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Pecan Cultivar Differences in Aphid Reproduction and Abundance[1]

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J. Entomol. Sci. 47(1): 86-91 (January 2012)

Key Words host plant resistance, *Carya illinonensis* Wangh., *Monellia caryella*, *Monelliopsis pecanis*, *Melanocallis caryeafoliae*, Hemiptera, Aphididae

Foliage-feeding aphids of pecan include 3 species that are considered as potential pests – yellow pecan aphid (*Monelliopsis pecanis* (Bissell)), blackmargined aphid (*Monellia caryella* (Fitch)), and black pecan aphid (*Melanocallis caryeafoliae* (Davis)) (Hemiptera: Aphididae). The biology of these aphids is well documented, and nymphs and adults are easily identified by the descriptions and drawings of Tedders (1978, USDA Tech. Bull. 1579). The reproductive rates of the 3 aphid species also are well documented on pecan (Kaakeh and Dutcher 1992, Environ. Entomol. 21: 632 - 639). Aphid abundance on pecan varies among pecan cultivars to the extent that pecan plant breeders often indicate that a new introduction is either susceptible or tolerant to aphids. Cultivar selection is an important decision for pecan producers, and cultivars with naturally lower levels of aphids require fewer aphidicides. The overall costs of aphid control are considerably lower on pecan cultivars with natural tolerance or host plant resistance to aphids.

Relative abundance of pecan aphids on pecan cultivars observed by horticulturalists during the breeding of new cultivars and the subsequent extended evaluation of cultivar performance in the field are qualitative and are readily available in 2 sources (Sparks 1992, Pecan Cultivars: The Orchard Foundation. Pecan Production Innovations, Watkinsville, GA, USA 446 p.; Worley 2002, Compendium of Pecan Production and Research. Edwards Bros., Inc. Ann Arbor, MI, USA. 479 p.). Other examples found in the literature indicate that: black pecan aphids are a problem on 'Alley'; 'Pawnee' is resistant to aphids (Thompson et al. 2000, J. Amer. Pom. Soc. 54: 193 - 198); 'Navaho' is resistant to aphids (Thompson et al. 1995, HortScience 30: 156 - 157) and; 'Choctaw', 'Gloria Grande', 'Jackson', 'Caddo', and 'Shawnee 'are susceptible to black pecan aphids (Calcote and Scott. 1988, Proc. Southeastern Pecan Growers Assoc. 81: 83 - 95). Host plants for blackmargined aphid include pecan, water hickory, hican and scrub hickory. Yellow pecan aphid host plants are pecan and nutmeg hickory.

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Host plants for black pecan aphid are pecan and water hickory (Smith et al. 1993, Proc. Southeastern Pecan Growers Assoc. 86: 133 - 144). Blackmargined aphids will not survive on shagbark, sand, bitternut, black, mockernut hickory, southern shagbark, pignut or red hickories, black walnut, or butternut (Smith et al. 1992, Proc. Southeastern Pecan Growers Assoc. 85: 129 - 133). Our objectives were to compare the reproductive ability of 3 aphid species on 5 pecan cultivars in clip cages in the field and then describing the seasonal occurrence and abundance of the 3 species on trees of 23 pecan cultivars planted in a provenance collection.

Experiments were conducted at the University of Georgia Tifton Campus, Coastal Plain Experiment Station, Tift Co., USA. Trees were planted in 1927 and 1955, and all trees received uniform management methods over the entire period (Worley and Mullinix 1994, Georgia Agric. Expt. Sta. Bull. no. 426). The reproductive potentials of 3 aphid species were determined on 'Moneymaker', 'Schley', 'Van Deman', 'Sioux' and 'Elliot' pecan tree cultivars. In July 2009, 4 - 5 compound leaves were enclosed in a 60 × 70 cm white insect rearing sleeve (part no. DC 300W-L-P, BugDorm, Taichung, Taiwan) and infested with aphids to establish colonies of the 3 aphid species for the experiments. Three weeks later, adult winged females were collected from the sleeves and confined in clip cages on the lower surface of single pecan leaflets. Each clip cage was constructed from a 3.07 × 3.07 cm piece of self-adhesive, foam, weather stripping (0.48 cm thick) (3M Corp., Minneapolis, MN, USA) with a 2.56-cm diam. hole cut in the center. The self-adhesive side of the foam piece was covered with a 3.07 × 3.07 cm piece of nylon screen (11 × 11 per cm mesh). A 25-mm diam. carbone ring (Boye Co., Antiloch, TX, USA) was fitted into the hole in the foam beneath the nylon screen. The cage was held in place on the leaf surface by a spring-loaded hair clip (part no. 55309N, Conair Corp., East Windsor, NJ, USA) with the nonadhesive surface next to the leaf surface. Aphids were retained in the circular leaf space for feeding and reproduction.

One field-collected, winged, parthenogenetic female aphid adult was placed in the clip cage to produce nymphs. After 24 h, the adult and all except 1 of the nymphs were removed with fine brush, leaving 1 nymph per cage. The remaining nymph matured to a winged, parthenogenetic, adult aphid. All the nymphs produced by the winged adult were counted every 1 - 3 d until the adult died. All the nymphs remained in the clip cages with the adult until they matured to new adults when they were removed. Nine clip cages were installed on each of 5 cultivars – 'Elliot', Schley', 'Van Deman', 'Moneymaker' and 'Sioux'. Clip cages were placed on limbs that could be easily accessed from the ground selected from 2 trees per cultivar. Three of the 9 clip cages were set out with one of the three aphid species. The experiment was conducted 2 times (Aug. and Sep.) for a total of 6 clip cages per aphid species per cultivar. Starting and ending period were not the same for all replicates. If the adult aphid died during the first 7 days within the clip cage, the aphid was replaced with a new adult, and the data from the first attempt were not used to calculate the means. Counts were taken for 11 days from the first day of reproduction. Yellow pecan, blackmargined, and black pecan aphids have prereproductive periods of 6, 7, and 10 days, respectively (Kaakeh and Dutcher. 1992, Environ. Entomol. 21: 632 - 639). The data were analyzed for cultivar differences with analysis of variance and LSD ($P < 0.05$) (SAS Institute, Inc. 2007, SAS System ver 9.1.3. Cary, NC).

Pecan aphids were sampled from full leaf expansion (21 June 2009) to leaf fall (22 Sep 2009) in a provenance collection of pecan varieties on the UGA Tifton Campus. Ten leaves were collected from the foliage of the lower limbs (1 - 3 m high) of the

periphery of the tree crown, and the numbers of aphids of each species were counted and recorded 1 time per week for 14 wks. One or 2 trees of each of 23 pecan cultivars were sampled depending on the number of trees in the collection. Ten cultivars were represented by 2 trees. Thirteen cultivars were represented by a single tree propagated from a scions collected from native trees. All the trees are propagated on seedling rootstocks, and each tree has a unique rootstock. Inferences made for cultivars represented by 1 tree are referred to as "the [cultivar name] tree". Inferences made for cultivars represented by 2 trees are referred to by the cultivar name. The means were summed over all sample dates and divided by the number of sample dates to determine the average number of aphids per leaf per week. These averages were ranked from highest to lowest in terms of aphid abundance. The data from the 10 cultivars represented by 2 trees were analyzed as 10 treatments with 2 replications and 10 subsamples per replication with a general linear models program (SAS Institute, Inc. 2007, SAS System ver 9.1.3. Cary, NC.) and Scheffé multiple range test (Snedecor and Cochran 1967. Statistical Methods. Iowa State Univ. Press. 593 p). The data from cultivars represented by 1 tree were considered as preliminary and were analyzed to determine the average of the aphid counts on each sample date.

Aphid reproduction, expressed as the number of nymphs produced per aphid during the adult life span, differed significantly among pecan cultivars. Clip cage trials indicated that: yellow pecan aphids produced more nymphs on 'Sioux' than on 'Moneymaker', 'Elliot', 'Schley', and 'Van Deman'; blackmargined aphids produced more nymphs on 'Moneymaker', Elliot' and 'Schley' than on 'Van Deman' and an intermediate number of nymphs on 'Sioux ' that was not significantly different from the number of nymphs produced on 'Moneymaker', 'Elliot', 'Schley', and 'Van Deman'; black pecan aphids produced more nymphs on 'Schley' than on Moneymaker', 'Elliot', 'Sioux', and 'Van Deman' (Table 1).

The season-long aphid counts in the pecan cultivars indicated that aphids are able to increase to higher abundance on certain cultivars or trees and not on others.

Table 1. Aphids reared in clip cages on pecan trees of 5 pecan cultivars had significant differences in the number of nymphs produced over an 11-d period.

	Number of nymphs produced per adult aphid for indicated species		
Cultivar	yellow pecan aphid	blackmargined aphid	black pecan aphid
'Moneymaker'	16.8 b	11.2a	34.0 b
'Elliot'	15.3 b	10.5 a	27.7 b
'Schley'	12.0 b	12.5 a	42.0 a
'Van Deman'	12.3 b	6.2 b	27.5 b
'Sioux'	24.7 a	8.3 ab	27.8 b
LSD Value ($P < 0.05$)	5.6	4.1	6.8

Means in the same column and followed by the same letter are not significantly different (F-test (4, 25), LSD ($P < 0.05$).

Table 2. Mean number of aphids per leaf per week over the entire season for 3 species of aphids on 10 pecan cultivars represented by 2 trees in the provenance collection.

Cultivar	yellow pecan aphids	Cultivar	blackmargined aphids	Cultivar	black pecan aphids
'Moreland'	1.34 a	'Moneymaker'	1.33 a	'Schley'	1.53 a
'Elliot'	1.29 a	'Van Deman'	1.24 ab	'Moneymaker'	1.30 ab
'Van Deman'	1.27 a	'Moreland'	1.24 ab	'Van Deman'	1.22 bc
'Schley'	1.26 a	'Stuart'	1.24 ab	'Moreland'	1.20 bc
'Moneymaker'	1.24 a	'Schley'	1.22 ab	'Merrimac'	1.16 bcd
'Merrimac'	1.16 a	'Elliot'	1.18 ab	'Barton'	1.11 cd
'Stuart'	1.15 a	'Sioux'	1.16 ab	'Sioux'	1.11 cd
'Barton'	1.14 a	'Merrimac'	1.15 b	'Jackson'	1.07 d
'Sioux'	1.11 a	'Barton'	1.15 b	'Stuart'	1.06 d
'Jackson'	0.97 a	'Jackson'	1.09 b	'Elliot'	0.97 e

Means for the same aphid species and followed by the same letter are not significantly different (GLM, Scheffé Test, $P < 0.05$).

Table 3. Average number of aphids per leaf per week over the entire season for 3 species of aphids on 13 pecan cultivars represented by 1 tree in the provenance collection.

Cultivar	yellow pecan aphids	Cultivar	blackmargined aphids	Cultivar	black pecan aphids
'Melrose	1.35	'Melrose'	1.58	'Alley'	1.65
'Zinner	1.30	'Zinner'	1.46	'Kiowa'	1.58
'Alley'	1.20	'Register'	1.35	'Zinner'	1.23
'Register'	1.19	'Alley'	1.28	'Lineberger'	1.22
'Kiowa'	1.16	'Faircloth'	1.17	'Candy'	1.15
'Lineberger'	1.07	'Lineberger'	1.17	'Register'	0.96
'McMillan'	1.00	'Kiowa'	1.17	'McMillan'	0.94
'Faircloth'	0.95	'McMillan'	1.12	'Melrose'	0.90
'Curtis'	0.95	'Candy'	1.03	'Faircloth'	0.90
'Candy'	0.94	'Curtis'	0.99	'Gafford'	0.86
'Amling'	0.90	'Gafford'	0.97	'Curtis'	0.85
'Lager 1'	0.82	'Lager 1'	0.96	'Amling'	0.84
'Gafford'	0.82	'Amling'	0.95	'Lager 1'	0.81

Average abundance of aphids is ranked from highest to lowest based on 10 samples collected per tree for each sample date.

Average number of aphids per leaf per week over the 14 sampling dates indicates the "seasonal abundance" for the 3 species of aphids on each pecan cultivars. Among pecan tree cultivars represented by 2 trees seasonal abundance of yellow pecan aphid abundance was the same in all cultivars tested. Seasonal abundance of black-margined aphid abundance was higher in 'Moneymaker' than in 'Jackson'; seasonal abundance of black pecan aphid was higher in: 'Schley' than in 'Van Deman', 'Moreland', 'Merrimac', 'Barton', 'Sioux', 'Jackson', 'Stuart', and 'Elliot'; 'Moneymaker' than 'Barton', 'Sioux', 'Jackson', 'Stuart', and 'Elliot'; and, 'Van Deman', 'Moreland' than 'Elliot' (Table 2). It is not possible to determine whether the differences are caused by the individual tree or the cultivar among pecan tree cultivars represented by 1 tree. In pecan propagation, the scions are grafted to seedling rootstocks and each rootstock has a unique genotype. However, the data offer a preliminary indication of which cultivars may be susceptible or tolerant of aphids for future research. Among pecan tree cultivars represented by 1 tree, overall aphid abundance was ranked from highest to lowest (Table 3). The 'Amling', 'Gafford', 'Lager 1', 'Curtis', 'Stuart', 'Jackson', 'McMillan', and 'Faircloth' trees sustained similarly low levels of aphids in all 3 aphid species. Differences among cultivars for these 13 trees could just as likely be due to the location in the orchard and/or rootstock. All other observed pecan cultivars sustained higher levels of aphids of one or more species of aphids that the lowest group.

In commercial pecan orchards, aphid reproduction is countered by natural control and insecticides to prevent outbreaks of yellow pecan and blackmargined aphids in the early season and outbreaks of all 3 species in the late season that can be injurious to the foliage. Control of pecan aphids has not been successful with insecticides alone or with natural control alone. Our results indicate that aphid reproductive rates differ between pecan cultivars and that aphids are more abundant on certain pecan cultivars. Significant aphid outbreaks occurred on 5 of the 23 cultivars or trees in our study. The seasonal aphid abundance results are limited because the different cultivars were planted between 1927 and 2005 in the provenance collection as they were discovered and not in a randomized pattern. These sampling results, however, were collected systematically and consistently over the entire season and are more valuable than the casual ratings by horticulturalists reported in the cultivar announcements. The clip cage method identified potentially resistant or tolerant among 5 pecan cultivars and indicated that black pecan aphids have higher seasonal abundance on 'Schley' and produced more nymphs per adult on 'Schley' than on the other four pecan cultivars.

Acknowledgment

Thanks to the Georgia Agricultural Commodity Commission for Pecans for funds for supplies and The Higher Education Commission of Pakistan for support of the stipends for Haider Karar and Mahr Ghulam Abbas.