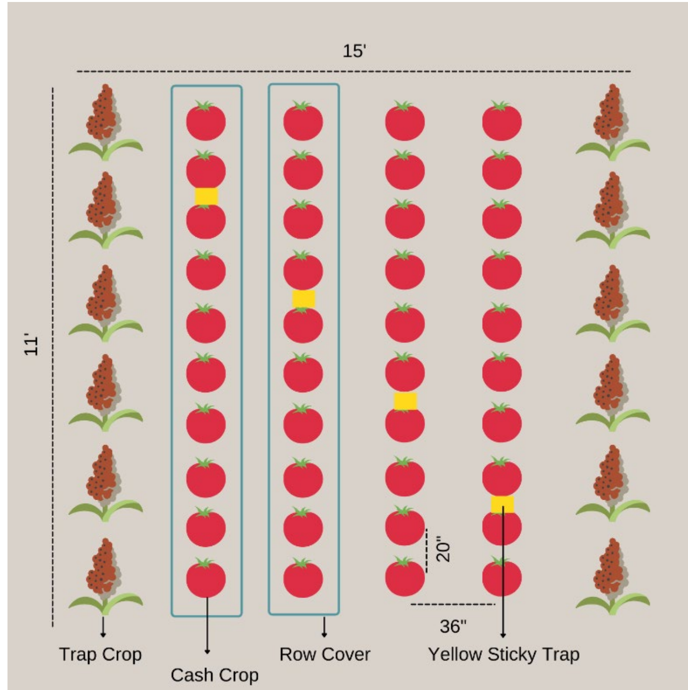

Fig. 2 Field experimental design used for variable plots in 2019.

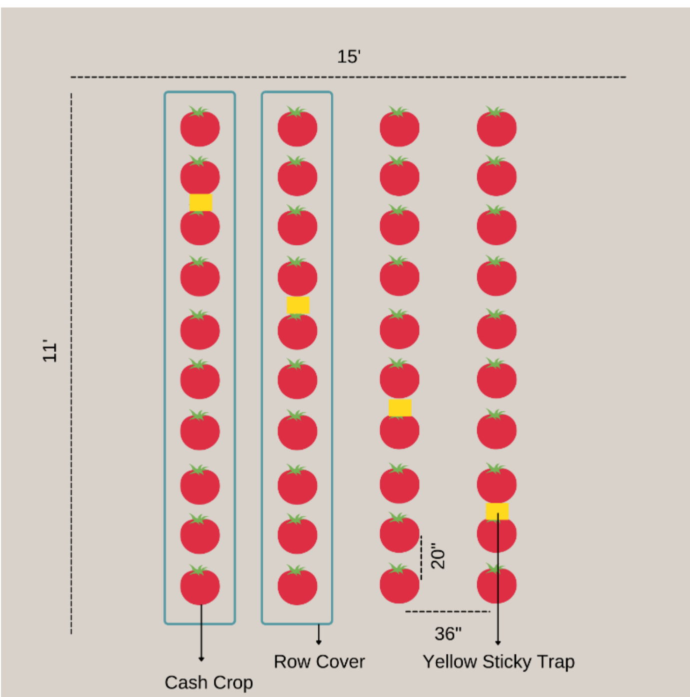

Fig. 3 Field experimental design used for control plots in 2020.

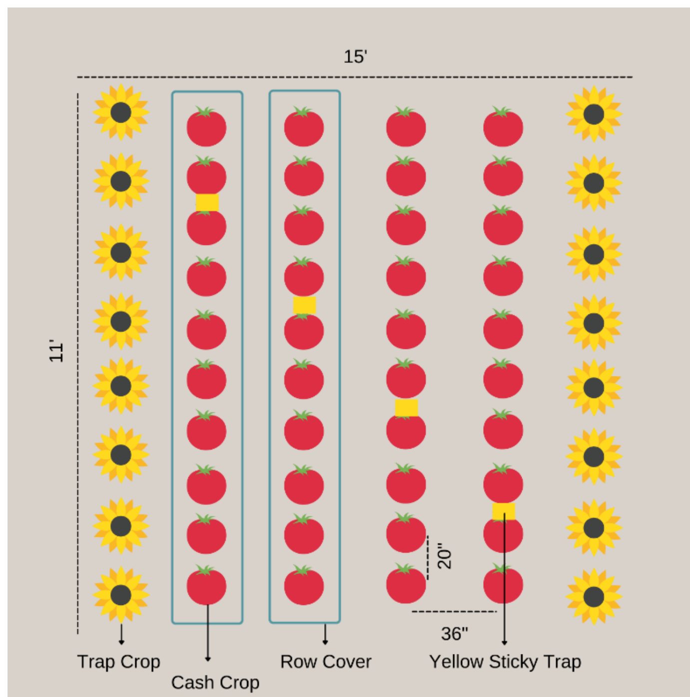

Fig. 4 Field experimental design used for variable plots in 2020.

Trap Crop Results: Throughout both seasons, the sorghum, sunflowers, and tomatoes were regularly inspected for signs and symptoms of stink bugs (Figs. 5&6). In 2019, Utah experienced abnormally high stink bug populations, this mainly included *Thyanta* spp.. This was likely due to environmental factors such as the wet spring, delayed start to summer, and sporadic cooling rains. Regardless, stink bugs were rarely observed in our experimental plots. Due to minimal evidence of stink bug infestation, the effectiveness of our trap crops was measured by harvest yields, comparing the variable to control plots. Tomatoes were harvested during a 3-4-wk period. At the end of the season, total yield weights were analyzed and compared (Figs. 7 & 8). Tomatoes were categorized as marketable or cull. Cull included tomatoes with sunburn, shape deformities, or general pest damage. In the 2020 season, cull tomatoes were further sub-categorized as to whether they had insect feeding damage. Stink bugs feed with piercing-sucking mouthparts which can lead to dimpling and clouding on tomato fruits. Other true bugs can cause similar damage.

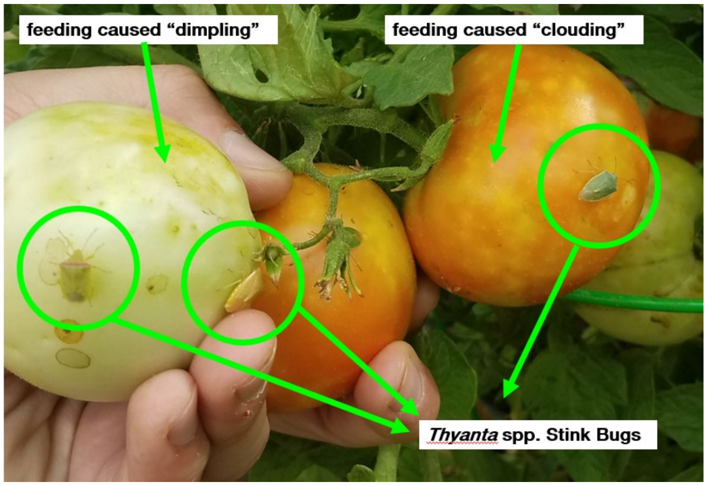

Fig. 5. *Thyanta* spp. stink bugs observed in tomato fields causing dimpling and clouding feeding damage to the fruit.

Fig. 6. Stink bug nymph observed on dwarf grain sorghum trap crop.

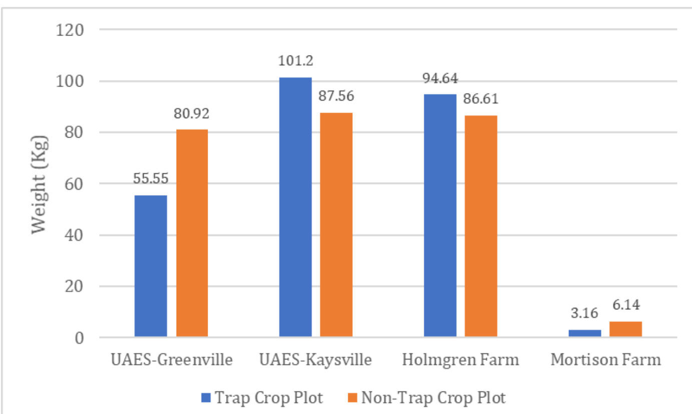

Fig. 7. Total yield of tomatoes in plots with trap crops compared to those with no trap crops in 2019.

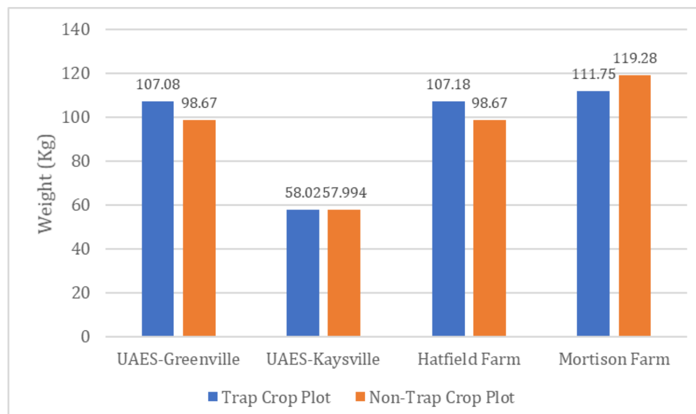

Fig. 8. Total yield of tomatoes in plots with trap crops compared to those with no trap crops in 2020.

	UAES-Greenville		UAES-Kaysville		Holmgren		Mortison	
	Yield Total (kg)	% of Cull/Plot	Yield Total (kg)	% of Cull/Plot	Yield Total (kg)	% of Cull/Plot	Yield Total (kg)	% of Cull/Plot
Variable-Marketable	29.7	46.6%	65.1	35.7%	74.2	21.6%	1.3	58.9%
Variable-Cull	25.9		36.1		20.4		1.9	
Control-Marketable	46.4	42.7%	58.8	33%	60.9	86.6%	2.8	54.4%
Control-Cull	34.5		28.7		25.7		3.3	

Table 1. Yield weights of marketable and cull tomatoes in 2019.

	UAES-Greenville		UAES-Kaysville		Hatfield		Mortison	
	Yield Total (kg)	% of Insect Damage/Plot	Yield Total (kg)	% of Insect Damage/Plot	Yield Total (kg)	% of Insect Damage/Plot	Yield Total (kg)	% of Insect Damage/Plot
Variable-Marketable	40.8	6.18%	35.5	41.9%	75.7	7.2%	88.1	8%
Variable-Cull	6.4		16.5		23.7		14.7	
Variable-Cull (Insect)	3.2		37.5		7.7		9	
Control-Marketable	24.2	5.09%	37.1	39.9%	65.1	15.4%	71	29.3%
Control-Cull	3.8		12.7		18.3		13.2	
Control-Cull (Insect)	2.8		33.2		15.3		35	

Table 2. Yield weights of marketable and cull tomatoes in 2020.

Total yield weights of plots with and without trap crops indicated no clear patterns (Tables 1 & 2). The variable plots did not always have less insect damaged fruit as expected. In some locations, the control plots had more marketable fruit. This may be due to variation in soil quality or nutrition across the plots in some locations, lack of significant stink bug presence, lack of attraction of trap crops to stink bugs and other Hemiptera within the given plot design (e.g., ratio of trap to cash crop), or operator variation in fruit sorting at harvest. The percentage of culled fruit was exceptionally high in all locations in 2019, particularly at the Mortison Farm. Culled fruit were again high at UAES-Kaysville in 2020, but lower in the other locations. The percentage of culled fruit due to insect damage was similar among the control and variable plots, except at the Mortison Farm, where it was 3 times higher in the control plot.

The average marketable yields were24.89 kg for plots without trap crops and 23.51 kg for plots with trap crops. These values were not significantly different, with a p-value of 0.93. A stronger difference may have been observed with a larger sample size.

Objective 2

Determine whether the early-season application of row covers will reduce the incidence of beet curly top virus on tomatoes.

This objective was carried out on the same four commercial vegetable farms as the trap crop component of the trial. In both years, the row cover trials were integrated into the same plots used for the trap crop trials. Due to the different life cycles of the pests being observed, it was expected that neither the trap crop component nor row cover component of this project would affect one another.

For both the 2019 and 2020 seasons, row covers were used on 4 of the 8 ten-plant rows (see Figs. 1-4). Agribon AG-15 spun-bonded fabric was used in 2019 and ProtekNet insect netting was used in 2020. Row covers were installed when the tomatoes were planted (mid-May) and disassembled in mid-June. This 5-6-wk period is when beet leafhoppers (vectors of the beet curly top virus) were estimated to be moving from weedy hosts to vegetable hosts, including tomatoes.[12] All 8 tomato rows at each site had one yellow sticky trap placed within each exposed and covered row. Each week, general leafhopper numbers on the traps were recorded, and suspect beet leafhoppers were collected for identification through analysis. Throughout the season, the tomato plants themselves were closely monitored for symptoms of the beet curly top virus. Any suspect positive plants were sampled and tested by PCR methods in the Nischwitz lab.

Row Cover Results: Row covers proved highly effective in excluding leafhopper populations. In 2019, the number of leafhoppers per site rose from early June through early August, but the covered rows had consistently fewer numbers than the exposed rows (Fig. 9). In 2020, the number of leafhoppers dropped from early June through late July, but the covered rows still had consistently fewer numbers than the exposed rows (Fig. 10). This difference between years may have been due to the physically lower placement of the traps compared to the 2019 season. As the tomatoes grew, the traps became covered by foliage in the 2020 seasons.

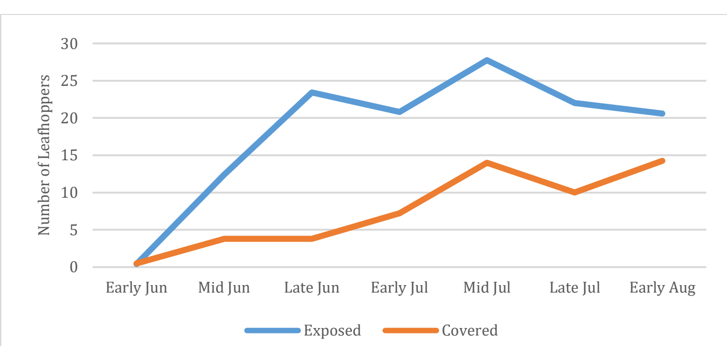

Fig. 9. Mean number of leafhoppers on traps in tomato plots, 2019.

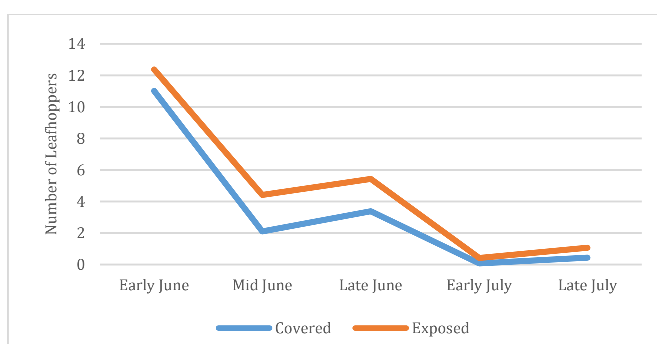

Fig. 10. Mean number of leafhoppers on traps in tomato plots, 2020.

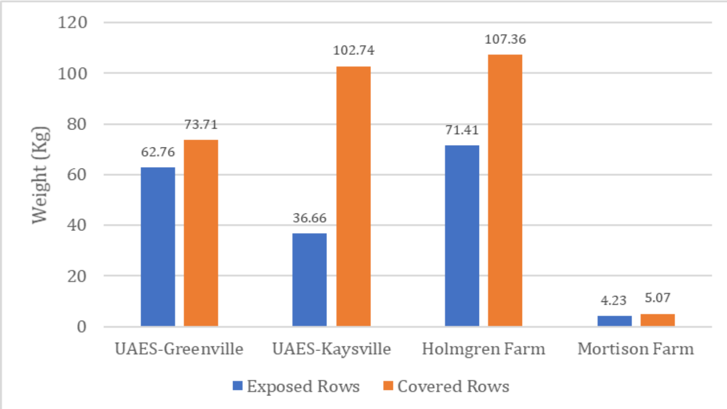

Fig. 11. Total yields of covered tomatoes vs exposed tomatoes in 2019

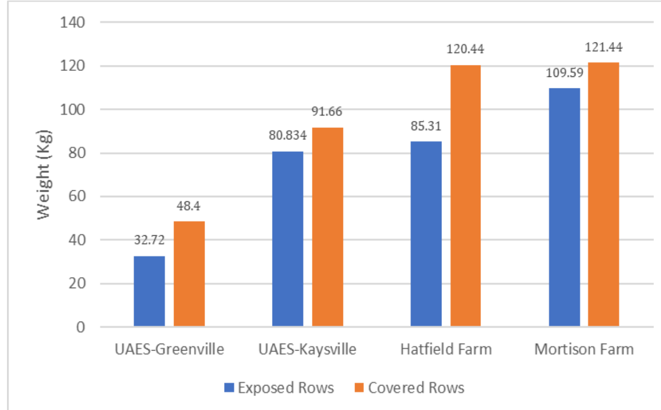

Fig. 12. Total yields of covered tomatoes vs exposed tomatoes in 2020

In both seasons, the tomato rows that were covered had higher yields than exposed rows. This was likely due to the early season protection from beet leafhoppers, other pests, and abiotic conditions (e.g., cold nighttime temperatures), and potential for heat retention under the covers. The covered rows in Greenville had a 17.4% yield increase from the exposed rows in 2019 and a 47.9% increase in 2020. Kaysville saw a 180.3% and13.4% increase. Mortison Farm had a 19.9% and 10.8% increase. In 2019, Holmgren Farm had a 50.3% yield increase. In 2020, Hatfield Farm had a 41.2% yield increase (see Figs. 11 & 12).

Throughout both seasons, various tomatoes in the trial plots were randomly selected for testing for beet curly top virus. None of the plants tested positive. However, other tomato plants grown nearby on the farms (not included in the trial) were sampled, and they tested positive for the virus. This indicated there was a presence of the virus, but the beet leafhoppers vectoring it did not contact the exposed or covered tomatoes in our trials. The presence of the row covers over two tomato rows in the study plots may have deterred beet leafhoppers from the two exposed rows. Beet leafhoppers utilize visual and chemical (odor) cues to locate potential host plants.[12]

Objective 3
Determine the practicality of using both trap cropping and row covers for tomato growers from factors such as land use, additional costs, water use, time, and labor.
Scientific literature currently demonstrates that both row covers and trap cropping systems are an effective means of pest control. For Utah's vegetable production, their effectiveness relies on factors such as application timing, weather, crop selection, location, current practices, and target pests.

Our study showed promising data for row covers, especially in increasing yields. Depending on materials used, field size, and other factors, costs and labor may support use of row covers.

Further on-farm research is needed to evaluate different trap cropping systems to determine consistently effective trap crop species and size of plantings required in Utah's vegetable production. In this study, trap crops were planted in single rows around the edge of the plots. A higher ratio of trap to cash crop may be needed to support reduction of stink bugs and other Hemiptera in tomato fields.

When a statistical analysis of the data was done, it showed an average marketable yield of 49.78 kg for our covered tomato rows and average marketable yield of 37.93 kg for our uncovered tomato rows. This gave a p-value of 0.24. A stronger significance may have been observed with a larger sample size.

Changes/Problems

There were no changes in research schedules or budget expenditures. Due to the ineffectiveness of the dwarf grain sorghum trap crop in 2019, we switched the trap crop to sunflowers in 2020. In 2019, mule deer were a major challenge at Mortison farm in Salt Lake County. Early season feeding damage led to dramatic yield loss at harvest. This was combatted in 2020 by using a fencing barrier around the plots. The wind was also a major challenge both seasons for the row covers. Regular strong gusts at various locations would displace row covers and require reconstruction. The periods of cover displacement may have influenced leafhopper results.

We expected greater effectiveness of the trap crop systems than observed. The yield weight data and visual observations were inconsistent and showed no clear pattern in efficacy of trap crops. This could be due to low stink bug populations at trial sites, inappropriate trial design, or ineffective choices of trap and cash crops. Though our trap crop results were minimal for this trial, enough scientific literature demonstrates their effectiveness suggesting that they could still be considered a viable option for insect management in Utah vegetable production. Additional studies are required to explore these or other trap crops. It is highly suggested to evaluate larger ratios of trap to cash crops to determine if this field design could be effective.

References

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