INTEGRATED MANAGEMENT OF THRIPS AND TOMATO SPOTTED WILT VIRUS IN FIELD-GROWN FRESH MARKET TOMATOES

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Abstract. During the spring tomato growing season in north Florida and south Georgia, the primary threat to yields is Frankliniella occidentalis, or western flower thrips. Thrips feed on flower tissue, pollen, and developing fruit and transmit tomato spotted wilt virus (TSWV), which may infect plants at a rate of 10% to 50% and above during an epidemic year. Of the different IPM practices currently available, resistant varieties, UV-reflective (metallized) mulches, and acibenzolar-S-methyl (Actigard) are three tools that have shown great potential for lowering thrips numbers and incidence of TSW in fields. A survey was conducted during August and September 2002 to document tactics currently being used in north Florida and south Georgia to minimize damage caused by thrips and TSW and to determine the level of adoption of IPM practices by area growers. Of surveyed acreage, results showed that 8% of planted tomatoes utilized UV-reflective mulches, while 69% was planted using TSW-resistant varieties. Corresponding yields were 2100 boxes/acre for reflective mulch plantings, 2068 boxes/acre for resistant varieties and 1800 boxes/acre for growers planting on black mulch without resistant varieties. Incidence of TSW was similar, with 5.7% infection when reflective mulches were used, 8% infection with resistant varieties, and 16% infection when neither IPM technique was employed. Actigard was used by 55% of growers and only 17% of growers did not use reflective mulches, resistant varieties, or Actigard in their operations to combat TSW. All growers scouted for thrips on a weekly basis, and insecticide sprays averaged 12-20 times for the spring season. Although most growers (>75%) have adopted multiple IPM tactics for combating thrips and TSW, extension efforts should continue until all tomato operations integrate a combination of these pest management tools into their production practices.

Integrated Pest Management (IPM) is a production philosophy that has been gaining in federal and state research focus since the 1970s. The National Coalition of Integrated Pest Management (1994) defines IPM as “a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks”. Preventative methods include planting disease- and insect-resistant vegetable varieties, cultivation, and destruction of pest overwintering sites, among others, while suppressive pest control methods include use of biological control agents, in-season pesticide sprays, and others that reduce existing pest populations to tolerable levels (Flint and Gouveia, 2001). Research conducted by Bauske et al. (1998) surveyed tomato growers in seven southeastern U.S. states, including north Florida and Georgia, and found these two states to have achieved medium or high levels of IPM adoption (>75% of respondents) by meeting federal mandated guidelines laid out by the Clinton administration in 1993 (Natl. Coal. Integrated Pest Mgt., 1994). Although Florida and Georgia reported the highest percentages of growers in the medium and high IPM categories, they also shared the largest numbers of insecticide applications during the growing season, listing thrips and TSW as their greatest pest concerns during the spring (Bauske et al., 1998).

Florida production of fresh market tomatoes accounts for 40% of the United States supply (Bloem and Mizell, 2000). The north Florida tomato industry, although centered in Quincy, Fla., includes tomatoes grown and packed in Gadsden, Jackson, and Liberty Counties, Fla., as well as Decatur and Grady Counties, Ga. Western flower thrips (WFT) (Frankliniella occidentalis) first appeared in Georgia in 1981 (Beashear, 1985) and Florida in 1986 (Bloem and Mizell, 2000; Kucharek et al., 1990). Damage was first identified as cosmetic indentations on small fruit, known as ‘halospotting’, and caused by female oviposition of F. occidentalis, resulting in cull fruit (Salguero Navas et al., 1991b). Not long after, TSW appeared in Florida in 1988 (Bloem and Mizell, 2000) and WFT were found to be the primary vector.

Subsequent research has determined that among the six species that vector TSW, F. occidentalis, onion thrips (Thrips tabaci), and tobacco thrips (F. fusca) occur in Florida (Kucharek et al., 1990). Thrips are common between late April and early June, with greatest densities occurring during May within a 2- to 3-week window (Salguero Navas et al., 1991a). As pest populations increase in tomato fields, growers find insecticide sprays alone fail to reduce thrips numbers (Brown and Brown, 1992; Kucharek et al., 1990) or incidence of tomato spotted wilt. Also, some carbamate and organophosphate insecticides heavily relied upon, such as methamidophos, are considered as ‘high risk’ by the Food Quality Protection Act (FQPA) and may be unavailable for use in the future (Momol et al., 2000). Therefore, finding effective IPM practices for tomato production will be crucial for survivability in the future.

One such practice is the planting of tomatoes on aluminumized mulch, or UV-reflective mulch. Terry (1997) discussed the importance of color for thrips host finding, stating their preference for low UV-white, blue, and yellow hues. Since UV reflectance is high (>75%) (Olson et al., 2002), aluminumized mulches interfere with thrips host-seeking behavior, making surfaces of otherwise attractive colors repellent (Vernon and
Gillespie, 1990). Greenough and Black (1990) found that immigration of thrips into fields and subsequent TSW incidence was reduced for tomato, pepper, and tobacco produced with reflective mulches, and Stavisky et al. (2002) reported decreased numbers of *F. occidentalis*, and 50% reduction of disease incidence as a result of mulch reflectance.

An alternative to reflective mulches is plant resistance. New tomato cultivars resistant to TSW have been developed and more work is currently underway to evaluate germplasm that might have future potential. Resistance to TSW is conferred by a single dominant gene (*Sw-5*) (Scott, 2000), and although this is one of the best means for disease control, an integrated production approach is necessary to prevent resistance development in thrips (Momol et al., 2000). Currently, most TSW-resistance is found in select BHN varieties (BHN Seed, Bonita Springs, Fla.), and these accounted for 10-13% of planted Florida acreage according to 2000-2001 records (Maynard and Olson, 2000, 2001).

Lastly, systemic acquired resistance (SAR) inducers are new compounds being used in commercial tomato production. Acibenzolar-S-methyl (Actigard; Syngenta Crop Protection, Greensboro, N.C.) has recently been labeled for use on certain vegetables and has been shown to induce systemic acquired resistance against a broad range of pathogens (Momol et al., 2000).

A sustainable IPM program will incorporate several of these and other tactics to manage thrips and TSW. The objective of this survey was to document which tactics are being used in north Florida and south Georgia to minimize damage caused by thrips and TSW and to determine the level of adoption of IPM practices by area growers.

**Materials and Methods**

A survey was compiled during the summer of 2002 by county extension agents in Florida and Georgia and UF extension specialists to determine IPM practices of local tomato growers. Spring 2002 proved to be an epidemic year for thrips and TSW outbreak. The survey was conducted primarily by on-farm interviews and phone calls. The first part inquired about growers’ implementation of UV-reflective mulches for thrips management and determined acres covered under black mulch versus reflective mulches, TSW incidence for both systems, yield per acre, and overall effectiveness of reflective mulches.

The second part of the survey sought to record how much production took place using TSW-resistant tomato varieties and their effectiveness for disease management. Actigard usage and effectiveness was also determined.

The third part of the survey inquired about growers’ scouting and spray practices. Questions asked determined frequency of scouting activities and sprays for thrips. Finally, current and future research needs requested of extension by growers was recorded and ranked based on priority.

Economic analysis was conducted during Spring 2003 to determine cost of production using UV-reflective mulches and TSW-resistant tomato varieties and net return to the farm when compared with planting on black mulches.

**Results and Discussion**

The spring 2002 production season proved an epidemic year for TSW incidence. Although production was high, losses were significant. Approximately 80% response was achieved by the survey, accounting for 90% of total tomato acreage for the spring crop. Survey results showed that on approximately 1813 acres of spring tomatoes, only 8% of total acreage was grown on UV-reflective mulches, accounting for 25% of growers utilizing it, while 50% of growers planted TSW-resistant varieties, accounting for approximately 69% of surveyed acreage. There was no acreage that utilized both reflective mulches and TSW-resistant varieties, so it is unknown if improved thrips and disease management would be achieved by combining those cultural practices. Also, it was found that 22% of total acreage was grown without using either reflective mulches or TSW-resistant varieties for disease management.

Less than half of all growers reported yield data, but of those who did, it was determined that for reflective mulches, average yield was 2100 boxes per acre, while yield for TSW-resistant acreage was 2068 boxes per acre. Farm operations that used neither reflective mulches or resistant varieties averaged 1800 boxes/acre (Fig. 1).

Due to the thrips outbreak in 2002, TSW was correspondingly high. Infection rates ranged from 0% to 50% on some farms. For those using reflective mulches, disease incidence ranged from 2% at the low end to 8% at the high, with an average of 5.7% infection. Disease incidence on TSW-resistant fields was reported to be 0% at the low and 50% at the high, although the average rate of infection was much lower (approx. 8%-12.5%). Tomato acreage on black mulch with no resistant varieties planted averaged 16% infection during the growing season (Fig. 2).

Analysis was conducted spring 2003 to determine possible economic benefits of reflective mulches and resistant varieties to growers (Table 1). It was found that the cost of planting and harvesting was higher for both resistant varieties and UV-reflective mulches ($1301/acre and $1599/acre, respectively) compared to planting on black mulch using non-resistant varieties. However, net return as a result of having more harvestable fruit of marketable quality was $709/acre for fields planted with resistant varieties and $652/acre for fields planted with reflective mulches. These figures correspond with

![Fig. 1. Effect of integrated pest management cultural practice on tomato yields in north Florida and south Georgia during spring 2002. Yields are expressed in 25-lb. boxes harvested per acre.](image-url)
farm data obtained from one local grower in south Georgia who uses reflective mulches. During an epidemic year, these IPM cultural practices prove invaluable, and data further shows increased production costs are justified by returning profits to farms that would otherwise be lost due to disease incidence.

Acibenzolar-S-methyl (Actigard) was used by 55% of growers to aid in disease management, accounting for 45% of total planted acreage, being used by growers on reflective mulch and with TSW-resistant varieties, as well as by growers who simply planted on black plastic mulch. From this study, it was difficult to quantify disease and yield numbers, or growers' attitudes toward Actigard as a disease management tool. However, work done by Momol et al. (2000) showed that applications of Actigard did not enhance disease management in reflective mulch plots, while TSW reduction was observed when Actigard was used on tomatoes grown on black plastic.

Survey results did show that 17% of growers used neither resistant varieties, reflective mulches, or Actigard for thrips and disease management, accounting for 17% of total tomato acreage in 2002. These statistics show that these few growers fall within the low IPM user range, as defined by Vanderman et al. (1994) and Bauske et al. (1998), since only scouting and insecticide sprays were used for pest management. This low level of IPM adoption is no longer a recommended practice.

The third part of the survey analyzed growers' scouting and spray practices. Results showed that all growers scouted fields weekly, while 82% scouted twice per week. All growers sprayed for thrips once or twice per week, and insecticide spray frequency averaged 12-20 times per season. It was unclear from the data provided if there were one or two growers who sprayed less. Time of spraying always coincided with the time of peak thrips outbreaks each year occurring from late April through early June. These findings coincide with other research that has recorded the high number of insecticide sprays tomato growers apply to manage thrips (Bauske et al., 1998; Brown and Brown, 1992). Growers who rated insecticide effectiveness as poor were also those who did not include methamidophos (Monitor; Arvesta Corp., San Francisco, Calif.) into their production strategy. Conversely, all growers who rated insecticide effectiveness as good used Monitor, and 88% of growers using Monitor incorporated other materials, mainly pyrethroids such as cyfluthrin, fenpropathrin, and lambda-cyhalothrin, into their spray programs to increase effectiveness. Kucharek et al. (1990) suggested combining pyrethroids with other insecticides as they have been noted for flushing out thrips. Spinosad (Spin Tor, Dow AgroSciences LLC, Indianapolis, Ind.), a naturalyte insect control product composed of spinosyns A and D, and of considerably lower toxicity, was included in the spray programs of 82% of survey respondents. Spin Tor and Monitor, although not efficient in managing primary spread of TSW in tomatoes, have both been shown to be effective in reducing late-season secondary disease spread regardless of mulch type used (Olson et al., 2002).

In conclusion, when asked what growers think to be the most important research needs of tomato growers in the north Florida/south Georgia area, they listed 1) more effective means for thrips and TSW management, 2) whitefly and tomato yellow leaf curl virus control during fall production, 3) methods for managing bacterial spot (Xanthomonas campestris pv. vesicatoria) during fall production, and 4) control tactics for two-spotted spider mite (Tetranychus urticae Koch.). Other areas of research needs included bacterial wilt (Ralstonia solanacearum), southern blight (Sclerotium rolfsii), and fusarium wilt (Fusarium oxysporum f. lycopersici) management strategies, and finding replacements for methyl bromide.

Survey results showed that the north Florida/south Georgia tomato production region has achieved the goal of 75% adoption of IPM practices by 2002 (Natl. Coal. Integrated Pest Mgt., 1994). Eighty-two percent of growers used either reflective mulches + Actigard, or TSW-resistant varieties + Actigard to manage thrips and TSWV. During years of epidemic TSW occurrences, reflective mulches and resistant varieties are relatively equal in their ability to justify additional costs and return economic benefits to growers. Future extension efforts should focus on improving techniques currently in place and in continuing to educate clientele on benefits of improved IPM production systems.

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**Table 1. Value of integrated pest management cultural practices for decreasing incidence of tomato spotted wilt (TSW) for north Florida and south Georgia commercial growers during spring 2002.**

<table>
<thead>
<tr>
<th>IPM Practice</th>
<th>Yield (25-lb boxes)</th>
<th>Add. revenue ($/acre)</th>
<th>Add. prod. cost ($/acre)</th>
<th>Net return ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistant*</td>
<td>2308</td>
<td>2070</td>
<td>1801</td>
<td>709</td>
</tr>
<tr>
<td>UV mulch†</td>
<td>2100</td>
<td>2250</td>
<td>1599</td>
<td>652</td>
</tr>
<tr>
<td>Bl. mulch*</td>
<td>1800</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Tomatoes produced using TSW-resistant varieties.
†Tomatoes produced on UV-reflective mulches, with reflectance approx. 75% or greater.
*Tomatoes produced on black plastic mulch using non TSW-resistant varieties.

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**Fig. 2.** Tomato spotted wilt virus incidence as affected by integrated pest management cultural practices in north Florida and south Georgia tomato crop during spring 2002.
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**Literature Cited**


