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CHAETOSIPHON FRAGAEFOLII (HOMOPTERA: APHIDIDAE): A POTENTIAL NEW PEST IN FLORIDA?

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During the spring of 2003-2004, the strawberry aphid, *Chaetosiphon fragaefolii* (Cockerell) (Homoptera: Aphididae), was found infesting ten different strawberry cultivars, *Fragaria ananassa* Duchesne, grown under protected culture in a greenhouse in Marion County, FL. The cultivars were 'Treasure', 'Earlibrite', 'Strawberry Festival', 'Sweet Charlie', FL 97-39, 'Camarosa', 'Carmine', 'Camino Real', 'Diamante', and 'Ventana'. This is the first report of the presence of *C. fragaefolii* in cultivated strawberry in Florida (Division of Plant Industry, DPI E2004-278-201).

In December 2003, the strawberry aphid was observed on a strawberry cultivar trial at the University of Florida Plant and Science Research Unit at Citra. The susceptibility of ten strawberry cultivars to natural infestations to the cotton aphid, *Aphis gossypii* Glover, was being evaluated. 'Treasure', 'Earlibrite', 'Strawberry Festival', 'Sweet Charlie', FL 97-39, 'Camarosa', and 'Carmine' plugs were grown at UF facilities as described by Paranjpe et al. (2003); 'Camino Real', 'Diamante', and 'Ventana' plugs came from a Canadian nursery. Two months after the beginning of the trial, samples of an "unknown" aphid in the cotton aphid trial were taken to the Division of Plant Industry in Gainesville, FL, for identification. On 22 January, samples were identified as *C. fragaefolii*, the true strawberry aphid. Since the strawberry aphid was detected relatively early in the season, two applications of insecticidal soap (10%) (28 January and 12 February) were required to effect control. Two days after the second soap application, 10 *Chrysoperla rufilabris* L. and *Aphidoletes aphidimyza* L. per m^2 were released. Both methods were relatively successful; however, resurgence of pests was heavy by mid March causing the early termination of the crop. No insecticides were used to control the aphid because the strawberry trial and other crop trials in the greenhouse depended on bumblebees (highly susceptible to pesticides) for pollination. At the end of the trial, the strawberry aphid was eliminated from the greenhouse and hopefully eradicated from Florida. A heavy application of soap and oil (40%) was made before removing the plant material from the greenhouse. All material was buried and burned. The strawberry aphid has not been detected in strawberry crops on other outdoor locations of the farms or in other production areas in Florida.

Based on a sample of the aphid population, the following observations and conclusions were made: the life cycle of *C. fragaefolii* includes overwintering eggs, nymphs, adult apterae (wingless) and alatae, and parthenogenetic females. Eggs are white yellowish when deposited, but soon after, become shiny and black. Nymphs are small (0.8-1.1 mm) (n = 20) and morphologically similar to the adults. They vary in color from light green to pale yellow. Adults are 1.3-1.5 mm long, pale to yellowish green with short knobbed setae over the body; the antennae are as long as, or longer, than the length of the body; siphunculi are long, pale and slender, about ¼ body length, and legs are pale green and almost translucent. According to Heinz (1998), sexual forms are quite rare because aphids reproduce parthenogenetically throughout the winter if the temperature remains above 4.5°C; however, *C. fragaefolii* was found in a greenhouse (average day temperature 21°C), and sexual forms were observed at the cultivar trial (DPI E2004-278-202). Blackman & Eastop (2000) suspected that day length rather than temperature trigger the formation of sexual forms. The large number of exuviae on the leaves indicates proliferation of the aphid in the crop. As in other species of aphids, the strawberry aphid feeds on the underside of leaves close to veins. The insect also was observed feeding on tips, petioles, small fruits, calyxes, and young flowers. Leaf curling was not observed but foliage turned chlorotic, which probably diminished the photosynthetic capability of the plant. Aphids were more abundant on certain cultivars. 'Carmine' (4.3 ± 1.8 aphids/leaflet), 'Strawberry Festival' (3.7 ± 0.8 aphids/leaflet), FL 97-39 (2.9 ± 1.3 aphids/leaflet), and 'Diamante' (2.1 ± 1.1 aphids/leaflet) were the most affected (alpha = 0.05, confidence interval 95%).

The strawberry aphid is considered an important pest of strawberries in open fields worldwide, including the U.S. (California, Michigan, Minnesota, South Carolina, and Washington), Canada, northern Mexico, Europe, Great Britain, South Africa, New Zealand, and Australia (Dixon et al. 1987; Blackman & Eastop 2000). *Chaetosiphon fragaefolii* is well known in most of North America where strawberries are grown but not in Florida. Whether *C. fragaefolii* might have been in Florida prior to its recent discovery or may have come from transplants from Canada is uncertain. The taxonomy of the genus is difficult. In 1938-1939, specimens taken from *Rose* spp. in Florida were identified as *C. fragaefolii* (DPI records); however, it was recently determined that they actually correspond to *C. thomasi* Hille Ris Lambers. It was established that *C. fragaefolii* will not colonized rose, and that records of *C. fragaefolii*

on roses should be referred to *C. thomasi* (Blackmand & Eastop 2000). *Chaetosiphon fragaefolii* has been reported on wild strawberry, especially *F. chiloensis* in North America, *F. vesca*, *F. virginianana*, and *Ponsetia anserine* L. (Frazier 1974; Blackman & Eastop 2000). We report *C. fragaefolii* on cultivated strawberry in greenhouses.

Chaetosiphon fragaefolii transmits viruses that can cause strawberry yellow edge virus (SYEV), strawberry crinkle virus (SCV), and strawberry mottle virus (SMV) (Krczal 1979, 1982; Blackman & Eastop 2000; Converse 2002; Posthuma et al. 2002). For instance, symptoms of SCV are necrotic lesions with irregular spots on veins, epiniasty, crinkling, distortion, and uneven expansion of leaflets. Lesions on petioles and stolons produce angularity, streaking and deformation of petals (Frazier & Mellow 1970; Frazier 1974). These symptoms were not observed on any of the cultivars in our trial. *Chaetosiphon fragaefolii* can acquire the viruses within 24 h of birth. After a latent period of 10-19 days, the infected aphid can transmit virus for up to 2 weeks (Mellow & Frazier 1970).

In Florida, strawberries are an annual crop grown on approximately 7,100 acres; 95% of the acreage is located in the Plant City area of west central Florida (NASS-USDA 2003). Production costs average more than $23,000 per acre, making strawberry one of the most expensive crops in Florida to produce (FAFD 2002). The area of strawberry grown under protected cultivation in Florida is less than 1 ha (NASS-USDA 2003). The overall industry produces 15% of the total U.S. crop and accounts for more than 17% of the total dollar value generated from sales of fresh berries in the U.S. (NASS-USDA 2003). If the strawberry aphid were to spread into commercial production areas of Florida, it could cause severe damage to the strawberry industry, especially if viruses were present. Strawberries require a highly integrated management system to control pests to insure profitability. In addition to *C. fragaefolii* (the strawberry aphid), *C. jacobi*, *C. minor* (Forbes), *A. gossypii* (the cotton aphid), *A. forbesi* Weed (the strawberry root aphid also sometimes known as "the strawberry aphid"), *Macrosiphon euphorbiae* (Thomas) (the potato aphid), and *Myzus persicae* (Sulzer) (the green peach aphid) infest strawberries (Table 1) (Blackman & Eastop 2000). *Chaetosiphon fragaefolii* and *C. jacobi* have not been reported before in Florida strawberries.

Should the strawberry aphid become established in Florida, effective and timely control is essential in strawberry production due to the aphid's ability to develop large populations in a short period. Cultural and mechanical control of the strawberry aphid in the greenhouse or open field should include inspecting incoming transplants and eliminating infested crop material from the production site. Plant monitoring should begin early in the season and continue throughout the duration of the crop. Leaflets and shoots must be visually inspected from random locations throughout the field. After identification of the pest, yellow sticky cards can be used to detect the winged form; however, if alates are found, a well-established aphid population is already in the crop. The presence of ants, which feed on sugar produced by the aphids, may also be a sign of a heavy infestation.

No extended information is available regarding the effect of natural enemies on *C. fragaefolii*. In general, augmentation of biological control suffers from a lack of basic and well-designed strategies for release on a large scale, especially in open field conditions (Heinz 1998). Although parasitic wasps are species specific, *Aphelinus* species which are commercially available, may have an effect on strawberry aphid populations (Biobest Aphelinus-system http://www.biobest.be, http://bugssandbees.com; Koppert, http://www.koppert.nl; Syngenta, http://syngenta.com). The parasitic wasp *Aphidius colemani* L, was used successfully in the greenhouse to control the cotton aphid in the cultivar trial; however, *A. colemani* was not observed parasitizing *C. fragaefolii*. The numerous capitate setae of *C. fragaefolii* may protect the aphid from parasitic wasps. Several biological control options are available for aphid control. Lady beetles, such as *Hippodamia convergens* Guérin-Méneville (Rodriguez-Saona & Miller 1999) and *Coleomegilla maculata* DeGeer (Rondon et al. 2004) are important aphid feeders. Lacewings such as *Chysoperla rufilabris* and *C. carnea* Say, and the predatory midge *A. aphidimyza* are voracious predators of aphids (Heinz 1998). *Aphidoletes aphidimyza* attacks many species of aphids; it can act alone or in combination with a parasite for rapid knockdown of aphid infestations. This predator is most effective on aphid "hot spots."

If biological control is used, one should reduce or limit the use of broad-spectrum pesticides; preventive releases are recommended; monitor weekly to detect first sign of pest. If honey dew is present, it may interfere with the search capability of the parasitoid, and the use of light soap is suggested. If insecticides are used to suppress the strawberry aphid, a full coverage is recommended. For greenhouse aphid control, Tanigoshi & Bergen (2003) recommend Acatara® (thiomethoxam), Admire® (imidacloprid), Assail® (acetar) and Fulfill® (pymetorzine). Insecticidal soap (2.5 oz/gal water) can effectively reduce strawberry aphid population but may harm the crop (personal observation); in addition, botanical insecticides such as neem (Azatin™, Neemazad™, and Nemix™) may be effective. Strains of the fungus *Beauveria bassiana*, commercially available as Naturalis-O™ and BotaniGard™, may provide good control of aphids. Insect growth regulators

TABLE 1. THE STRAWBERRY, *Fragaria ananassa* DUCHESNE, APHID COMPLEX (MODIFIED FROM BLACKMAN & EASTOP 2000).

Scientific name	Frequency in the strawberry crop in the U.S.*
Acyrthosiphon rogersii (Theobald)	2
Aphis forbesi Weed	1
Aphis gossypii Glover	1
Aphis ruborum (Börner)	2
Aulacorthum solani (Kaltenbach)	2
Chaetosiphon fragaefolii (Cockerell)	1
Chaetosiphon jacobi Hille Ris Lambers	2
Chaetosiphon minor (Forbes)	2
Ericaphis fimbriata (Richards)	2
Ericaphis wakibae (Hottes)	2
Macrosiphum euphorbiae (Thomas)	2
Macrosiphum rosae (Linnaeus)	2
Myzus ascalonicus (Doncaster)	2
Myzus ornatus Lains	2
Rhodobium porosum (Sanderson)	2
Sitobion fragariae (Walker)	2
Aphis ichigocola Shinji	3
Aphis maidiradicis Forbes	3
Aphis nasturtii Kaltenbach	3
Aulacorthum circumflexum (Buckton)	3
Hyalomyzus fragaricola L.K. Ghosh	3
Hyperomyzus rhinanthi (Schouteden)	3
Macrosiphum pallidum (Oestlund)	3
Myzaphis rosarum (Kaltenbach)	3
Myzus cymbalariae Stroyan	3
Myzus persicae (Sulzer)	3
Abstrusomyzus valuliae (Robinson)	3
Paramyzus longirostris Miyazaki	3
Pemphigus bursarius (Linnaeus)	3
Rophalosiphoninus latysiphon (Davidson)	3

*1 Frequent, 2 Occasional, 3 Rare.

(IGR) are another least toxic insecticide that can be used. IGR kills insects by disrupting their development, stopping the molting process (interfere with chitin production), and mimicking juvenile hormone (insects never get into a reproductive stage) (Sunderland 1992).

Future information regarding biological and ecological aspects of the strawberry aphid will set the basis of an effective integrated pest management program for the aphid if it becomes established in Florida.

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SUMMARY

During the spring 2003-2004 growing season, the strawberry aphid, *Chaetosiphon fragaefolii* (Cockerell) (Homoptera: Aphididae), appeared for the first time in damaging numbers on the strawberry, *Fragaria ananassa* Duchesne, a high value commodity in Florida. Nymphs and adults of the strawberry aphid were found infesting ten different strawberry cultivars: 'Treasure', 'Earlibrite', 'Strawberry Festival', 'Sweet Charlie', FL 97-39, 'Camarosa', 'Carmine', 'Camino Real', 'Diamante', and 'Ventana'. A brief description of the morphology, biology, damage, and ecology of the pest is presented. Correct identification, early detection of the strawberry aphid, and adequate timely control can prevent the spread of this pest.

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