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First report of broad mite (Acari: Tarsonemidae) on commercial strawberry in Florida

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Broad mite, *Polyphagotarsonemus latus* (Banks) (Trombidiformes: Tarsonemidae), is a small, widely distributed tarsonemid mite found on commercial crops across 6 continents (Gerson 1992). Eggs are oval, upper surfaces are covered with whitish spots, and lower surfaces are firmly attached to undersides of young leaves (Fig. 1 A,B). Slow-moving larvae molt into quiescent nymphs after about 1 d, and adults emerge after an additional day (Fig. 1 A,C). Adult males emerge first, and are active in locating and carrying nymphal females to apical portions of leaves so that mating can occur as soon as females emerge. Fecundity is around 40 eggs per female, and the entire life cycle can be completed in as little as 5 d under optimal conditions (25 °C, high humidity, low-light) (Gerson 1992). Populations are known to build quickly (130 eggs per cm^2 on young citrus leaves), and they typically reach peak levels between Apr and Aug in Florida (Peña 1990).

Broad mites have been collected on plants from over 60 families, including Rosaceae (Gerson 1992). They have caused economic damage on a wide range of food crops, including apple, avocado, beans, cantaloupe, citrus, coffee, cotton, cucumber, eggplant, grapes, guava, mango, papaya, pear, potato, tea, tomato, and watermelon (Peña & Campbell 2005), as well as many ornamental plants. Broad mites commonly feed on the undersides of young foliage, causing downward leaf curling, rigidity, shriveling, blistering, and darker coloring (Gerson 1992). Heavily infested plants lose leaves, fail to flower, or produce fruit that is distorted, cracked, bronzed, or blemished (Gerson 1992). Mite-related damage can develop in plant parts distant from mite feeding as well as after mites have been controlled with an acaricide, suggesting symptoms are the result of systemic mite toxins (Bassett 1981). Virus- and disease-related damage symptoms can be similar to those

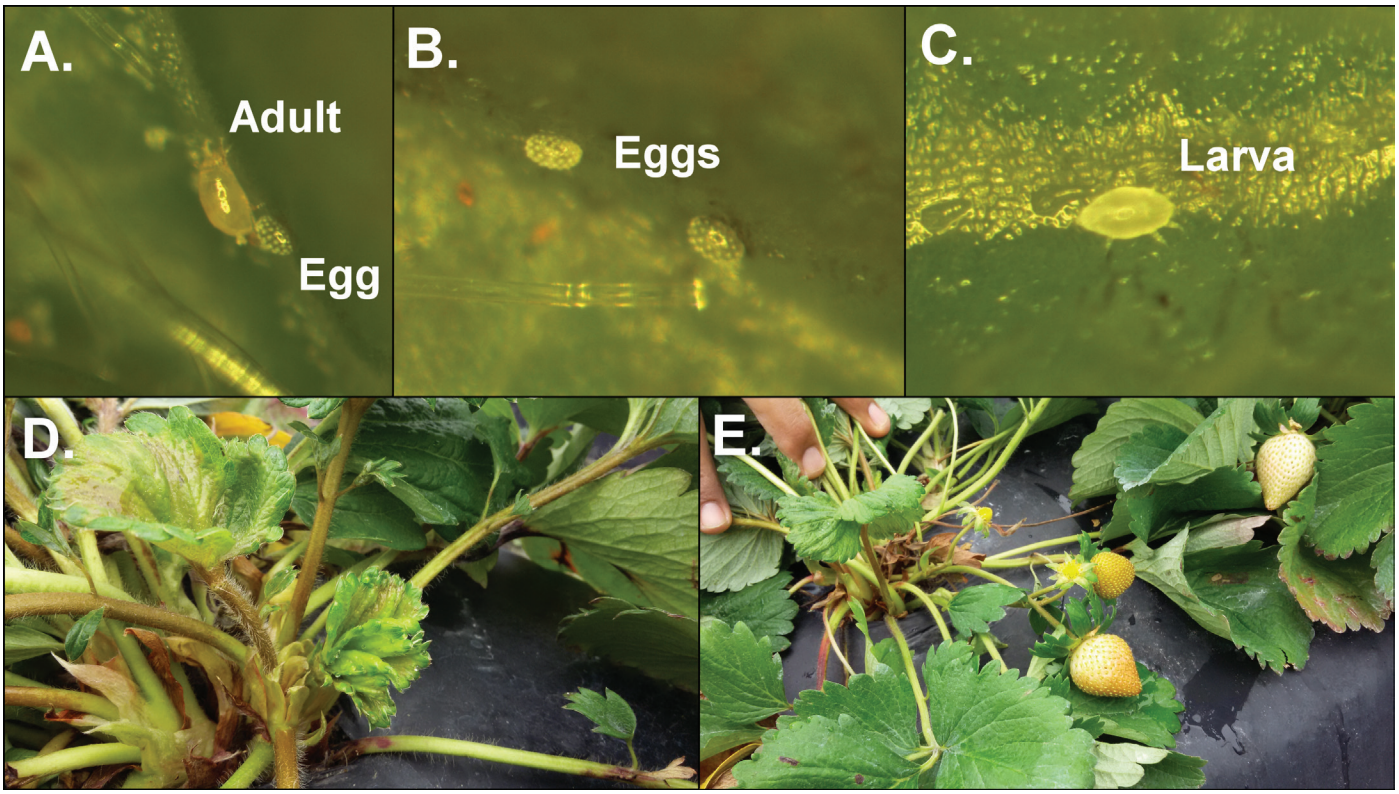

Fig. 1. Developmental stages (A,B,C) of broad mite, *Polyphagotarsonemus latus* (Banks), and damage to strawberry leaves (D) and fruit (E) caused by broad mite feeding.

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caused by broad mite feeding, but visual differences have been characterized for some crops, and it appears that broad mites do not transmit plant viruses (Dhooria & Bindra 1977; Alcantara et al. 2011).

In early Jan 2016, a grower reported finding stunted plants of 'Odessa' strawberry (*Fragaria* × *ananassa* Duchesne [Rosaceae]) in a few small areas (< 1%) of a single field (Field 1). Mites on these leaves were examined under a stereomicroscope by Renkema and determined to be broad mite due the spotted appearance of the eggs. Most broad mites were found on upper sides of young, tightly curled or uncurling leaves. Damage attributed to broad mite feeding appeared as darkening and shortening of leaf petioles, yellowing and browning with some wrinkling or curling of young leaves, and uniform yellowing or bronzing of immature fruit (Fig. 1 D,E).

On 15 Jan 2016, a meeting to discuss broad mites was organized, and approximately 30 participants, mainly strawberry growers and industry representatives, heard presentations on broad mite biology, damage, dispersal, and management options. After the meeting, multiple grower-submitted strawberry plants exhibiting damage were examined; however, most of these samples contained cyclamen mite, *Phytonemus pallidus* (Banks) (Trombidiformes: Tarsonemidae), and none contained broad mite. Cyclamen mite is a well-known pest of strawberries, inhabiting young expanding leaflets and causing damage similar to that observed in broad mite-infested plants. While cyclamen and broad mite immature motile stages and adults are similar in appearance, the eggs of each species are distinct. Cyclamen mite eggs are oval, smooth, and twice as long as wide (Jeppson et al. 1975).

In central Florida during the 2016–2017 growing season (Oct-Mar), broad mites were again found in 'Odessa' strawberries and also in 'Florida Radiance' and Sweet Sensation® 'FL-127'. Plants that were stunted, with tightly curled and discolored leaves, were recorded from at least 5 fields (< 1% of each field area affected). All examined plants contained all stages of broad mite, and no plants with damage symptoms contained cyclamen mite. Mite samples were confirmed as broad mite by LeFors and Johnson at the University of Arkansas Fruit and Nut Entomology Laboratory. Specimens were preserved on slides for identification and retained as vouchers. Morphological identification was based on characteristics described by Lindquist (1986). Fields with confirmed broad mite populations were south and west of Plant City, Florida, USA, with about 16 km between the 2 fields furthest apart. The greater number of fields with broad mites recorded in the 2016–2017 than in the 2015–2016 growing season may indicate that this pest will be an increasing concern for Florida strawberry growers.

On 7 Jan 2016, 2 locations in the affected field were selected where plant damage due to mite feeding was severe. In each location, 1 plant with the highest level of visible damage and 4 successive plants in each direction from the single plant along the strawberry row were sampled. A young, expanding trifoliate was removed from each plant and transported to the laboratory in a plastic bag. Broad mites were brushed from the trifoliates onto rotating sticky disks and counted on 1/10 of the disk surface to estimate the number of motiles (larvae and adults). The grower applied Oberon® 2 SC (spiromesifen) (Bayer CropScience, Research Triangle Park, North Carolina) at 1.17 L per ha on 8 Jan to the entire field, and plants were sampled again on 12 Jan.

On 7 Jan 2016 at location 1, the number of motile broad mites was highest on the plant with the most visible damage, but at location 2 higher broad mite numbers were found on some of the adjacent plants than on the central plant. This variability indicates that broad mite numbers may be highly aggregated among plant trifoliates (Table 1). At both locations, some adjacent plants had highly different mite counts (0 or 10 vs. 200 or more) (Table 1). On 12 Jan 2016, broad mite counts were reduced on 7 of 9 infested plants in location 1, and 3 of 5 infested plants in location 2. However, 4 plants had the same or increased counts. Oberon 2 SC may not have been effective due to inadequate toxicity or coverage.

Table 1. Differences in numbers of broad mite, *Polyphagotarsonemus latus*, motiles per expanding trifoliate on 9 consecutive strawberry plants (plant '0' had significant damage) at 2 sampling locations in a commercial field near Dover, Florida, on 1 d before and 4 d after applying Oberon 2 SC on 8 Jan 2016.

		No. of broad mite motiles		
Location	Plant no.	7 Jan	12 Jan	Difference
1	8	10	0	-10
	7	330	400	+70
	6	50	30	-20
	5	10	60	+50
	0	190	10	-180
	1	320	110	-120
	2	190	40	-150
	3	340	0	-340
	4	420	120	-300
	Total	1850	770	-1000
	Mean	231.3	96.3	-123.8
	SD	146.53	130.16	151.27
2	8	30	30	0
	7	0	0	0
	6	0	0	0
	5	10	0	-10
	0	310	60	-250
	1	0	0	0
	2	80	220	+140
	3	110	20	-90
	4	0	0	0
	Total	540	330	-210
	Mean	60.0	36.7	-23.3
	SD	101.98	71.76	103.32

As the Florida strawberry industry moves to earlier planting and first harvest dates (late-Sep to mid-Nov versus mid Oct to late Nov) when temperatures are typically warmer and humidity is higher, early-season pests that thrive in these conditions, such as broad mite, may require specific control actions. Acaricides labelled for strawberries with efficacy on broad mite are Portal® XLO (fenpyroximate) (Nichino America Inc., Wilmington, Delaware) and Agri-Mek SC (abamectin) (Syngenta Crop Protection, Greensboro, North Carolina). On 18 Jan 2016, Bayer CropScience (Research Triangle Park, North Carolina) obtained a FIFRA 2(ee) recommendation for the use of Oberon 2 SC for broad mite on strawberry in Florida. Broad mites have achieved pest status in an increasing number of crops over the years (Cross & Bassett 1982; Brown & Jones 1983), recently including blackberry (*Rubus*) in the USA (Vincent et al. 2010). Changes in pesticide use, such as broad mite insensitivity to pyrethroids, which are relied upon in many crops to control other pests, or reliance on biological control agents for other pests, may have led to attainment of pest status by broad mite (Bassett 1985; Vaissayre 1986; Isaacs et al. 2013).

For blackberry, synthetic acaricide alternatives to Agri-Mek (e.g., Microthiol® Disperss® (NuFarm Australia Inc., Laverton North, Australia), M-Pede® (Dow AgroSciences, Indianapolis, Indiana), and JMS Stylet Oil® (JMS Flower Farms Inc., Vero Beach, Florida) were effective (> 92% mortality by 3 d after treatment) on broad mites in a laboratory leaflet dip bioassay (LeFors et al. 2017). Several predatory mite species also should be considered for use in small fruit crops, as broad mite populations on vegetables were reported to be controlled by *Neosei-*

ulus cucumeris (Oudemans) (Mesostigmata: Phytoseiidae) (Weintraub et al. 2003), *Amblyseius* (=*Neoseiulus) swirskii* Athias-Henriot (Mesostigmata: Phytoseiidae) (van Maanen et al. 2010) and *Neoseiulus californicus* (McGregor) (Mesostigmata: Phytoseiidae), but the effect of *Neoseiulus barkeri* Hughes (Mesostigmata: Phytoseiidae) was erratic (Fan & Petitt 1994; Peña & Osborne 1996).

We thank Florida strawberry growers for submitting samples and scouting their fields for broad mite damaged plants.

Summary

During the past 2 strawberry-growing seasons in Florida (Oct to Mar in 2015–2016 and in 2016–2017), broad mite, *Polyphagotarsonemus latus* (Banks), was found on the upper sides of young strawberry leaves and on fruit. Damage symptoms were similar to those reported from other affected crops: leaf curl, browning and yellowing of leaf tissue and bronzing of ripening fruit, but less than 1% of plants in surveyed fields appeared to be affected. Broad mites were found in 1 field in 2015–2016 but in at least 5 fields in 2016–2017, indicating a possible increase in their potential to affect strawberry. Small areas of a field treated with Oberon 2 SC (spiromesifen) were sampled for broad mites. Post-application counts were generally lower than pre-application counts, although there was a high degree of intra-plant variability in counts. Future efforts should be directed at monitoring broad mite populations and their influence in strawberry and implementing management practices, if necessary, that have been effective in other crops.

Key Words: cyclamen mite, acaricides, spiromesifen, pest management, blackberry

Sumario

Durante las últimas 2 temporadas de la siembra de fresa en Florida (octubre a marzo del 2015-2016 y en el 2016-2017), el ácaro ancho, *Polyphagotarsonemus latus* (Banks), se encontró en la parte inferior de las hojas jóvenes y en la fruta. Los síntomas de daño fueron similares a los reportados de otros cultivos afectados: el enrollo de hojas, el bronceado y amarillamiento del tejido de las hojas y bronceado de la fruta madura, pero menos del 1% de las plantas en los campos estudiados parecían estar afectadas. Se encontró el ácaro ancho en 1 campo en el 2015-2016, pero en al menos 5 campos en el 2016-2017, lo que indica un posible aumento en su potencial para afectar a la fresa. Se muestrearon pequeñas áreas de un campo tratado con Oberon 2 SC (spiromesifen) para detectar el ácaro ancho. El conteo despues de la aplicación fue generalmente más bajo que el conteo antes de la aplicación, aunque hubo un alto grado de variabilidad dentro de la planta en el conteo. Los esfuerzos futuros deben estar dirigidos a monitorear las poblaciones del ácaro ancho y su influencia en la fresa y aplicar prácticas de manejo, si es necesario, que han sido eficaces en otros cultivos.

Palabras clave: ácaro ciclamen, acaricidas, espiromesifeno, manejo de plagas, mora

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