Economic Impact of the Two-Spotted Spider Mites (*Tetranychus Urticae*) on Strawberries Grown as a Perennial

Greg English-Loeb and Steve Hesler

Department of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY.

Currently, an economic threshold of 5 mites per leaf has been recommended for perennial strawberries grown in New York; however, it is not clear if this threshold is valid during the establishment year. Moreover, the threshold of 5 mites per leaf may be conservative for established plantings during the vegative growth stage (mid-summer to fall). Our current research suggests that June-bearing strawberries are tolerant of mite damage during the establishment year. We could not detect an impact on yield when infestation reached 10 mites per leaf and we suspect that thresholds could be raised to at least that number before treatment is warranted. Similarly, established plantings can likely tolerate 20 mites per leaf during late summer without reducing yield the next season.

Two-spotted spider mite (TSSM) *Tetranychus urticae*, can be a serious pest of strawberries. This appears to be especially true in regions where strawberries are grown in an annual production system as is used in California (Strand 1994). In fact, research over the past 20 years has concentrated on the impact of TSSM on strawberry grown as an annual (Sances et al. 1982, Gimenez-Ferrer et al. 1994, Walsh et al. 1998), while information on the impact of spider mites on strawberry grown as a perennial has received little recent attention. Currently, an economic threshold of 5 mites per leaf has been recommended for perennial strawberries grown in New York (Kovach et al. 1993), although this estimate is based mostly on anecdotal observations rather than manipulative experiments. It is unclear whether this threshold should vary with the year of planting or the time of season. For this project we assessed the impact of *T. urticae* on strawberries grown using a perennial production system, the system predominantly used in the Northeast.

The majority of strawberries that are grown in the Northeast are June-bearing varieties. These cultivars undergo different developmental processes depending on whether day lengths are getting longer or shorter (Pritts and Handley 1998). Thus, as day lengths shorten (summer and fall) plants initiate flower buds and produce vegetative runners. The following spring, when days are lengthening, plants flower and fruit mature. Mite feeding at these different developmental periods may have different effects on subsequent yield. Age of the planting may also influence the impact of spider mite damage. In particular, first year plants, due to their smaller size, may be less tolerant of spider mite injury than older plants. Moreover, the matted row system typically used in the Northeast relies on vigorous growth the first year, with the production of an abundance of runners in order to maximize yields in the second growing season. Mite injury may reduce growth and runnering. The purpose of this three-year project was to develop baseline data on the impact of TSSM on June-bearing strawberries grown in New York, data which can be used to refine economic thresholds. Our objectives were:

1. To assess the impact of *T. urticae* on perennial strawberry during the year of establishment.
2. To assess the impact of *T. urticae* on established perennial strawberry as a function of time of season.

This report focuses on results from the third year in which we evaluated the impact of previous injury on yield.

Methods

A new planting of June-bearing strawberries was established in late May 2001 at the New York State Experiment Station in Geneva, New York. The planting consisted of 30 rows approximately 22 meters in length with four-foot spacing between rows using three rows of the cultivar 'Honeoye' followed by three rows of the cultivar 'Jewel' across the planting. This plot was used to assess impact of TSSM damage on established strawberries. During 2001 plants showed some symptoms

We divided the 2002 planting into 25 plots (six rows [three Earliglow and three Cavendish] by 4.5 m) and assigned them to one of five treatments: 1) No spider mite damage; 2) Low level of mite damage during growth and sexual reproductive phase (June to August, 2002, although plants were not allowed to mature fruit), 3) High level of mite damage during growth and sexual reproductive phase; 4) Low level of mite damage during vegetative reproductive phase (runnering, August through mid-October, 2002); 5) High level of mite damage during vegetative reproductive phase. Each treatment was replicated five times for each cultivar. Miticide (Kelthane 35 WP at 3 lb/A rate in 50 to 100 gallons of water) was applied once at borders of each replicate plot (down edge rows) and a two-foot section between replicate plots (across rows) to maintain treatment integrity.

Approximately three weeks after planting (18 June 2002), TSSM were added to treatments two and three (early-season damage). Mites were obtained from a laboratory colony and reared on strawberry. Each plant of the center four rows of each plot assigned to treatment two (early season, low impact) was infested with from 10 to 20 large motile TSSM plus eggs. Similarly, each plant of the central four rows of plots assigned to treatment three (early season, high impact) was infested with 30 to 40 motile TSSM plus eggs. We treated control plots (treatment one) and plots assigned to late-season damage treatments (four and five) with a miticide (Kelthane 35WP, 2.5 lb/A, 75 gallons per A of water) on 11 July to kill TSSM. Control plots were again treated with Kelthane on 5 August 2002. All plots were treated with a pyrethroid insecticide (Asana [esfenvalerate]) at a rate of 1.5 to 7 fl. oz./A several times during the season to reduce populations of predatory mites.

Plants in our 2001 planting were kept mite free in 2001. At the start of the 2002 season we divided it into 25 plots (six rows [three Honeoye and three Jewel] by 4.5 m) which were assigned to one of five treatments: 1) No spider mite damage; 2) Low mite damage during vegetative reproductive phase (runnering, August through mid-October, 2002); 3) High mite damage during vegetative reproductive phase; 4) Low level of mite damage during growth and sexual reproductive phase (May-June 2003); and 5) High level of mite damage during growth and sexual reproductive phase. Each treatment was replicated five times for each cultivar. TSSM from our laboratory colonies were released on plants in the center four rows of plots assigned to late-season damage (treatments two and three) on 8 August, after regrowth of plants following renovation. Plots assigned to low mite damage (treatment two) received approximately 350 motile mites plus eggs while plots assigned to high mite damage (treatment three) received 700 motile mites plus eggs. We treated control plots (treatment 1) and plots assigned to early-damage in 2003 (treatments four and five) with a miticide (Kelthane 35WP, 2.5 lb/A, 75 gallons per A of water) on 22 August 2002 and 18 September 2002 to kill TSSM. All plots were treated with a pyrethroid insecticide (Asana [esfenvalerate]) at a rate of 7 fl. oz./A once during August to reduce populations of predatory mites. In the spring of 2003 TSSM from our laboratory colonies were released into plots assigned to receive a low or high level of mite damage during the growth and fruiting period (treatments four and five, respectively). Treatment four plots received approximately 600 motile mites plus eggs while treatment five plots received approximately 1,200 motile mites plus eggs on 27 May.

Mite populations in each planting were estimated approximately every week from 26 June through September in 2002 and in the established planting during June of 2003. Census data were used to estimate accumulated mite days for each cultivar in each plot during the season. Accumulated mite days provides a quantitative assessment of mite injury to plants and is determined by multiplying the number of days between two successive censuses by the average number of mites per leaflet between the same two successive censuses. Yield was assessed in 2003 in all plots of both plantings by collecting, counting and weighing ripe fruit from one meter sections systematically placed within each cultivar of each plot over about a three week period (until fruit was small and not marketable).

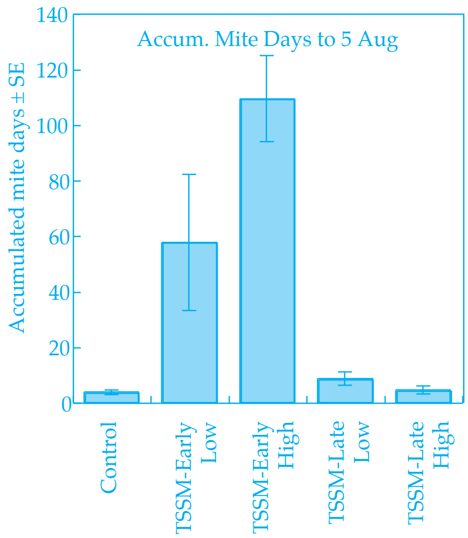

Figure 1. Accumulated mite days (± standard error) from 21 June to 5 August 2002 for strawberry plants assigned to different levels and timings of feeding injury from Two-spotted Spider Mite (TSSM).

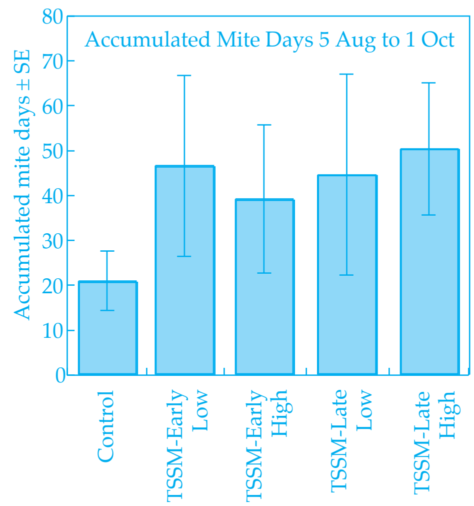

Figure 2. Accumulated mite days (± standard error) from 5 August to 1 October 2002 for strawberry plants assigned to different levels and timings of feeding injury by Two-spotted Spider Mite (TSSM).

Results

Effects of Mite Abundance in the Establishment Year. We were successful in establishing TSSM in plots of our 2002 planting assigned to the early-season treatments, although accumulated mite days (AMD) were not as high as we had originally desired (Figure 1). AMD were generally low in control plots and plots assigned to the late-season treatments. Moreover, high impact plots had about 1.5 more AMD than low impact plots (Figure 1). TSSM densities per leaf peaked between 16 July and 23 July with an average of 6.8 motile mites per leaf (SE = 1.5) on plants assigned to the high mite impact treatment and 4.3 motile mites per leaf (SE = 2.2) for plants assigned to low mite impact treatment. Our currently recommended economic threshold is 5 mites per leaf. AMD during the second half of the experiment was less than achieved during the first half and was similar among the four treatments infested with

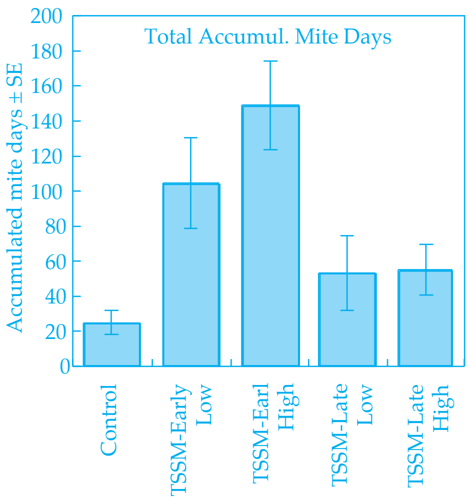

Figure 3. Accumulated mite days (± standard error) from 21 June to 1 October 2002 for strawberry plants assigned to different levels and timings of feeding injury by Two-spotted Spider Mite (TSSM).

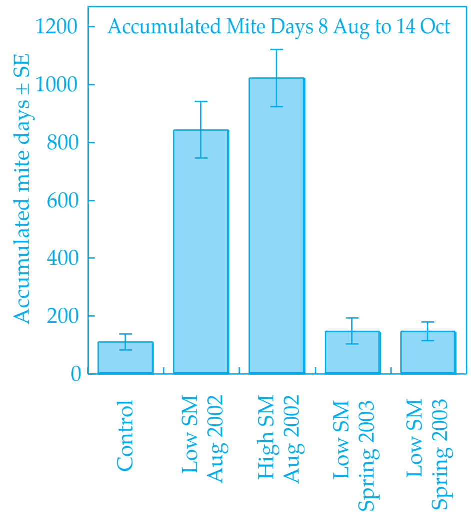

Figure 4. Accumulated mite days (± standard error) from 8 August to 14 October 2002 in plots of a second year planting of strawberries assigned to different levels and timings of injury from two-spotted spider mite (TSSM).

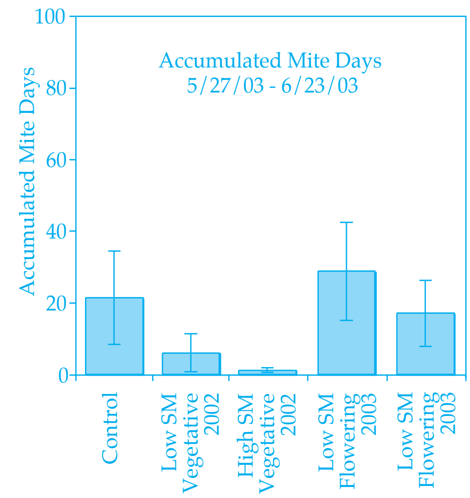

Figure 5. Accumulated mite days (± standard error) from 27 May to 23 June 2003 in plots of a third year planting of strawberries assigned to different levels and timings of injury from two-spotted spider mite (TSSM).

mites (Figure 2). Thus, AMD during the full season was somewhat greater for treatments two and three, that had mites for the entire season, compared to treatments four and five, that only had TSSM during the second half of the season (Figure 3). Peak mite densities in the second half of the season were about the same among treatments and all were below 3 mites per leaf.

The moderate densities of TSSM we achieved during the establishment year (2002) had no impact on either yield ($F_{4,36}$ = 0.165, P = 0.5) nor weight per berry ($F_{4,36}$ = 0.36, P = 0.83) in 2003. Yield did not differ between Earliglow and Cavendish ($F_{1,36}$ = 1.3, P = 0.25), although weight per berry, not surprisingly, was almost twice as much for Cavendish compared to Earliglow (9.8 g/berry vs. 5.5 g/berry; $F_{1,36}$ = 134, P < 0.001).

Effect of Mite Abundance on Established Strawberry Beds. As planned, abundance of TSSM in all plots in our 2001 planting was very low during the flowering and fruiting period of the 2002 season (data not shown). However, mites became quite abundant during the second half of the season in plots assigned to receive mites, reaching a maximum density of 63 motile mites per leaf on 9 September for the high-release plots, and 52 mites per leaf on 23 September for the low-release plots. AMD exceeded 1000 for the high-release plots and over 800 for the low-release plots (Figure 4). Toward the end of the season mite numbers in control plots and plots assigned to receive mites in the spring of 2003, began to build and reached maximum densities of around 6 motile mites per leaf before declining. AMD were below 150 in theses plots.

In the spring of 2003 mite abundance was quite low in all plots despite the release of large number of laboratory-reared mites into plots at the end of May (Figure 5). Average peak densities remained below 2 mites per leaf for all treatments. There was no clear explanation for why mite numbers did not increase during this time period.

High accumulated mite densities in the fall of the proceeding year in an established strawberry planting had no impact on yield the next season nor did very low accumulated mite densities in the current year ($F_{4,36}$ = 0.73 P = 0.58). There was a significant difference between the two cultivars with Honeoye out producing Jewel in 2003 (3,854 g/2m for Honeoye and 2,645 g/2m for Jewel, $F_{1,36}$ = 14.6, P < 0.001). Similarly, we found no treatment effect on weight per berry ($F_{4,36}$ = 1.1, P = 0.38) but berry weight for Jewel was slightly higher than Honeoye (9.3 g/berry for Jewel vs. 8.1 g/berry for Honeoye, $F_{1,36}$ = 15.0, P < 0.001).

Discussion

Our objective for this project was to examine the impact of TSSM on yield parameters of June-bearing strawberries in the Northeast when damage accumulates during different growth periods. Specifically, we were interested in determining to what extent damage during the year of establishment negatively impacted yield the second year and to what extent damage during the vegetative period or damage during the flowering period negatively impacted yield of an established planting. We were only partially successful in accomplishing these objectives primarily because we had difficulty maintaining sufficiently high mite densities in some plots at certain times of the year. We were most successful at developing large populations and damage during the vegetative growth period of an established planting (Figure 4). Average peak densities greatly exceeded the current threshold of 5 mites per leaf, yet we could not detect an impact on yield the next season. This suggests that June-bearing strawberries are very tolerant of mite damage during the vegetative phase, at least for Honeoye and Jewel, the two cultivars we worked with in this project.

We were unsuccessful, however, in assessing the impact of TSSM during the flowering phase of an established planting (Figure 5). Mite numbers never really developed despite a large release in the spring. The 2003 growing season was cool and wet and this undoubtedly helped suppress populations, although other factors were probably important as well. Average peak densities were below current thresholds for all but a few plots where they briefly exceeded 5 mites per leaf. Thus, it is difficult to draw any definitive conclusions regarding the suit ability of our current threshold based on our results. It is probably conservative for a healthy planting, but by how much is unclear.

We also had difficulty developing adequate mite populations during the establishment year, especially in the second part of the season.
Part of the reason for the difficulty was that predatory mites colonized the field and reduced population growth. Several applications of a pyrethroid insecticide known to be very toxic to predatory mites were only marginally successful.

Summary

During the establishment year with June bearing strawberries we imposed average peak TSSM densities during the first part of the growing season that exceeded the common threshold of 5 mites per leaf, yet this did not translate into a yield reduction the following season. Thus, five mites per leaf is a conservative threshold for June-bearing strawberry during the establishment year. Given the fact that we could not detect a yield impact for several plots that exceeded 10 mites per leaf, we suspect that thresholds could be raised to at least 10 before treatment is warranted. For established strawberry plantings, our results indicated that plants can tolerate substantial mite feeding later in the summer without causing significant economic injury.

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Greg English-Loeb is a research and extension professor in the Department of Entomology who specializes in berry crop and grape insect management. Steve Hesler is a Research Support Specialist who works with Dr. English-Loeb.