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Aphid Populations and Spread of Peanut Mottle Virus[1]

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ABSTRACT

Higher percentages of peanuts than soybeans or cowpeas become infected when these crops are growing equal distances from a source of peanut mottle virus (PMV). The total number of aphids trapped in these crops are about equal and cannot explain this differential percentage infection. Known vectors of PMV such as *Aphis craccivora* Koch and *Myzus persicae* (Sulzer) comprised 31% of the aphid population in peanuts compared to 14% in soybeans and 17% in cowpeas and could be responsible for the higher number of peanut infections. In addition, trapping of live aphids in peanut fields showed that viruliferous *Rhopalosiphum maidis* (Fitch) were present. Laboratory studies confirmed *R. maidis* could transmit PMV from peanut to peanut. This is the first report of *R. maidis* as a vector of PMV.

Key Words: *Arachis hypogaea*, groundnut, epidemiology, vectors, virus spread, peanut mottle virus.

Peanut mottle is a disease of peanuts (*Arachis hypogaea* L.) that is worldwide in distribution (2, 3, 8, 9, 12) and is quite prevalent in the Southeastern United States, an area of high peanut production (6). This disease is caused by peanut mottle virus (PMV) which was first described by Kuhn (9) in 1965. The virus is seed transmitted in peanuts (2, 3, 9) with subsequent field dissemination often leading to epidemics (5). Peanut mottle causes significant yield losses (9) and in Georgia this can be $10 million per year (10).

Peanut mottle virus is spread from peanuts to soybeans (*Glycine max* [L.] Merrill) (5) causing economic loss in this latter crop. Previous studies (5) indicated a higher disease incidence in peanut than in soybean. In addition, we recently reported (7) the natural infection of several forage legumes (clovers and lupines) with PMV. The virus infects numerous species within the Leguminosae but has limited hosts outside of this family (4).

The virus is transmissible by mechanical inoculation and by aphids. Reported PMV vectors are *Aphis craccivora* Koch, *Rhopalosiphum padi* (L.), *Myzus persicae* (Sulzer), *Aphis gossypii* Glover, and *Hyperomyzus lactucae* (L.) (2, 3, 11). In these studies the aphids were maintained on a suitable host, permitted to feed on infected peanut and then transferred to an appropriate indicator host. Little detailed information is available on natural transmission under field conditions, such as the specific aphids migrating into or through the various crops, the aphids responsible for the secondary spread and the percentage of the total aphid population that may transmit PMV.

Demski (unpublished) has found cowpeas (*Vigna unguiculata* (L.) Walp. subsp. *unguiculata*) to be naturally infected with PMV. Cowpeas are often grown next to peanuts and soybeans and little is known about their natural infection with PMV.

The objectives of this study were to determine a) the comparative aphid populations in peanut, soybean, and cowpea fields, b) correlate aphid populations with disease incidence, and c) to ascertain the specific vectors of PMV under field conditions.

Materials and Methods

Aphid populations in peanuts, soybeans and cowpeas were determined by counting aphids collected in yellow water pan and sticky can traps. The yellow dishpans, 30 cm diameter, were filled 3/4 full with water to which one tablespoon of liquid detergent (Joy) was added. Water pan traps were placed on cement blocks 35 m apart in fields of each crop. Two to five pans were used depending on plot size. Aphids were collected and pans cleaned daily from mid-June to mid-August after which they were collected twice weekly. The aphids were preserved in 70% ethanol for later identification. The yellow sticky cans (1) were located 35 m apart with three traps placed in each crop. The cans were mounted 1 m above the ground on poles. Generally a trap was positioned for each 1200 sq. m. of ground space. The total number of aphids on the traps were counted and the polyethylene sleeves (coated with Tack Trap®) changed at weekly intervals.

Virus-free 'Florunner' peanut plantings were established in various size plots (0.05 to 0.4 ha) between the 10th and 20th of May in Cecil clay-loam soil. Similar plots of soybeans and/or cowpeas were positioned adjacent to the peanut plots (Fig. 1). A source of PMV was provided when plants were in the 3rd true leaf stage by mechanically inoculating the peanut plants in the row next to the adjacent plot. Mirror image plots were located 200 m distant to negate prevailing wind factors. Additional plots were established using a row of infected soybean as the virus source. Virus spread was determined by weekly visual inspection of the plants located 1, 10, 25 and 50 m from the virus source. The visual inspection was corroborated by periodic indexing to *Phaseolus vulgaris* 'Topcrop' as described by Kuhn (9).

Natural viruliferous aphids were trapped in the field by placing yellow water pans near infected peanuts. The detergent was omitted and the water pans were checked approximately every five minutes for live

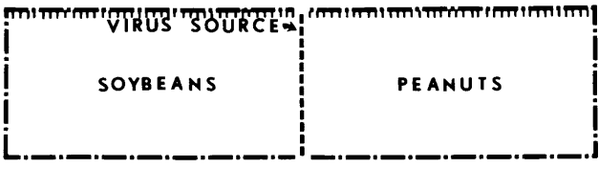

Fig. 1. Field plot arrangement show the position of each crop in relation to the source of virus.

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aphids. Aphids flying into the water pans were immediately transferred by small wooden dowels to virus-free peanut seedlings. A plastic sleeve was placed over the seedling and aphid. The aphids were allowed to feed from 1 to 24 hours and then transferred to 70% ethanol for future identification.

Virus transmission with aphids in the laboratory was accomplished by placing the aphids in a small flask overnight for a starvation period. A single PMV infected peanut leaflet was detached from a culture plant and taped to a No. 7 rubber stopper. An aphid was placed on the infected leaflet and observed under a dissecting microscope. After the aphid was observed to probe for 1 min, it was placed on a virus-free seedling for one hour. The aphid was then removed and the peanut plants placed in the greenhouse. After three weeks, all peanut plants were assayed for PMV by indexing on Topcrop bean.

Results

The total aphid population in three different crops as determined by two trapping techniques is presented in Table 1. Although variation occurred on given weeks the weekly average number of aphids differed little between peanut and soybean. Yellow water pan traps indicated more aphids in cowpea plantings, especially in June and early July.

The prevalence of two known vectors of PMV (*Aphis craccivora* and *Myzus persicae*) was monitored in each crop and is presented in Table 2. Both species were present in all crops although the numbers were quite low after the first week of August in peanut and soybeans and could not be found in cowpeas. *A. craccivora* occurred in relative high numbers in all three crops in June and July, and then (depending on the week and crop) decreasing to a low level. It was not until August that the numbers of *A. craccivora* declined in peanut. *M. persicae* numbers were relatively high in cowpeas in June but were low during the rest of the growing season in all crops with the exception of one peak in peanut during mid-July. These two vectors accounted for 31, 14, and 17 percent of the total aphid populations in peanut, soybean and cowpea, respectively. However, these two vectors only averaged 11, 6, and 1 percent, respectively, in peanuts, soybean and cowpea of the population in August and September.

The percentage of peanut plants infected with PMV 1 m and 10 m from an infected peanut source is presented in Fig. 2. At 1 m from the source, the percentage of PMV infected plants increased rapidly until the end of July (65%)

Table 1. Total number of aphids caught per trap per week in yellow water pan and sticky board traps in peanut, soybean and cowpea (June to September 1979).

	June		July					August				Sept.		Total	Weekly Ave.
	19	26	3	10	17	24	31	7	14	21	28	4	11		
Peanut	23* (18)+	21 (38)	20 (42)	20	52	17 (14)	25	27	16 (26)	33	45 (26)	27	4 (5)	330 (169)	25 (24)
Soybean	— (26)	39 (64)	27 (38)	10	20	15 (16)	15	29	18 (11)	21	50 (14)	47	20 (3)	311 (172)	26 (25)
Cowpea	85 (22)	50 (28)	37 (43)	30	66	34 (29)	29	42	19 (14)	34	34 (18)	20	25 (13)	505 (167)	39 (24)

*Numbers without parenthesis are from yellow water pan traps.

+Numbers in parenthesis are from sticky board traps.

Table 2. Number of *Aphis craccivora* and *Myzus persicae* trapped per yellow water pan per week in peanut, soybean and cowpea fields (June to September 1979).

	June		July					August				Sept.		Total	% of Total Aphid Population
	19	26	3	10	17	24	31	7	14	21	28	4	11		
Peanut - A. craccivora	8	16	10	10	8	8	13	11	0	1	0	1	0	86	26
- M. persicae	1	1	0	0	11	0	1	2	0	1	0	0	1	18	5
Soybean - A. craccivora	-	5	8	0	3	0	0	1	0	0	0	2	2	21	7
- M. persicae	-	10	1	1	2	1	1	5	0	0	0	1	0	22	7
Cowpea - A. craccivora	29	6	5	3	2	1	0	0	0	0	0	0	0	46	9
- M. persicae	21	8	1	4	3	1	2	1	0	0	0	0	0	41	8

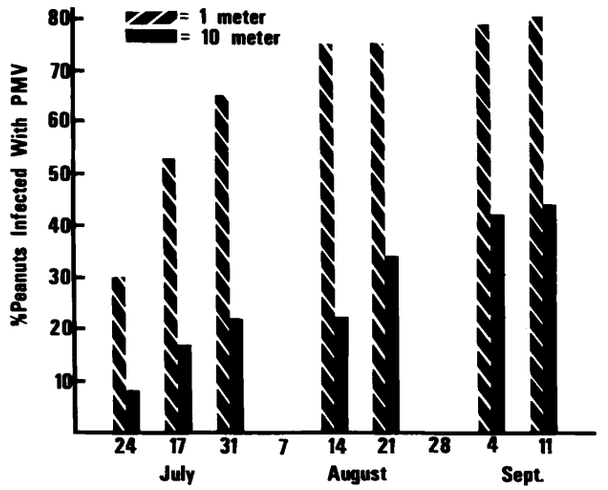

Fig. 2. The spread of PMV to peanut plants located 1 m and 10 m from a source of infected peanut plants.

followed by a slower percentage increase into September (80%). A steady percentage increase of PMV infected peanut plants over the entire time period developed in plants located 10 m from the source. At 10 m, 22% of the plants were infected at the end of July and 43% were infected by the second week of September. The spread of PMV to plants 50 m from the source was negligible. A lower percentage of PMV infected plants occurred in soybeans and cowpeas at equal distances (and time period) from the source when compared to peanuts. Comparative preliminary data indicates that for each 100 peanuts that are infected 1 m from the virus source, 43 and 33 soybeans and cowpeas, respectively, become infected.

The results of live aphid trapping by placing field aphids on virus-free peanut seedlings indicated that some species other than reported vectors were transmitting PMV in the field. These studies indicated that *R. maidis* was viruliferous for PMV. *R. maidis* transmitted PMV from infected peanut to 6 of 112 peanut plants using individual aphids in laboratory tests.

Discussion

The reported source of PMV is seed transmission in peanut (5). The virus is subsequently disseminated by aphids (3) to peanut and other susceptible crops. When the source of virus is positioned equal distances between peanut and soybean, the percentage of infected plants is always much higher in peanuts (5). Since the virus source was uniformly accessible to both crops and both crops are susceptible, the vector populations in each crop could account for the differential of PMV infected plants. This study indicates that the total number of aphids do not account for this difference in percentage plants infected. Both methods of trapping indicates a fluctuating aphid population in all crops.

Although peanuts had fewer total aphids during the season than soybean or cowpeas, PMV infected a higher percentage of the peanuts. This suggests that peanuts may be more susceptible than soybeans or cowpeas to PMV, is more attractive to certain migrating aphids, or that there are differences in the ability among aphid species to transmit PMV. These latter two may be supported by the higher percentage of *A. craccivora* in peanuts (26%) than in cowpeas (9%) or soybeans (7%). It is, however, unexplainable why the vector population (*A. craccivora and M. persicae)* decreased in the latter half of the growing season but virus spread continued at a steady rate as illustrated by the plants at the 10 m position (Fig. 1). Other aphids may be responsible for field transmission at different times of the year. Indeed *R. maidis* was shown to be viruliferous in peanut fields and probably responsible for the spread of PMV in peanuts. Corn is a crop that is abundant in the peanut growing areas. *R. maidis* does not colonize and migrate from corn until the stalk stage so this aphid may be more abundant in the middle to later developmental stages of peanut.

The natural spread of PMV in peanuts was similar to that reported previously (5). These data indicate that the PMV vectors are transmitting the virus only short distances (primarily less than 50 m). This may be a result of the aphid retention time for PMV being short (3); however, field aphids retain the virus long enough to be trapped, transferred to tester plants, and feed on these plants.

The live aphid trapping technique used in this study is time consuming and has the problem that all aphids do not remain on the tester plant and some are lost; however, this technique is useful in indicating the aphids that are responsible for field spread.

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