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FIRST RECORD OF *APHIS HELIANTHI* (HOMOPTERA: APHIDIDAE) AS A PEST OF CELERY

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ABSTRACT

In 1989, the aphid *Aphis helianthi* severely damaged five of 10 scouted celery fields in west central Michigan. In 1990 and in 1991, *A. helianthi* again was a problem, reaching pestiferous levels in three of 10 and two of 10 scouted fields, respectively. This insect has not been reported previously as a pest of celery or any other commercial crop. Insecticide efficacy studies showed that some of the most commonly used insecticides are ineffective against *A. helianthi*. Resistance or tolerance to insecticides may explain its new status as a pest.

Aphis helianthi Monell is a polyphagous aphid known from numerous hosts (Palmer 1952). It is usually olive green with black cornicles, although its appearance varies considerably among generations (Robinson and Chen 1969). *A. helianthi* is reported to overwinter on the red-osier dogwood, *Cornus stolonifera* and occasionally has been observed to remain on dogwood all summer (Robinson and Chen 1969). Its usual summer host is annual sunflower, *Helianthus annuus* (Robinson and Chen 1969), although it does not cause economic problems on this composite. It also occurs on many other plant species, including other native annual species of *Helianthus* (Rogers et al. 1978), and some of the wild Umbelliferae (Rojanavongse and Robinson 1976). Cultivated umbellifers, such as commercially grown celery (*Apium graveolens*), are rarely colonized (Blackman and Eastop 1984). We found that *A. helianthi* is the major aphid pest of commercially grown celery in Michigan. We also report results of insecticide trials that suggest a resistance problem with the aphid.

MATERIALS AND METHODS

As part of a larger project to develop an integrated pest management program for Michigan celery, ten celery fields in western Michigan each belonging to different celery growers were scouted weekly during the growing seasons of 1989 through 1991. Sampling included visual inspection of 20 plants at five sites in each field (100 plants per field). A field was identified as having a *A. helianthi* infestation if more than 2% of the plants had aphids. Specimens of the aphid from infested celery were identified in 1989 by Manya Stoetzel of the USDA as *Aphis helianthi*. Voucher specimens were depositied at Michigan State University Entomology Museum, East Lansing, Michigan

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Table 1. Pesticide rates used in 1990 and 1991 trials against *A. helianthi*. Rates are kg active ingredient/ha unless otherwise noted.

compound (brand and formulation)[a]	1990 rate	1991 rate
acephate (Orthene 75 S)	1.12	1.12
avermectin (Agri-mek .15 EC)	0.01	–
chlorothalonil (Bravo 720, 6 EC)	3.35	–
diazinon (Diazinon 8 EC)	1.12	1.12
endosulfan (Thiodan 3 EC)	1.12	1.12
methomyl (Lannate 1.8 L)	1.01	1.01
methomyl + piperonyl butoxide	–	0.50 + 0.56
naled (Dibrom 8 EC)	1.12	1.12
permethrin (Ambush 2 EC)	0.22	–
pyrethrins + piperonyl butoxide (Pyrenone)	–	0.035 + 0.35
insecticidal soap (Safer's Soap)	175.8 ml/l	–

[a] 75 S = 75% soluble powder, EC = emulsifiable concentrate in lbs per gallon, L = liquid suspension in lbs per gallon.

(Voucher #1992-06). Aphid infestation levels were recorded weekly during 1989–1991 growing seasons. Cumulative frequency of infested celery was calculated as the cumulative number of infested celery plants observed (out of 1000 inspected per week) divided by the total number of infested plants observed during the scouting season.

Pesticide Trials. The 1990 insecticide trial was conducted in a commercial field in Kent Co., Michigan. Treatments were applied 13 August to a section of the field with high populations of *A. helianthi*. Plots were one row wide by 30 m long, with an untreated row between each plot as a buffer. Treatments, consisting of 10 insecticides or insecticide/synergist combinations and one fungicide, were randomized within the three treatment rows (blocks). The fungicide Chorothalonil (Bravo 720) was included to test for possible impacts on *A. helianthi*. Before treatment, three heavily infested plants in each plot ($>$ ca. 50 aphids visible per plant in rows (blocks) 1 and 2 and $>$ ca. 25 aphids per plant in row 3) were selected and flagged for sampling after treatment. Treatments were the highest recommended application rates (Table 1). Pesticides were applied between 0600 and 0730 hr with a hand-held CO_2 sprayer and single hollow cone nozzle at 3.16 kg/cm^2 (45 lb/in^2) 560 l/ha (60 gal/a), except for the insecticidal soap and avermectin treatments (1120 l/ha).

The three flagged plants from each plot were cut at the soil surface, grouped by plot in large plastic bags, and returned to the laboratory where they were washed in 70% ethanol. The ethanol was filtered through a fine mesh screen and the aphids, dirt, etc. on the screen rinsed into a beaker using a saturated sucrose solution. The sucrose solution caused the insects to float and the dirt to sink, allowing the insects to be decanted into a suction filtration apparatus. The aphids and other insects, primarily syrphid larvae (Diptera:Syrphidae) deposited on a filter paper during filtration were identified and counted under a dissecting microscope (10 x).

The celery used in the 1991 insecticide trial was dug 9 July from the field of a commercial celery grower in Muskegon Co., Michigan. The celery, approximately one month preharvest, was severely infested. Plants were dug and immediately placed in individual 20 cm diam. clay pots. Plants were transported to a greenhouse at Michigan State University and hooked up to an automatic soil watering system. On 11 July, seven insecticide treatments were applied with a hand-held CO_2 sprayer and a flat fan nozzle at 3.51 kg/cm^2 (50 lb/in^2) and 560 l/ha (based on 71 cm between rows, 20 cm between plants in the row). Ten randomly selected, heavily infested plants were used in each treatment and in the control. Treatments included standard insecticides registered for use in celery. Rates of compounds used were the highest recommended for celery (Table 1). The synergist piperonyl butoxide, which blocks mixed function oxygenase activity, was also tested since mixed function oxygenases are important in insecticide resistance in other insects (Casida 1970). One week posttreatment, the celery was cut off at soil level and rinsed in 70% ethanol as previously described. The ethanol was filtered through a filter paper and the aphids caught on the paper were counted while using a dissecting microscope (10X). Because the celery was not contaminated with particles of muck soil, the rinse in saturated sucrose solution was not used.

Data were square-root transformed before ANOVA; non-transformed data are reported in the figures and text. Tukey's HSD (P=.05) was the multiple comparisons test used. Data for correlation of aphid and syrphid numbers were not transformed before analysis.

RESULTS

In 1989, five of the 10 scouted fields developed high populations of *A. helianthi* (greater than 2% of the plants in the fields were infested). Damage to infested celery was similar to that caused by green peach aphids, with curled and twisted leaves and petioles. In 1990, three of 10 fields became severely infested during the growing season. In 1991, aphids infested two of 10 fields scouted and appeared, but did not reach damaging levels, in three more fields. One grower suffered a severe infestation with high aphid numbers in over 50% of his plants. A private consultant reported many other infestations in commercial celery during the same years. In 1991, *A. helianthi* was identified for the first time as a pest of cultivated celery in central Ontario, Canada (James Chaput, Kettleby Ontario Muck Research Station, pers. comm.).

In Michigan, *A. helianthi* was found in celery fields in Kent, Ottawa, Muskegon and Oceana counties beginning in May and continuing through September, but were most common during late July and August. The cumulative percent infestation summed over the three years of this study shows that aphids began to appear frequently in fields beginning at approximately 800 $dd_{10°C}$ (approximately the first week of July in 1989 and 1990, and the last week of June 1991, depending on location; Figure 1).

Growers reported difficulty controlling the aphid with standard insecticides in all three years. In the 1990 pesticide evaluation study, only acephate, a systemic organophosphate registered for trimmed celery but unavailable for use by the processing celery growers for whom we were scouting, and methomyl, a carbamate, substantially reduced aphid population sizes (Figure 2). None of the treatments resulted in statistically significant differences due to high variability of aphid numbers. These data match the growers' field experiences in 1990. The fungicide chlorothalonil seemed to adversely affect aphid numbers, although, not significantly.

High numbers of syrphid larvae (species unknown) were present on the plants in the 1990 trial (up to an average of 2.3 per plant)(Figure 2). Syrphid numbers were positively correlated with aphid numbers ($r^2 = 0.513$, $F=29.44$, $df=1,28$; $p < 0.0001$). However, graphical analysis also indicated that the naled and permethrin treatments tended to have high aphid numbers with respect to numbers of syrphids, compared to the untreated control (Figure 3a). This suggests that these insecticides are toxic to syrphids but less so to the aphids, perhaps due to resistance. The relationship of aphid and syrphid numbers in the other treatments were more similar to the control (Figure 3 a and b).

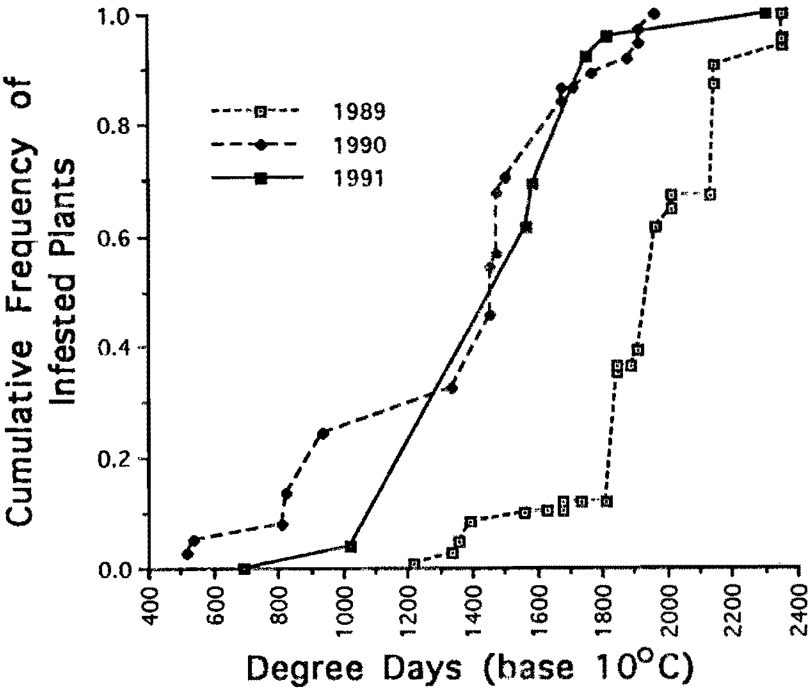

Figure 1. Cumulative frequency of celery plants infested by *Aphis helianthi* in 1989, 1990, and 1991. Data from 10 fields scouted weekly.

The results for the 1991 pesticide trial were similar to those of 1990 (Figure 4). Methomyl continued to give good control. Addition of piperonyl butoxide to methomyl did not increase its efficacy, although methomyl, by itself, was highly effective, indicating that methomyl resistance was not a problem. Endosulfan was effective against this population of aphids, in contrast to 1990 results. Addition of piperonyl butoxide might show more activity with endosulfan or naled in some *A. helianthi* populations. Pyrenone, a product that combines natural pyrethrum and piperonyl butoxide and not previously tested against *A. helianthi*, gave control that was equivalent to that of acephate. Diazinon and naled did not reduce *A. helianthi* numbers as compared with the control.

DISCUSSION

Addicott (1981) synonymized *Aphis heraclella* Davis with *A. helianthi* Monell based on the lack of morphological distinction, host plant phenology, and some host plant transfer experiments. There is still debate regarding this synonymy, but until further host transfer works shows otherwise, *A. helianthi* is the recognized species name (M. B. Stoetzel, United States Dept. of Agriculture-Agricultural Research Service, pers. comm.). *Aphis helianthi* is

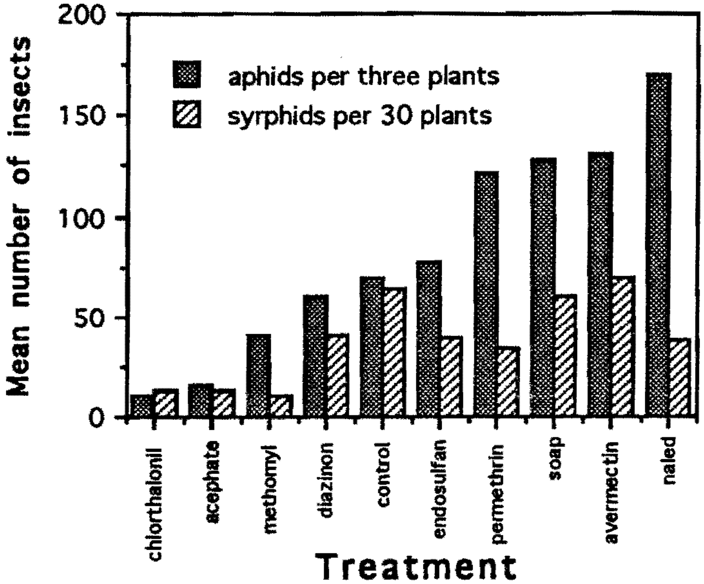

Figure 2. Mean number of *Aphis helianthi* and syrphid larvae in 1990 pesticide trial on celery.

referred to as the "sunflower aphid" by Essig (1938), although the Entomological Society of America does not accept this as a common name.

Other aphids, such as the green peach aphid, *Myzus persicae* (Sulzer), are pests of commercial celery in Michigan (and were occasionally present in fields in this study). Not until 1989 was *A. helianthi* identified as a major pest of this crop. It is unclear whether the aphid has been a long-standing pest of celery but never identified to species, or if the aphid has recently adopted commercial celery as a host. Essig (1938) identified *A. helianthi* (as *A. heraclella*) as a potential pest of celery in California, but there have been no reports of economically important injury from that state. Blackman and Eastop (1984) include *A. helianthi* in their key to pests of celery, but indicate that cultivated unbellifers are rarely colonized. Because of the recent identification of the aphid as a serious economic problem in Michigan in 1989 and in Ontario, Canada in 1991, it is probable that it is a new pest of cultivated celery, and may even be expanding its range.

It is perhaps not surprising that commercial celery has become a host for *A. helianthi*. The muck soil in which celery is grown and nearby ditch banks favor the growth of two potential alternate hosts for the aphid. The reported over-wintering host of *A. helianthi*, red-osier dogwood (Graves 1956), occurred on the periphery of most sites we scouted. We were not able to identify any *A. helianthi* on these trees, but we did not do a comprehensive sample, so some trees may have served as an inoculation source for the aphids that infested the celery. We also observed Jerusalem artichoke, *Helianthus tuberosus*, a relative of sunflower and a known host of *A. helianthi* (Leonard 1963) near the

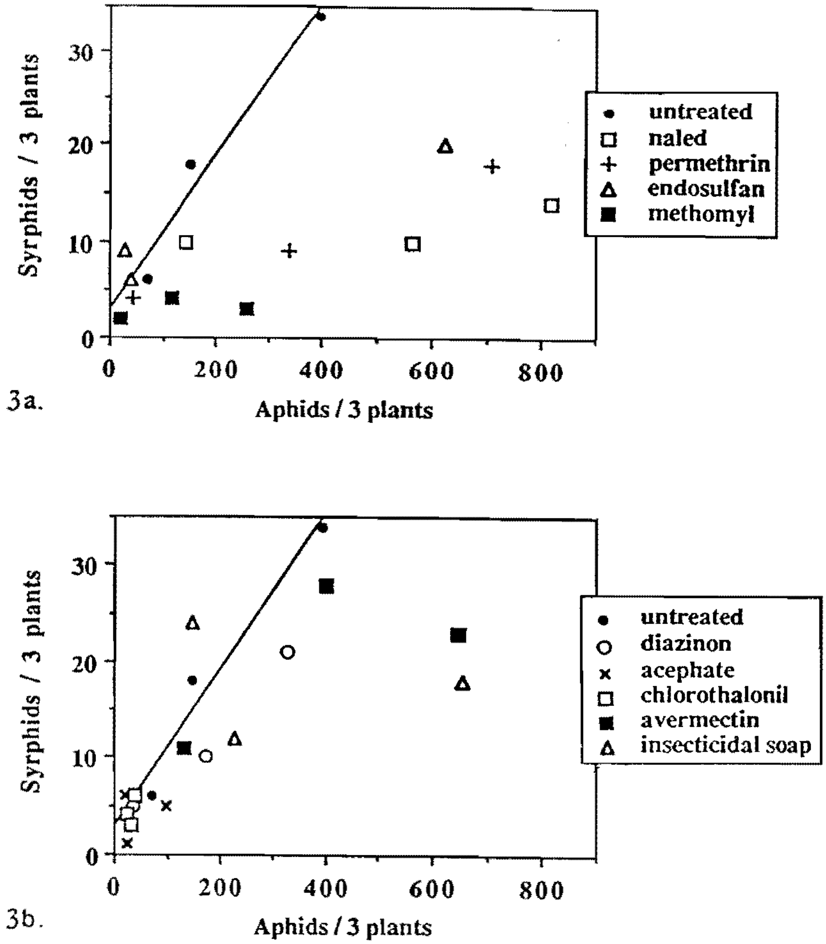

Figure 3. Aphid numbers compared to syrphid numbers by treatment for 1990 pesticide field trial on celery: a. naled, permethrin, endosulfan, methomyl, and untreated. b. diazinon, acephate, chlorothalonil, avermectin, Safer's soap, and untreated. The line represents the relationship between aphids and syrphids in the untreated control (slope=0.08 syrphid per aphid, $r^2=0.96$).

edge of many fields. *Helianthus tuberosus* may be serving as an alternate host of *A. helianthi*.

The source for *A. helianthi* infesting celery remains unknown. Because almost all Michigan celery growers start their own transplants on-farm, aphids are not being imported from other states. Celery plants are quite small at transplanting and no aphid infestations have been reported in greenhouses. It is unlikely that the aphids are being transported to the field on transplants.

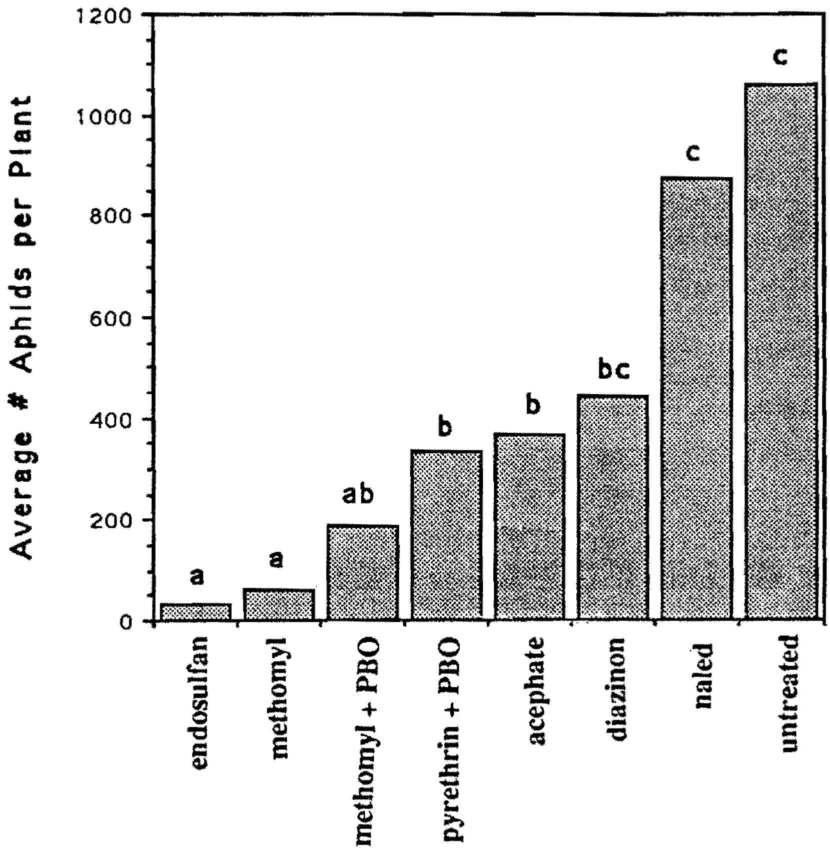

Figure 4. Number of *Aphis helianthi* per celery plant for 1991 insecticide trial. Counts were taken one week post-spray. Values with different letters are significantly different (Tukey's HSD, $P<0.05$).

It is possible that the aphids are harbored on wild or other cultivated umbels. More work on the innoculum source for *A. helianthi* infestations of commericial celery is needed.

Fungicides have been previously observed to reduce aphid populations. Studies have shown that chlorothalonil caused significant asparagus aphid mortality in the field and in the laboratory, although maneb, a fungicide with a different active ingredient, was not toxic (Prokrym 1988). Aphid/fungicide interactions may prove to be significant in managing this aphid in celery.

Insecticides may differentially affect the aphid and its natural enemies. Permethrin, naled, and endosulfan appear to adversely affect syrphids without reducing aphid populations. Although, as a whole, aphid and syrphid numbers were positively correlated in the 1990 trial, the above treatments showed high aphid numbers with low syrphid numbers (Figure 3a). The other treatments showed a relationship between aphid and syrphid numbers that was comparable to the control (Figure 3b). In developing a management strategy for this pest it will be necessary to consider these types of relationships. Pyrenone may warrant further study because of its high level of human safety and short days-to-harvest limit.

In the 1991 trial no compound gave total control, even though all were applied under "ideal" laboratory conditions. A preliminary test of the levels of esterases, enzymes that can detoxify many insecticides, showed levels to be very high in *A. helianthi* populations–much higher than levels in resistant green peach aphids. This suggests the aphid may use esterases to resist some of the insecticides we tested. The marked difference in efficacy of endosulfan on two different populations indicates that this species varies in its susceptibility to insecticides. Further tests of both resistant and susceptible populations are needed to evaluate the problem of resistance in this insect.

Although *A. helianthi* is a relatively new pest of celery, it is already widespread in Michigan and causing significant economic losses. Further study on aspects such as sampling, insecticide resistance, and the interaction between potential biocontrol agents and pesticides are required to ensure effective management.

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