

EFFECT OF TRAP COLOR ON SPECIES COMPOSITION  
OF ALATE APHIDS (HOMOPTERA: APHIDIDAE) CAUGHT  
OVER WATERMELON PLANTS

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ABSTRACT

The species composition and abundance of alate aphids caught in water traps containing green or yellow tiles were compared. Traps were operated in a watermelon field during the spring and autumn growing seasons of 1992. *Aphis spiraecola* Patch, a vector of watermelon mosaic virus 2 (WMV-2), accounted for 79% of the aphids caught in the spring and 91% of those caught in the autumn in yellow traps. However, this species accounted for only 6% and 11% of aphids caught in green traps in the spring and autumn, respectively. *Uroleucon pseudambrosiae* (Olive), also a vector of WMV-2, was the most abundant aphid in green traps in the spring but was absent in the autumn. *Aphis gossypii* Glover (16% of aphids in green traps) and *Aphis craccivora* Koch (31%) were more common in the autumn than in the spring and may be important vectors of cucurbit potyviruses at that time.

Key Words: Epidemiology, watermelon mosaic virus 2, *Uroleucon pseudambrosiae*, *Aphis* spp.

RESUMEN

La composición y abundancia de especies de áfidos alados capturados en trampas de agua de color verde y amarillo en una plantación de sandía durante la temporada de primavera y otoño fueron comparadas. *Aphis spiraecola* Patch fue colectado en cantidades muy altas en trampas amarillas durante la primavera y otoño. Esta especie representó el 6% y 11% de los áfidos capturados en trampas verdes durante la primavera y el otoño, respectivamente. *Uroleucon pseudambrosiae* (Olive), otro vector del virus mosaico de la sandía tipo 2 (VMS-2), fue el áfido más abundante en trampas verdes durante la primavera; sin embargo, este vector no se atrapó en la temporada del otoño. *Aphis gossypii* Glover (16% de los áfidos capturados en trampas verdes) y *Aphis craccivora* Koch (31%) fueron más comunes en el otoño, indicando que pueden ser importantes vectores en epidemias causadas por potivirus en cucurbitáceas en esa estación.

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Watermelon mosaic virus 2 (WMV-2), a potyvirus, is the most important virus affecting watermelon in the spring in Central and North Florida (Purcifull et al. 1988). WMV-2 is nonpersistently transmitted by many species of aphids (Coudriet 1962, Yamamoto et al. 1982, Adlerz 1987) and is thus difficult to control. Early infection can stunt plants and reduce fruit set (Demski & Chalkley 1974). Fruit from infected plants may develop ringspots on the rind and pale green varieties become bleached in appearance.

In our studies of the epidemiology and management of this virus we have used green tile water traps, first described by Irwin (1980), to estimate aphid landing rates. Peaks in the number of aphids caught in green tile traps correlated well with the first appearance

of WMV-2 in the spring in Florida (Webb & Linda 1993). Green tiles have also been used to monitor landing rates of aphid vectors in peppers, tobacco, and potatoes (Raccah et al. 1985, Gray & Lampert 1986, Boiteau 1990). The spectral reflectance properties of our tile closely match those of watermelon leaves and, theoretically, should trap only aphids that would be landing in the crop (Irwin & Ruesink 1986).

Adlerz trapped aphids at the Central Florida Research Center for many years, using yellow sticky boards, yellow water pan traps, and a suction trap (Adlerz 1974, 1976, 1978, 1987). Because much of what we know about locally important vectors is based on his research, we thought it essential to know how our green tile trap catches differed from yellow pan catches in terms of species composition and abundance.

A second cucurbit crop is often grown in the autumn when there are two additional potyviruses present, zucchini yellow mosaic virus (ZYMV) and the watermelon strain of papaya ringspot virus (PRSV-W). These viruses share many of the same vectors but may be transmitted with different efficiencies (Adlerz 1987). There are no published data available on the species composition of alate aphids landing in watermelon fields in the autumn. We thus compared green and yellow traps during the autumn growing season, not only to collect additional data on differences between traps, but to also identify the species of aphids landing in the crop at that time.

#### MATERIALS AND METHODS

The green tile used in our traps was chosen because its spectral reflectance closely matched that of watermelon leaves, specifically a young, but expanded leaf from the cultivar 'Charlee'. The reflectance of several green tiles and leaves was measured with an optical microreflectometer (Materials Science Center, University of Florida, Gainesville 32611).

Traps were constructed by using clamps to attach a clear plastic sandwich box (12.5 x 12.5 x 5 cm) to a metal rod, as described by Irwin (1980). Dark green ceramic tiles (made in England by H&R Johnson Tiles Ltd, a company now owned by ABC Tiles, Orlando, FL 32805), 10.8 x 10.8 cm, were placed in the box which was filled with water containing a small amount of detergent to break the surface tension. Yellow tile traps were identical to the green except that a yellow plastic tile (supplied by D. J. Schuster, University of Florida, Gulf Coast Research and Education Center, Bradenton) was used. No reflectance data were available for this tile.

In the spring, we placed five traps of each color within a 1.5-ha watermelon breeding field planted in early March. Black plastic mulch and drip irrigation were used in this field. One pair of traps was placed within each corner of the field and one pair near the center. Yellow and green traps were placed at least 5 m apart within a row of plants. Trap height was adjusted to canopy level. In the autumn (watermelon planted in mid August), two green traps were placed with each yellow trap (randomly arranged within a location but at least 5 m apart). Because green traps were not highly attractive to aphids, we hoped to increase our chances of trapping less abundant aphids by increasing the number of traps. For analysis, the number of aphids caught per trap location was divided in half.

We collected aphids five times a week for 12 wk in the spring (17 Mar. - 8 June) and for 9 wk in the autumn (21 Sept. - 20 Nov.) and stored them in 70% ethanol. Collected specimens that could not be identified in ethanol were cleared and mounted on microscope slides following the procedure outlined by Hille Ris Lambers (1950). Identifications were made or confirmed by the third author. Voucher specimens are housed in the Florida State Collection of Arthropods, Gainesville.

Aphids collected were identified for each date and totaled for each season by species and trap color. Those species that accounted for at least 3% of the total aphids caught

were compared within a season by trap color using *t*-tests. The number of aphids caught in green tile water traps in the autumn was divided in half before analysis, but total numbers caught are presented in Table 1.

## RESULTS

The spectral reflectance of the dark green tile we chose to use matched that of watermelon leaves both in position of peaks (550 nm for the leaves and 540 nm for tiles) and in percent reflectance (Fig. 1). Both leaves and tiles showed an additional peak in

TABLE 1. APHIDS COLLECTED IN WATER PAN TRAPS, LAKE COUNTY, FL, 1992

Aphid Species <sup>c</sup>	Spring <sup>a</sup>		Autumn <sup>b</sup>	
	17 Mar. - 8 June Green	Yellow	21 Sept. - 20 Nov. Green	Yellow
<i>Acyrtosiphon pisum</i> (Harris)	0	1	1	0
<i>Aphis coreopsidis</i> (Thomas)	0	1	0	1
<i>Aphis craccivora</i> Koch*	3	5	67	95
<i>Aphis fabae</i> -Scopoli complex	0	4	0	0
<i>Aphis gossypii</i> Glover*	1	5	34	46
<i>Aphis helianthi</i> Monell complex	0	3	1	3
<i>Aphis middletonii</i> (Thomas)*	7	43	11	30
<i>Aphis nerii</i> Boyer de Fonscolombe*	0	5	0	1
<i>Aphis rubifolii</i> (Thomas)	0	2	0	0
<i>Aphis sambuci</i> L.	0	12	0	0
<i>Aphis spiraecola</i> Patch*	7	1143	26	2349
<i>Aphis</i> sp.	0	3	2	0
<i>Brachycaudus helichrysi</i> (Kaltenbach)	0	1	0	0
<i>Geopemphigus flocculosus</i> (Moreira)	0	0	0	1
<i>Hayhurstia atriplicis</i> (L.)	2	2	0	0
<i>Hyalopterus pruni</i> (Geoffroy)	1	1	0	0
<i>Hysteroneura setariae</i> (Thomas)*	1	0	0	0
<i>Lipaphis erysimi</i> (Kaltenbach)	2	14	1	0
<i>Macrosiphum euphorbiae</i> (Thomas)*	0	1	0	0
<i>Microparsus olivei</i> Smith and Tuatay	0	0	0	1
<i>Myzocallis multisetis</i> Boudreaux and Tissoth	0	1	2	0
<i>Myzus persicae</i> (Sulzer)*	3	48	0	7
<i>Rhopalosiphum cerasifoliae</i> (Fitch)	0	2	0	0
<i>Rhopalosiphum maidis</i> (Fitch)	0	3	4	6
<i>Rhopalosiphum nymphaeae</i> (L.)	0	0	1	1
<i>Rhopalosiphum padi</i> (L.)*	1	5	1	0
<i>Rhopalosiphum rufiabdominalis</i> (Sasaki)	2	9	1	1
<i>Sarucallis kahawaluokalani</i> (Kirkaldy)	0	0	0	2
<i>Schizaphis</i> sp.	0	0	2	0
<i>Sipha flava</i> (Forbes)	1	1	2	1
<i>Tetraneura nigriabdominalis</i> (Sasaki)	20	20	55	35
<i>Therioaphis riehmii</i> (Boerner)	0	2	0	0
<i>Uroleucon pseudambrosiae</i> (Olive)*	59	115	0	0
<i>Uroleucon</i> sp.	3	0	0	0
Unknown	0	1	0	0

<sup>a</sup>Total aphids caught in five traps of each color.

<sup>b</sup>Total aphids caught in five yellow tile traps or 10 green tile traps.

<sup>c</sup>Species followed by \* are known vectors of WMV-2 (Coudriet 1962, Yamamoto et al. 1982, Adlerz 1987, Webb & Yokomi 1993).

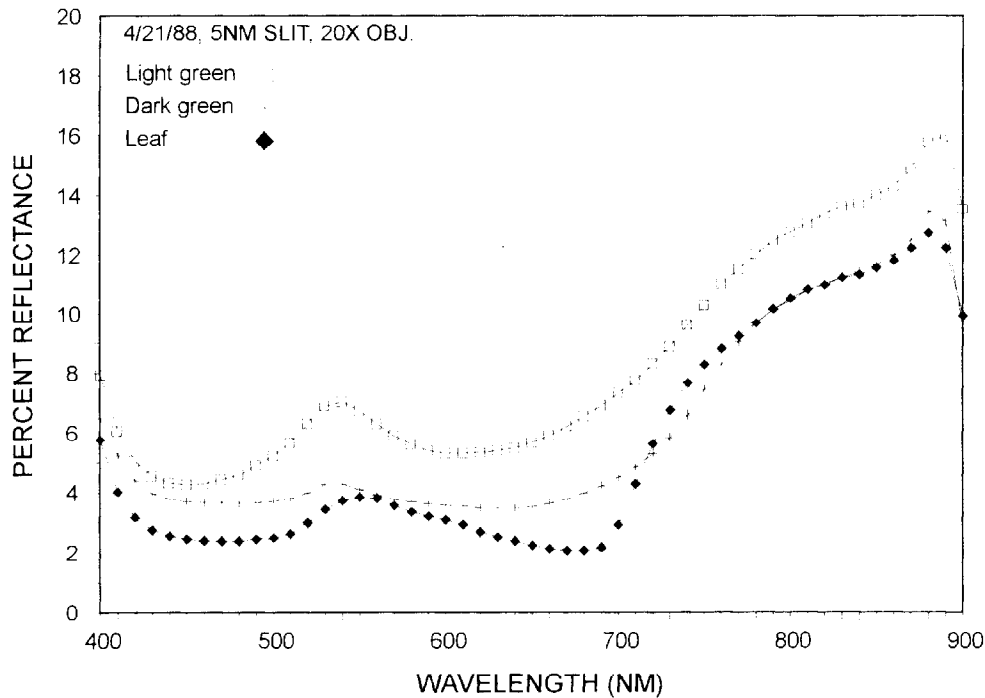


Fig. 1. Spectral reflectance of dark and light (lime) green tiles and a watermelon leaf.

the infrared region of the spectrum. A lighter, more yellow-green tile was also measured but was brighter (higher percent reflectance) than the leaves measured.

A total of 32 species was collected in both seasons from yellow tile traps (Table 1). More species were collected in the spring than in the autumn (28 versus 15), even though the total number of aphids was higher in the autumn (2579 versus 1453). Eight species in the spring and six in the autumn were represented by only one individual. Eleven species were trapped in both seasons.

A total of 23 species was collected from green traps (Table 1). Fifteen species were found in the spring and 17 in the autumn. In the spring, 113 individuals were collected from five traps versus 212 from 10 traps in the autumn. Only nine species were caught in both seasons. In a few cases, species represented by few individuals were caught in green tile pan traps in one season and yellow in the other. Three species [*Hysteronneura setariae* (Thomas), a *Schizaphis* sp., and a *Uroleucon* sp.] were collected only from green tile traps.

In the spring, *Aphis spiraeicola* Patch (= *A. citricola* van der Goot) was the most abundant aphid caught in yellow tile traps (Table 1, Fig. 2), constituting 79% of the total aphids collected. We caught more *Aphis* spp. (11 versus 4) with yellow traps than with green, although most were not abundant. *Myzus persicae* (Sulzer) also appeared to be attracted to yellow. *Tetraneura nigriabdominalis* (Sasaki), a species that feeds on the roots of grasses, was found in equal numbers in yellow and green traps (Table 1). Other grass-feeding species [*Rhopalosiphum* spp., *Sipha flava* (Forbes)] were not abundant, and there were no apparent differences between green and yellow traps.

*Uroleucon pseudambrosiae* (Olive) (formerly *Dactynotus*) was the most abundant species caught in green tile traps in the spring (Table 1, Fig. 2). The number of *U. pseudambrosiae* caught in green traps in the spring was not significantly different, however, than the number caught in yellow, based on season totals per trap ( $t = -1.6403$ ,

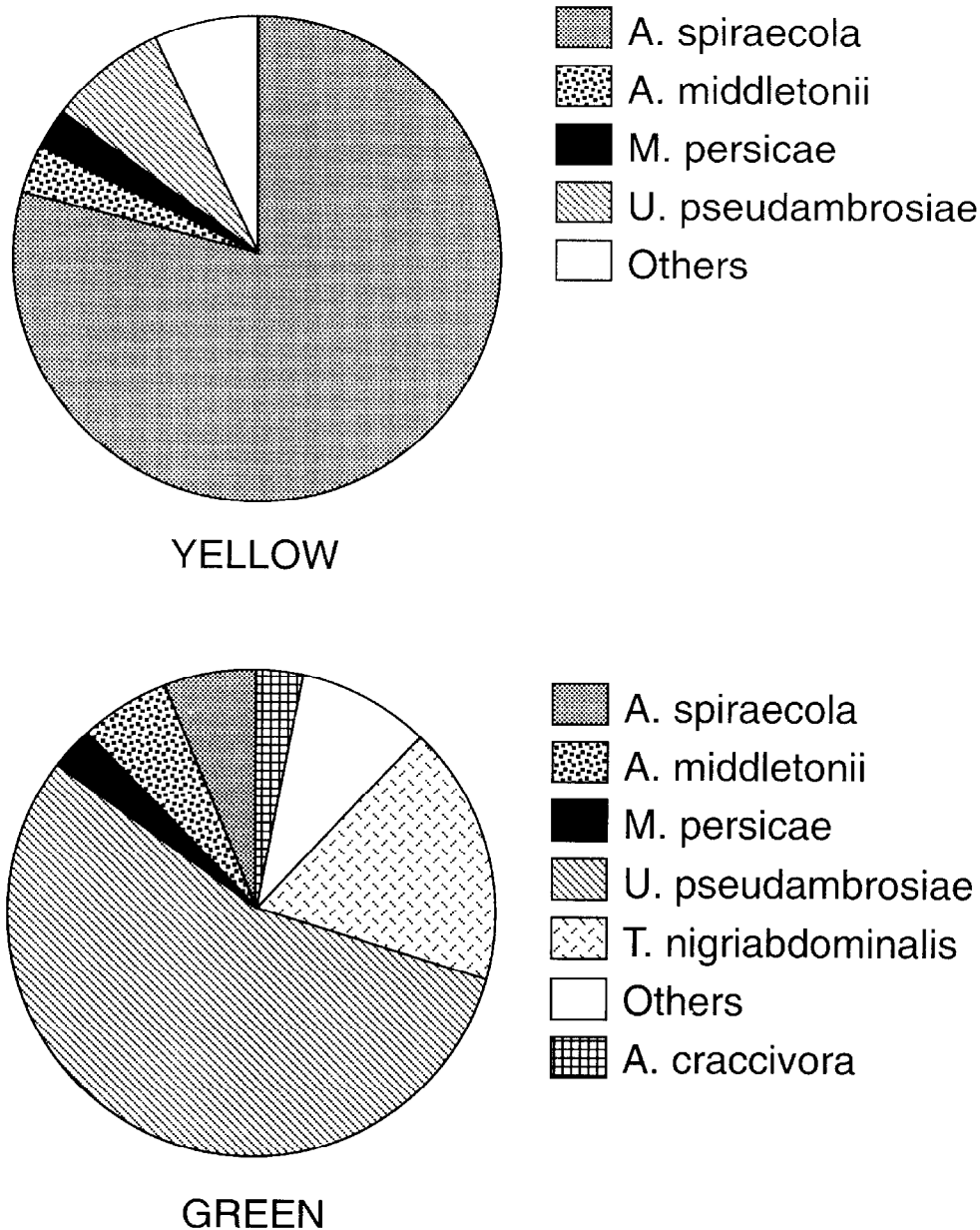


Fig. 2. Species composition of aphids caught in five yellow or five green tile water pan traps from 17 Mar. to 8 June 1992. For yellow tiles,  $n = 1453$ ; for green,  $n = 113$ .

$df = 4.5$ ,  $P = 0.1697$ ). The number of aphids caught in yellow traps varied more among traps than did the number caught in green traps (Fig. 3).

In the autumn, *A. spiraecola* accounted for 91% of aphids collected from yellow tile traps and for 11% of those from green tile traps (Table 1, Fig. 4). *T. nigriabdominalis* was also caught in both seasons, again in approximately equal numbers from the two traps (Table 1). Most of the *A. craccivora* Koch and *A. gossypii* Glover were collected in the autumn (Table 1). There were no significant differences in the number of *A. gossypii* caught in green versus yellow traps ( $t = -1.514$ ,  $df = 8$ ,  $P = 0.1685$ ), but *A.*

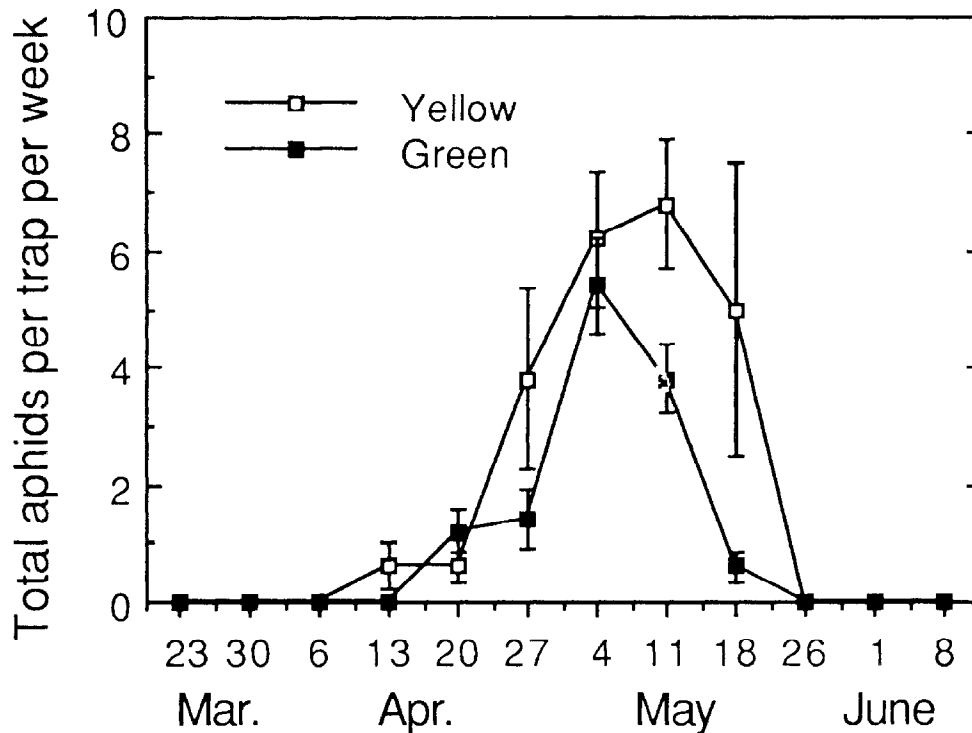


Fig. 3. Mean number of *U. pseudambrosiae* caught per trap in yellow and green tile traps.

*craccivora* was caught more often in yellow traps ( $t = -2.4733$ ,  $df = 8$ ,  $P = 0.0385$ ). No *U. pseudambrosiae* and very few *M. persicae* or *Lipaphis erysimi* (Kaltenbach) were caught in either trap in the autumn.

Of aphid species trapped in the spring, 39% of those caught in yellow traps and 47% in green traps were known vectors of WMV-2. The percentage of total aphids (individuals rather than species) caught that were potential vectors was much higher for both traps. Yellow trap catches were dominated by *A. spiraeicola*, a known vector. Thus, 95% of the total number of aphids trapped were theoretically capable of vectoring WMV-2. Fewer total vectors were caught in green traps (73%), even though the number of vector species trapped was higher, because *T. nigriabdominalis*, a non-vector (Adlerz 1987), accounted for 18% of the aphids caught.

In the autumn, 40% of the species trapped in yellow traps and 47% of those in green traps were potential vectors. Again, total numbers were much higher. Of the *A. spiraeicola* collected in yellow traps, however, 84% were trapped after 26 Oct. when most watermelon plants had senesced. These aphids thus had no role in the viral epidemic in the crop. In contrast, approximately 60% of aphids identified as *A. gossypii*, the only aphid to colonize watermelon, were collected by 6 Oct. (from both green and yellow traps). Differences between total aphids and total vectors in green traps were due to the presence of *T. nigriabdominalis*.

#### DISCUSSION

Yellow is highly attractive to many species of aphids (Taylor & Palmer 1972). Taylor & Palmer (1972) summarized data from three studies comparing yellow traps with

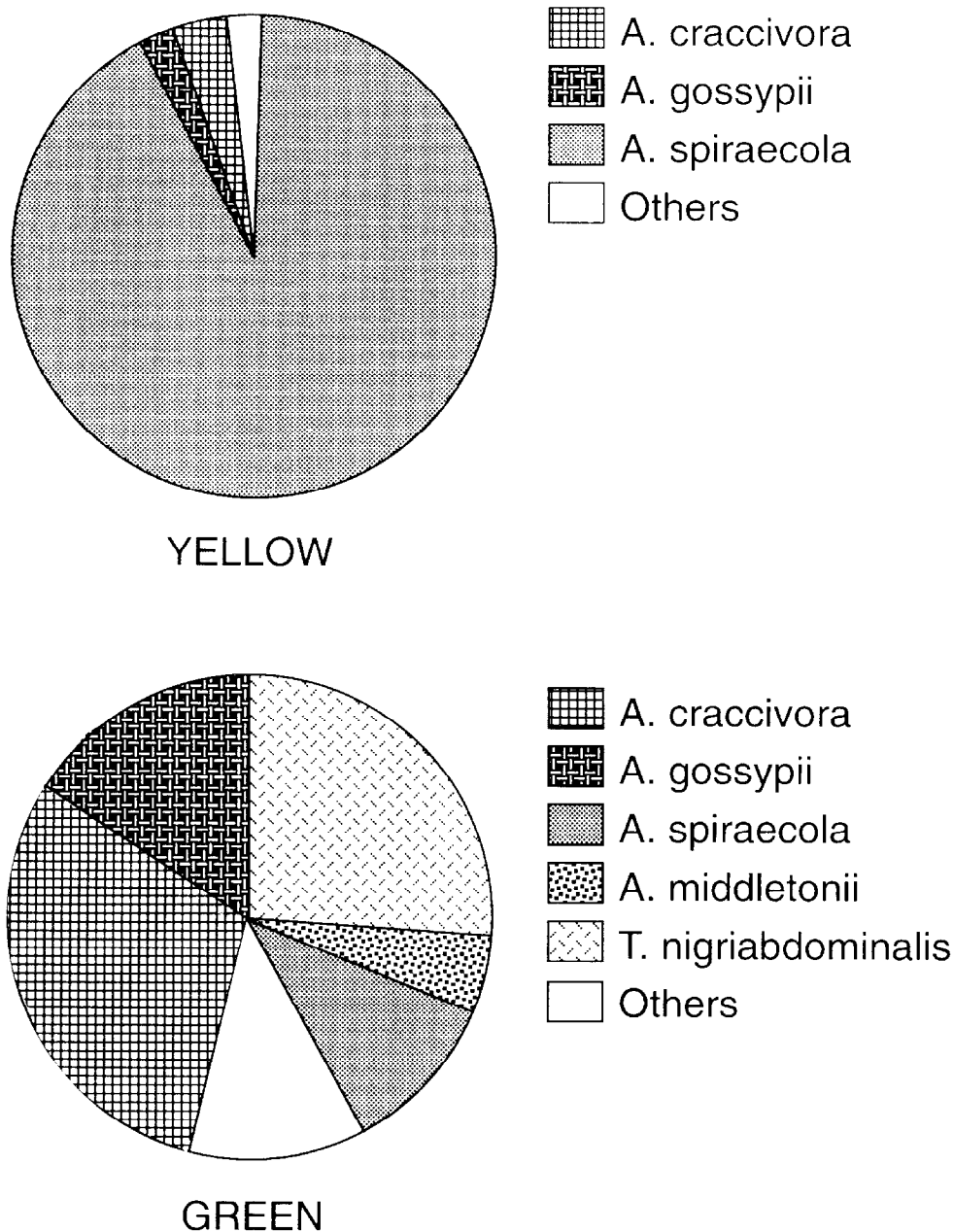


Fig. 4. Species composition of aphids caught in five yellow or ten green tile water pan traps from 21 Sept. to 20 Nov. 1992. For yellow tiles,  $n = 2579$ ; for green,  $n = 212$ .

non-selective traps. They concluded that yellow was generally attractive to species feeding on dicotyledons but not to those feeding on grasses and sedges. In one of the studies they summarized, *A. spiraecola* was more than 700 times more attracted to yellow than *R. padi*. In our study we also found that yellow was no more attractive to grass-feeding species than green (*T. nigriabdominalis*, for example) and was much more attractive to species feeding on dicotyledons, especially *A. spiraecola* and *M. persicae*. Both of these species are highly polyphagous. *A. spiraecola* has host plants in over 20 families, with citrus the most important crop plant (Blackman & Eastop 1984).

Halbert et al. (1986) found no differences in the number of *A. spiraecola* caught in yellow pan traps and in mosaic green tile pan traps. In addition to possible differences between our yellow traps and theirs, it is also possible that the mosaic green tile was more attractive to this species than the dark green tile used in our study. The spectral reflectance of our tiles matched leaves not only in the position of peaks, but in percent reflectance. Mosaic green tiles had a higher percent reflectance than soybean (Irwin & Ruesink 1986) or potato leaves (Boiteau 1990) and may be somewhat more attractive for this reason. The percent reflectance that we measured at each wavelength for watermelon leaves is not directly comparable to those for soybean and potato leaves (due, we assume, to different methods of measurement) but the peak wavelengths match and the overall pattern is relatively similar.

Our results matched those of Adlerz (1978) who stated that, in most years at Leesburg, *A. spiraecola* accounted for 79% to 99% of the aphids caught on yellow sticky traps or in water pan traps. The overwhelming numbers of this species caught by yellow tiles in our study accounted for a large part of the difference in total numbers of aphids caught by yellow and green tiles.

Although the number of aphids trapped with green tile water traps appears low, it is comparable to the number of aphids trapped in ermine lime tile traps by Gray & Lampert (1986) in North Carolina. The area of our green traps (117 cm<sup>2</sup>) was approximately equal to one large, or two or three small, watermelon leaves. If, as theorized, green traps mimic the leaf surface, then one should be able to estimate the number of aphids landing on a plant if the number of leaves or the total surface area is known (Gray & Lampert 1986). For example, from 12 to 18 May, five *A. middletonii* were caught in green tile traps, equivalent to 5 divided by (7 days x 6 traps) or 0.12 aphids per trap per day. We have found that by 8 wk after planting, or approximately at fruit set, a watermelon plant can have between 300 to 500 leaves with an average leaf area of 58 cm<sup>2</sup> per leaf (S.E.W., unpublished data). Thus 18 to 30 *A. middletonii* per day could be landing on one plant at a time when viral infection could still result in serious damage to the crop.

In this paper we have presented data for two seasons of one year. Adlerz reported many of the same species caught in yellow traps in earlier years (spring only) at the Central Florida Research Center, with differences mainly among those species of which he collected only one or two individuals per season (Adlerz 1974, 1987). He did report year-to-year differences in the abundance of *A. spiraecola* and *A. middletonii*, species thought to play a significant role in virus spread (Adlerz 1976, 1978, 1987). In the spring of 1993, many more *A. middletonii*, a root-feeding aphid, were present in green tile traps, and the increase of *U. pseudambrosiae* was delayed, probably because of a mid-March freeze which destroyed the flower stalks of its host, *Lactuca graminifolia* Michaux (unpublished data).

For epidemiological studies we think that green tile traps offer important advantages over yellow tiles. Although it is simple to trap aphids, it is expensive and time-consuming to identify them. Traps that attract large numbers of aphids create extra labor and potentially misleading information (Taylor & Palmer 1972).

The differential attractiveness of yellow also makes it difficult to draw conclusions about the relative abundance of a potential vector. Adlerz (1987) noted that yellow pans caught proportionately more *A. spiraecola* than a suction trap operated at plant height. In 1982, this species constituted 38% of total aphids trapped in pans versus 11% of aphids caught by suction trap (Adlerz 1987). In the same study, he also noted that most of the *Uroleucon* sp. were caught by the suction trap (27% versus 3% of total aphids in pans). We have found *U. pseudambrosiae* to be as efficient a vector as *A. spiraecola* in arena tests (Webb & Kok-Yokomi 1993) and suggest that its role in epidemics of WMV-2 may have been overlooked, partly because of the trapping methods used previously. Conversely, the importance of *A. spiraecola* may have been overemphasized.



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