NOTE

Effect of Rainfall on Population Abundance of Aphids (Homoptera: Aphididae) on Pecan[1]

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Research emphasis has been placed upon high temperatures and natural enemies as limiting factors reducing the populations of yellow pecan aphid, *Monelliopsis pecanis* Bissell, black-margined aphid, *Monellia caryella* (Fitch), and black pecan aphid, *Melanocallis caryaefoliae* (Davis) (Tedders, 1977, Ann. Entomol. Soc. Amer. 70: 687-690; Flores, 1981, Ph.D. Diss., Texas A&M Univ.; Liao et al., 1985, Environ. Entomol. 14: 122-126; Edelson and Estes, 1987, J. Entomol. Sci. 22: 336-347; Tedders et al., 1992, J. Entomol. Sci. 27: 135-142). However, information regarding the extent of aphid reductions by various intensities of natural rainfall was lacking. Therefore, the short-term influence of rainfall in reducing the density of aphids was studied on nine dates between 11 July and 20 August 1992.

Experimental work was conducted on twelve 13-yr-old naturally infested pecan trees in an orchard near Tifton, Georgia. Trees received the fungicide Super-Tin® on 20 July and 12 August, but no insecticides were applied. Each tree was divided into four sides (north, east, south, west). One terminal from the outer periphery of each side (1.5 - 2.5 m above the ground) was tagged for later observations. Before and after rainfall, the numbers of aphids (nymphs, winged adults, black aphid-mummies parasitized by *Aphelinus perpallidus* (Gahan) and all stages of associated predators were recorded from each terminal. Nymphs of *M. caryella* and *M. pecanis* were grouped as a complex; adults were separated by species. Counts were made between 2-8 h and 2-14 h before and after rainfalls, respectively, and the period between the two counts ranged from 11 to 32 h. A pairwise *t*-test was used to determine significant ($P < 0.05$) differences between aphid densities before and after each rainfall date (SAS Institute, 1985, Cary, N. C.). The frequency and amount of rainfall during the months of July and August were recorded hourly using an Envirocaster weather station (Neogen Corp., Lansing, Mich.) located within a pecan orchard 200 m from the experimental site.

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Pecan aphid populations were higher on the north sides of the trees (nymphs 31-48%, adults 32-71%) between 11 July to 4 August, but no aphid preference was observed when aphid population declined after 4 August. Densities of the three species did not exceed the thresholds recommended for aphid control. Aphid population declined steadily during the first four sampling dates (Table 1), rose to their seasonal peak when no rainfall occurred between 19 and 27 July, and then declined steadily for the next four observation dates. On all sampling dates, significant reductions ($P < 0.05$) among nymphs and winged adults were observed after each rainfall.

Winged *M. caryella* were the dominant species in all adult counts, comprising 74.4 to 96.7% of all species before rainfall; adult *M. pecanis* and *M. caryaefoliae* ranged from 2.0 to 12.0% and 0.9 to 15.1%, respectively, during the sampling period. The ratio of alate to apterous aphids before rainfall was very low (ranged from 0.08 to 0.11) during the first four observation dates, but increased (0.28-0.43) during the remaining dates. It was unclear whether the sharp drop in aphid density during August was due to rainfall alone or in conjunction with other factors such as low reproduction and emigration of winged forms. At high aphid densities, reproductive rate decreases and production of emigrating alates increases (Way and Banks, 1967, Ann. Appl. Biol. 59: 189-205).

The rainfall effect is variable and likely dependent on a number of factors such as aphid density, amount and duration of rainfall, time of its occurrence, duration of aphid exposure to rainfall, feeding site, presence of honeydew, wind speed, and interaction with other factors. Rainfall has previously been shown to be a factor regulating the population density of aphids (Medina-Gaud et al., 1967, Proc. 12th Congr. Int. Soc. Sugar Cane Technol. Puerto Rico. p. 1307-1320; Lourenco et al., 1983, Agron. Lusitana. 42: 147-152; Kim et al., 1986, Korean J. Plant Prot. 25: 129-132). Heavy rainfall was reported to dislodge *Acyrthosiphon pisum* Harris, *Brevicoryne brassicae* (L.), and *Macrosiphum rosae* (L.) from their host plants; whereas *Aphis fabae* Scop. cling to the host plant and survive (Dunn and Wright, 1955, Bull. Entomol. Res. 46: 369-387; Hughes, 1963, J. Anim. Ecol. 32: 393-424; Maelzer, 1977, Austral. J. Zool. 25: 269-284). Wind may have disturbed the pecan foliage and led to the leaves brushing together and dislodging many aphids. Strong wind resulted in sycamore aphids being brushed off (Dixon and Mckay, 1970, J. Anim. Ecol. 39: 439-454). A storm with 9.9 mm of rain and wind speed of 37-46 km/h reduced the population of potato aphids by 1.2 to 51.8% (Shands et al., 1956, J. Econ. Entomol. 49: 252-253). Wind speed accompanying the rain is a major cofactor (Walker et al., 1984, Environ. Entomol. 13: 724-732); in storms where wind is high, aphid mortality is likely to be great.

Rainfall in this experiment was at irregular intervals. It occurred in relatively short but heavy downpours, and sometimes was non-continuous and low. The irregular intervals between rainfalls and rain intensity were likely to have played a role in the fall and rise in aphid density. Also, the frequency of rainfall in this experiment did not indicate its severity on pecan foliage. Periods of aphid decline were not correlated with periods of high temperature during the test period. Gentry et al. (1975, Pecan Quarterly 9: 20-21) found that changes in yellow pecan aphid populations were not correlated statistically with the cumulative rainfall at 15 days before sampling or with mean temperature at

Table 1. Effect of rainfall on population abundance of *M. pecanis, M. caryella,* and *M. caryaefoliae* on pecan.

Date	Rainfall		Mean no. per compound leaf ± SEM					
			Nymphs			Winged adults		
	Total amount, mm (Min, Max / h)	Duration (h)†	Before rainfall	After rainfall	Mean difference‡	Before rainfall	After rainfall	Mean difference‡
July 11	4.83 (1.02, 3.81)	2	8.2 ± 0.9	6.3 ± 0.6	*	0.8 ± 0.2	0.5 ± 0.1	*
July 14	1.52 (0.25, 0.51)	4*	6.0 ± 0.6	5.2 ± 0.5	*	0.5 ± 0.1	0.2 ± 0.03	*
July 17	5.84 (2.54, 3.30)	2*	4.9 ± 0.4	3.8 ± 0.3	*	0.4 ± 0.04	0.3 ± 0.03	*
July 19	4.57, (0.25, 2.54)	4*	3.6 ± 0.3	2.9 ± 0.3	*	0.4 ± 0.1	0.2 ± 0.03	*
July 27	5.08 (0.25, 2.54)	8*	7.7 ± 0.6	5.4 ± 0.5	*	2.3 ± 0.2	2.0 ± 0.2	ns
Aug. 04	1.27 (0.25, 1.02)	2	6.7 ± 0.6	5.2 ± 0.4	*	1.9 ± 0.2	1.0 ± 0.09	*
Aug. 08	6.62 (0.25, 6.37)	2	2.7 ± 0.4	1.2 ± 0.2	*	0.8 ± 0.1	0.4 ± 0.04	*
Aug. 13-14	40.4 (0.25, 17.5)	16*	1.3 ± 0.2	0.8 ± 0.1	*	0.4 ± 0.04	0.2 ± 0.03	*
Aug. 19	15.8 (0.25, 7.11)	5	0.7 ± 0.1	0.5 ± 0.2	*	0.3 ± 0.03	0.2 ± 0.04	*

† Asterisk indicates non-continuous rainfall for a given duration.
‡ Mean difference between before- and after-rainfall counts was significant (*) or non-significant (ns) from zero (a pairwise t-test, $P < 0.05$, n = 48).

sampling. The intervals between sampling dates (15 days) in their study were so long that changes directly related to temperature and rainfall were not detected.

The role of natural enemies in reducing pecan aphids in this study could not be established because of their extremely low numbers. The ratio of predator to aphid density was too low to have caused the aphid decline and it was not clear how severely predators and parasitoids were affected by rainfall.

Results indicated that the rainfall reduced pecan aphid populations immediately after each rain event, but aphid density often increased within a week following rainfall. Similar results were reported by Atwal et al. (1971, Indian J. Agric. Sci. 41: 507-510). The amount of aphid reduction varied with aphid densities. Knowledge of the amount and frequency of rainfall during the growing season is important when choosing the sampling time and insecticide application interval for pecan aphid control. The application interval depends on the persistence of the insecticide used and weather conditions, mainly the rainfall, before and after application. If high aphid reduction occurs after rainfall, longer intervals can be appropriate for insecticide application, whereas this interval may be shortened if rainfall occurs within 24 h of application.

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