

**Economic threshold for two-spotted spider mites (*Tetranychus urticae*) on
strawberries grown as a perennial**

A Final Report to the North American Strawberry Growers Association
December 2003

Category-Production Research

Principal Investigator:

Greg English-Loeb, Department of Entomology, Cornell University, New York State
Agricultural Experiment Station, Geneva, NY. (315)787-2345, Fax-315-787-
2326. gme1@cornell.edu

Research Support Specialist:

Steve Hesler, Department of Entomology, Cornell University, New York State
Agricultural Experiment Station, Geneva, NY. (315)787-2605, Fax-315-787-
2326. sph12@cornell.edu

Introduction

Two-spotted spider mites (TSSM) *Tetranychus urticae* can be a serious pest of strawberries. This appears especially so in regions where strawberries are grown in an annual production system as is used in California (Strand 1994). Indeed, 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) and information on the impact of spider mites on strawberry grown as a perennial has received little recent attention. The purpose of this three-year project is to develop baseline data on the impact of TSSM on June-bearing strawberries grown in New York, which can be used to refine economic thresholds (Kovach et al. 1993). Our objectives were as follows:

1. To assess the impact of *T. urticae* on perennial strawberry during the first 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

Two new plantings of June-bearing strawberries were established in late May 2001 at the New York State Experiment Station in Geneva, New York. Each planting consisted of 30 rows approximately 22 meters in length and 4 foot spacing between rows with 3 rows of the cultivar 'Honeoye' followed by 3 rows of the cultivar 'Jewel' across the planting. The first plot was to be used to assess the impact of TSSM damage during the establishment year on yield the subsequent season while the second plot was to be used to assess impact of TSSM damage on established strawberries. During 2001 plants in both plots showed symptoms of *Verticillium* wilt, although these were more severe in the first plot. We decided, therefore, to re-plant the first plot in May 2002 using two new cultivars that possess greater resistance or tolerance to *Verticillium* wilt ('Earliglow' and 'Cavendish'). The second plot was retained since damage from the disease was less severe than in the first plot.

We divided the planting into 25 plots (6 rows [3 Earliglow and 3 Cavendish] by 4.5 m) in preparation for testing our first objective. Plots were assigned to 1 of 5 treatments in five blocks with 1 replicate per block. Treatments were: 1) No spider mite damage; 2) Low level of mite damage during growth and sexual reproductive phase (June to August, 200, although plants were not allowed to mature fruit), 3) High mite damage during growth and sexual reproductive phase; 4) Low mite damage during vegetative reproductive phase (runnering, August through mid-October, 2002); 5) High mite damage during vegetative reproductive phase. Each treatment was replicated five times for each

cultivar. Miticide (Kelthane 35 WP at 3 lb/Ac rate in 50 to 100 gallons of water) was applied once at borders of each replicate plot (down edge rows) and a 2-foot section between replicate plots (across rows) to maintain treatment integrity.

Approximately three weeks after planting (18 June 2002), TSSM was added to treatments 2 and 3 (early-season damage) in the new planting. Mites were obtained from a laboratory colony and reared on strawberry. Each plant of the center four rows of each plot assigned to treatment 2 (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 3 (early season, high impact) was infested with 30 to 40 motile TSSM plus eggs. We treated control plots (treatment 1) and plots assigned to late-season damage treatments (4 and 5) 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. We originally had planned to apply Kelthane on plots assigned to early-season damage (treatments 2 and 3) in early August to prevent further mite damage. However, since accumulated damage from TSSM was not sufficiently high we decided not to treat and allow mite populations to continue to develop in these plots. 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 second planting were kept mite free in 2001. At the start of the 2002 season we divided it into 25 plots (6 rows [3 Honeoye and 3 Jewel] by 4.5 m). Plots were assigned to 1 of 5 treatments in five blocks with 1 replicate per block. Treatments were: 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 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 2 and 3) on 8 August, after regrowth of plants following renovation. Plots assigned to low mite damage (treatment 2) received approximately 350 motile mites plus eggs while plots assigned to high mite damage (treatment 3) received 700 motile mites plus eggs. We treated control plots (treatment 1) and plots assigned to early-damage in 2003 (treatments 4 and 5) 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 4 and 5, respectively). Treatment 4 plots received approximately 600 motile mites plus eggs while treatment 5 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. At each sampling time, we collected 10 central leaflets from each cultivar in each of the 50 plots (25 in first planting, 25 in second planting). In the laboratory mites were

brushed off of leaflets on to glass plates and counted using a dissecting microscope. TSSM and predatory mites were enumerated. 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 1 meter sections systematically placed within each cultivar of each plot over about a 3 week period (until fruit was small and not marketable).

Results

Objective 1: To assess the impact of *T. urticae* on perennial strawberry during the first year of establishment.

Mite Abundance. We were successful in establishing TSSM in plots of our new 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 on 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 recommend 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 4 treatments that were infested with mites (Figure 2). Hence, AMD during the full season was somewhat greater for treatments 2 and 3, that had mites for the entire season, compared to treatments 4 and 5, 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.

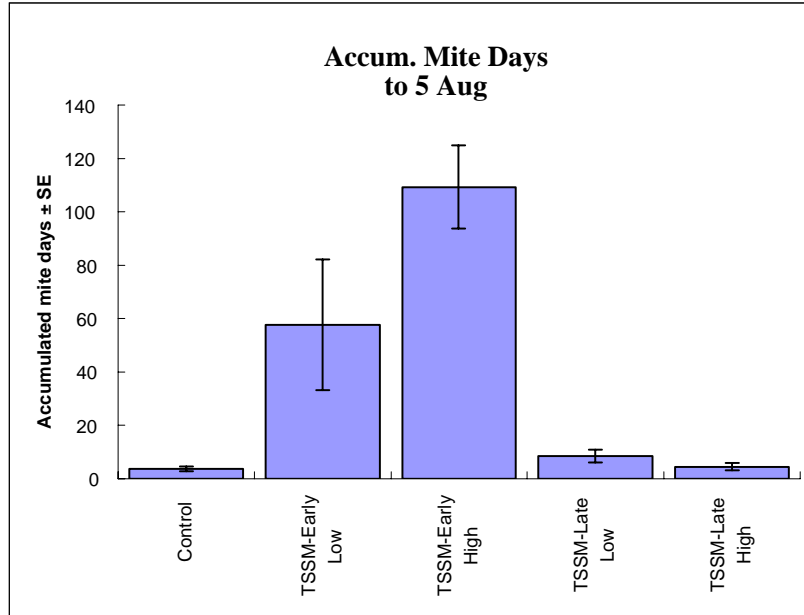


Figure 1. Accumulated mite days (\pm standard error) from 21 June to 5 August 2002 for strawberry plants assigned to different levels and timings of feeding injury from Twospotted Spider Mite (TSSM).

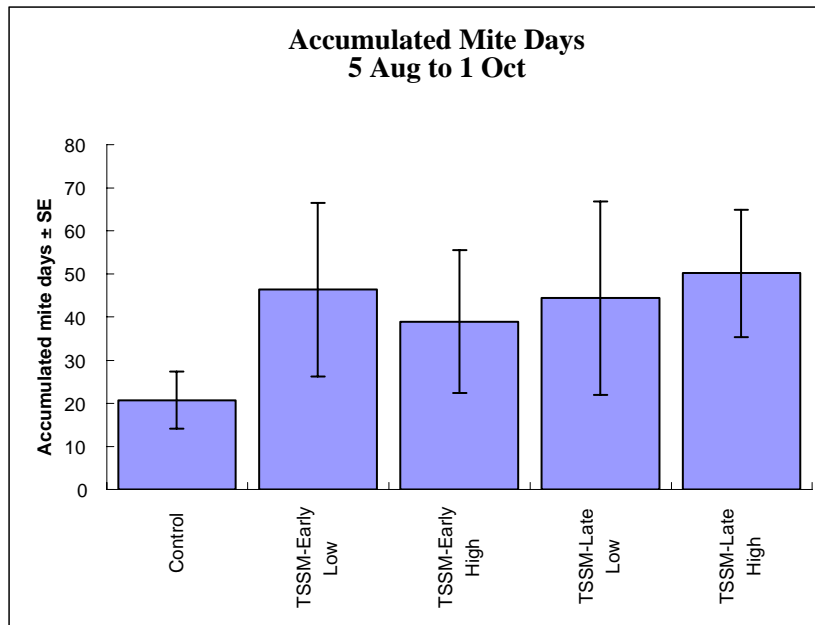


Figure 2. Accumulated mite days (\pm standard error) from 5 August to 1 October 2002 for strawberry plants assigned to different levels and timings of feeding injury by Twospotted Spider Mite (TSSM).

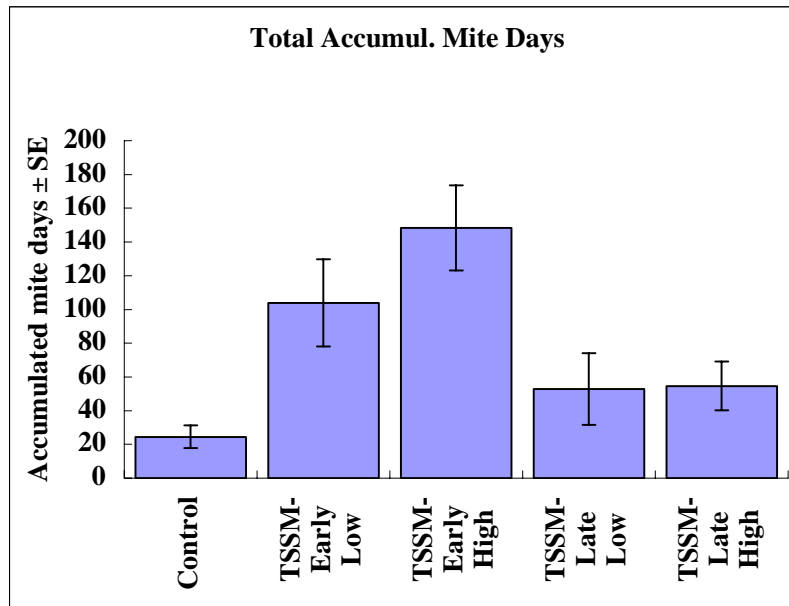


Figure 3. Accumulated mite days (\pm standard error) from 21 June to 1 October 2002 for strawberry plants assigned to different levels and timings of feeding injury by Twospotted Spider Mite (TSSM).

Yield Response. Moderate densities of TSSM during the establishment year had no impact on either yield ($F_{4,36} = 0.165$, $P = 0.5$) nor weight per berry ($F_{4,36} = 0.36$, $P = 0.83$). 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 large for Cavendish compared to Earliglow (9.8 g/berry vs. 5.5 g/berry; $F_{1,36} = 134$, $P < 0.001$).

Objective 2: To assess the impact of *T. urticae* on established perennial strawberry as a function of time of season.

Mite Abundance. As planned, abundance of TSSM in all plots in our second 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 these plots.

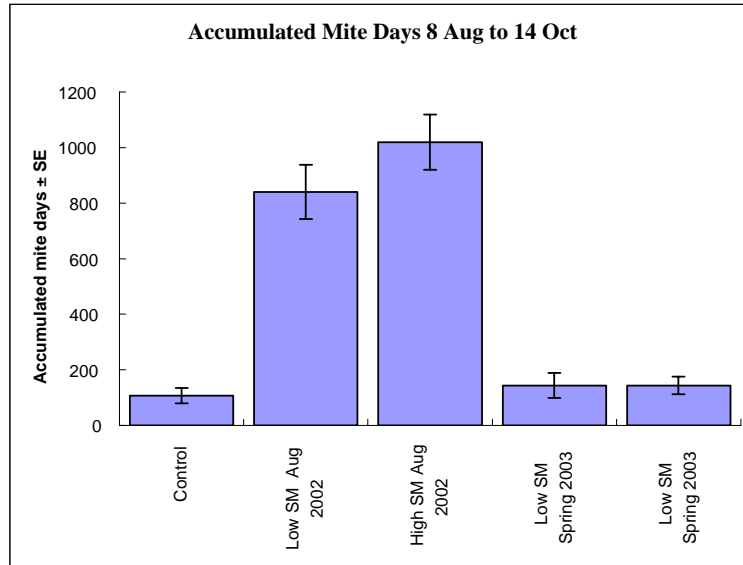


Figure 4. Accumulated mite days (\pm standard error) from 8 August to 14 October 2002 in plots of a second year planting of strawberries assigned to different levels and timings of injury from two spotted spider mite (TSSM).

In the spring of 2003 mite abundance was quite low in all plots despite releasing 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 is no clear explanation for why mite numbers did not increase during this time period.

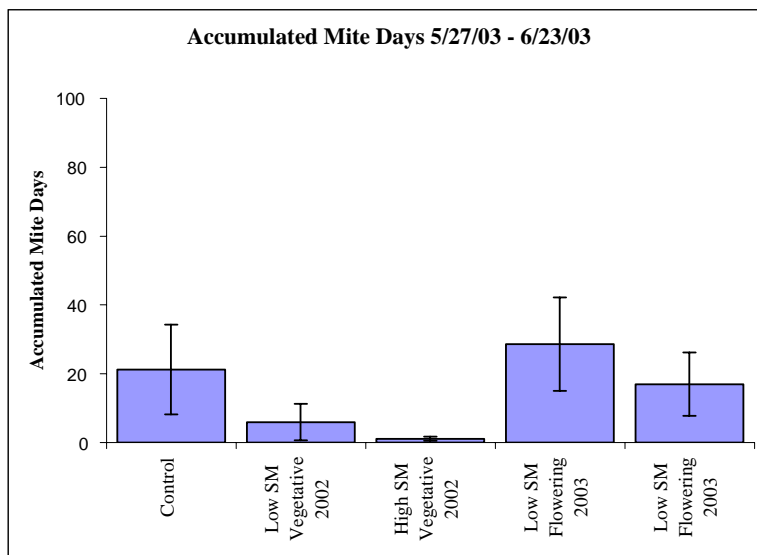


Figure 5. Accumulated mite days (\pm standard error) from 27 May to 23 June 2003 in plots of a third year planting of strawberries assigned to different levels and timings of injury from two spotted spider mite (TSSM).

Yield. 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, $F_{1,36} = 15.0$, $P < 0.001$).

Summary

Our objective for this grant was to examine the impact of TSSM on yield parameters of June-strawberries in the Northeast when damage accumulates at different time periods. Specifically, we were interested in determining to what extent damage during the year of establishment negatively impacted yield the second year (Objective 1) and to what extent damage during the vegetative period or damage during the flowering period negatively impacted yield of an established planting (objective 2). 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 and yet we could not detect an impact on yield the next season. This suggests that June-bearing strawberry is very tolerant of mite damage during the vegetative phase, at least for the two cultivars we worked with in this project (Honeoye and Jewel).

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. Hence, it is difficult to draw any definitive conclusions regarding the suitability 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. Average peak densities during the first part of the growing season did exceed threshold estimates, yet this did not translate into a yield reduction the following season. Hence, five mites per leaf is a conservative threshold for June-bearing strawberry during the establishment year. Given 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.

Acknowledgments

We would like to thank the North American Strawberry Growers' Association for partial

financial support of this research. A number of technicians helped with maintaining plantings, data collection, etc. including Elizabeth Loomis, Carrie Loomis, Jesica Nyrop, Jason Nyrop, Sara Villani, Kevin Conley, Charles Moser, Charlotte Gillespi, Andrea Gillespi, Suzy Fishel, Jeff Ugine, and Lindsay Minns.

References Cited

- Gimenez-Ferrer, R.M., W. A. Erb, B.L. Bishop, and J.C. Scheerens. 1994. Host-pest relationships between the twospotted spider mite (Acari:Tetranychidae) and strawberry cultivars with differing levels of resistance. *J. Econ. Entomol.* 87:168-175.
- Kovach, J., W. Wilcox, A. Agnello, and M. Pritts. 1993. Strawberry ipm scouting procedures. New York State Integrated Pest Management Program Number 203b.
- Pritts, M. P., and D. T. Handley. 1998. Strawberry production guide. Northeast Region Agricultural Engineering Service Cooperative Extension, Ithaca, NY.
- Sances, F.V., N.C. Toscano, L.F. LaPre, E.R. Oatman, and M.W. Johnson. 1982. Spider mites can reduce strawberry yields. *California Agriculture* 36:15-16.
- Strand, L.L. 1994. Integrated pest management of strawberries. University of California Statewide Integrated Pest Management Project, Division of Agriculture and Natural Resources Publication #3351.
- Walsh, D.B., F.G. Zalom, and D.V. Shaw. 1998. Interaction of the two spotted spider mite (Acari: Tetranychidae) with yield of day-neutral strawberries in California. *J. Econ. Entomol.* 91:678-685.