Overwintering biology of twospotted spider mites (*Tetranychus urticae* Koch) in human-made microclimates created for strawberry season extension

Hannah J. Burrack
Department of Entomology, North Carolina State University

System

In the southeastern United States, strawberries (*Fragaria × ananassa*) are grown primarily as annual plants on raised beds covered in plastic mulch (plasticulture systems[1]). Spring fruiting, or short day, varieties are the most common strawberries grown in North Carolina and surrounding states. These varieties are planted in the fall, maintained over the winter, and then produce fruit from April through early June.

Strawberry production is limited by temperature. Mid summer temperatures in North Carolina are too hot for commonly grown varieties to produce fruit, and winter temperatures are often too cold for economically viable fruit production.

To extend their short production season and increase yield, North Carolina growers often employ two strategies:

1. Floating row covers: Growers place row cover over beds for extended periods (up to four months) to increase winter growth and promote earlier fruiting and use row covers for short term frost protection (one week or less) in early spring.
2. High tunnels: In North Carolina, high tunnels are used to produce fruit on day neutral strawberry varieties in the fall or on short day varieties earlier in the spring than feasible with outdoor plantings.

Floating row cover over strawberry beds.

Strawberries for winter fruit production under a high tunnel, PRS.

Twospotted spider mites

Twospotted spider mites (*T. urticae*) are among the most significant arthropod pests of strawberries and can cause measurable reductions in yield at very low densities. Their impact on yield may be most severe when damage occurs pre-fruiting[2].

T. urticae are occasionally introduced into fields on transplants, but most commonly colonize strawberries after planting. Female *T. urticae* may undergo a facultative reproductive diapause if exposed to short day lengths when immature and require exposure to cold temperature followed by warming to greater than the lower development threshold (10-11.7°C[3,4]) to break diapause [5].

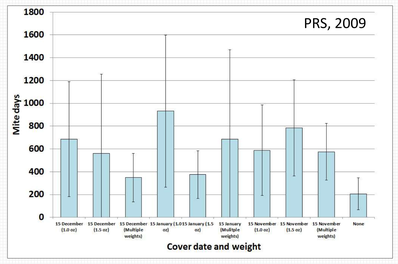
The winter biology of *T. urticae* is important in strawberries for two reasons. First, since damage by small populations of mites in spring may have a significant impact on yield, overwinter populations should be quantified to determine if management is necessary. Second, row cover and high tunnel systems in strawberries may increase temperatures above *T. urticae* development threshold, which may both decrease the proportion of females in reproductive diapause and allow for immature mites to develop resulting in continued population growth.

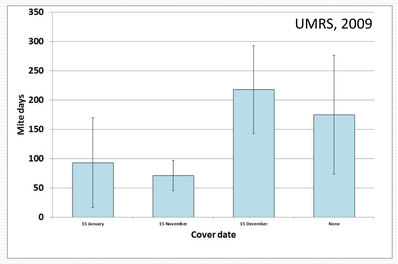
Anna Chapman led field research efforts , and Jessica Richards, Amanda Nelson, and Kelly Nash conducted laboratory mite counts. Funding for this research was provided by the North Carolina Strawberry Association.

Find more information about our work.

Results

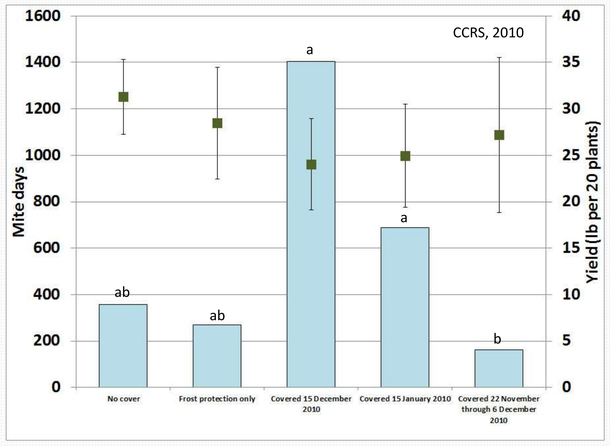
1. Row cover duration or weight did not significantly increase *T. urticae* severity during 2008-2009 strawberry season.





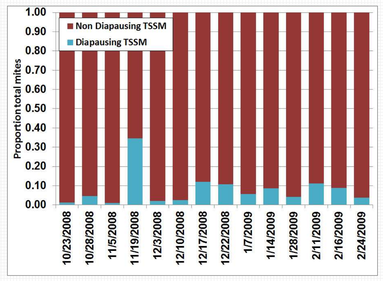
No significant impact of row cover duration or weight on total mite days at either location during the 2008-2009 growing season.

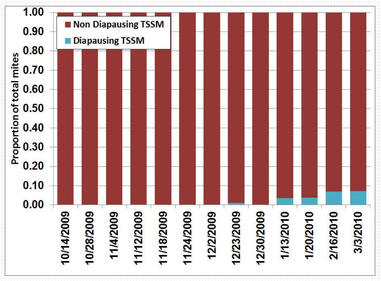
2. *T. urticae* severity was higher in plots covered for longer periods of time during the 2009-2010 growing season, but yield was not significantly reduced.



Total mite days over all observation dates (November 2009 through May 2010) and total yield per plot, CCRS. Mite days were log(x+1.5) transformed to meet the assumptions of ANOVA.
Mite days: F = 4.49; df = 4,15; p = 0.009
Yield: F = 0.20; df = 4,15; p = 0.9317

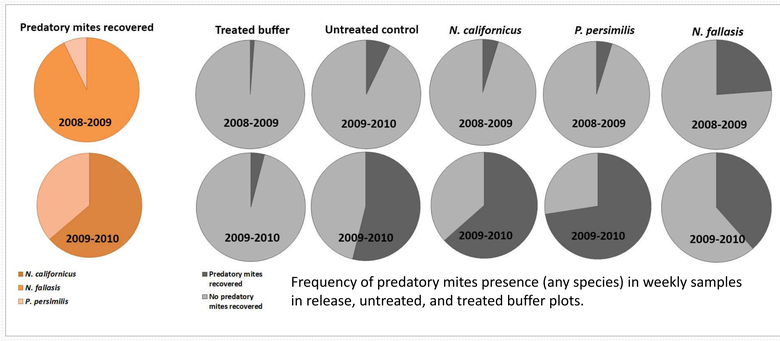
3. *T. urticae* rarely entered diapause in high tunnels and immature mites were recovered throughout winter.





Proportion of diapausing *T. urticae* recovered from untreated control plots weekly. Diapausing *T. urticae* are distinctively orange due to increased carotenoid production.

4. Predator release plots were more successfully isolated in 2008-2009 than in 2009-2010, but more predatory mites overwintered in 2009-2010.



Frequency of predatory mites presence (any species) in weekly samples in release, untreated, and treated buffer plots.

Approach

Floating row cover

We assessed *T. urticae* density on strawberry plants at three locations over the course of two years. During winter 2009-2010, we measured the impact of extended row cover use at the Piedmont Research Station (PRS; Salisbury, NC) and the Upper Mountain Research Station (UMRS; Laurel Springs, NC).
During winter 2010-2011, we measured the effect of both extended cover use and short term use at the Central Crops Research Station (CCRS; Clayton, NC).

High tunnels

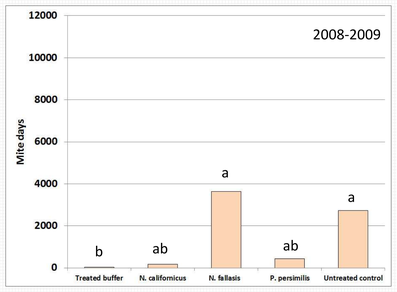
We observed the overwintering biology of *T. urticae* as well as three predatory mite species, *Phytoseiulus persimilis*, *Neoseiulus californicus,* and *N. fallasis* in high tunnel plantings at PRS during the winters of 2008-2009 and 2009-2010. Predators were released when *T. urticae* were detectable in all plots (5 Nov. 2008 and twice during 2009 on 14 Oct. and 2 Dec. because of low initial recovery rates). Mites were released at rates of 2/m^2 (2008) and 11/m^2 (2009). Higher release rates were used in 2009 due to higher initial *T. urticae* populations.

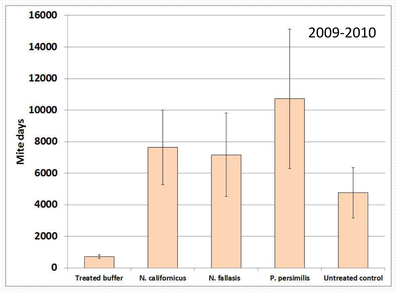
To minimize the movement of predatory mites between plots, release plots were surrounded on all sides by plots treated weekly during winter (from release through the start of harvest) with Acramite (bifenazate), Kanemite (acequinocyl), Oberon (spriomesifen), or Agri-Mek (abamectin) in rotation. The main goal of these treatments was to suppress mite populations and discourage predators from leaving release plots, but several of these materials have also been demonstrated to be toxic to predatory mites[6] or to decrease their egg production.

Data collection

Ten, midtier leaflets were collected from each plot weekly. In high tunnel plots, nitrile gloves were worn and changed between plots to avoid moving predatory mites. All leaflets for a plot were brushed together, using a mite brush, onto a glass plate coated with vegetable oil and counted under a stereomicroscope.

5. Predatory mites released in the fall did not significantly reduce winter and spring *T. urticae* severity but did successfully overwinter in high tunnels.





Predatory mite releases did not reduce total mite days as compared to the untreated control in either growing season.
2008-2009: F = 5.29; df = 4,10; p = 0.0150
2009-2010: F = 2.01; df = 4,15; p = 0.1441

Implications

- Extended row cover use may increase *T. urticae* severity, but this is less likely under cold conditions, such as those experienced at PRS and UMRS during 2008-2009.
- Plants should be observed for mites before row covers are placed and after they are removed.
- Spider mites remain reproductively active and can damage plants during winter under high tunnels.
- Predatory mites can successfully overwinter in high tunnels, but their impact on overwintering *T. urticae* is unclear.

References
[1]Louws, F.J., J. Harrison, D.W. Monks, K.A. Sorensen. 2003. Strawberry crop profile, North Carolina. http://bit.ly/1bedIBY
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[5]Koveos, D.S., A. Kroon, A. Veerman. 1993. Geographic variation of diapause intensity in the spider mite *Tetranychus urticae*. Physiological Entomology. 18: 50-56.
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