# APHID POPULATIONS IN RELATION TO TRISTEZA IN FLORIDA CITRUS

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ABSTRACT

Analysis of 16 years of monthly records of aphid populations in 130 Florida citrus groves disclosed *Aphis spiraecola*, *A. gossypii* and *Toxoptera aurantii* as the only species commonly attacking citrus. All three species are known to transmit tristeza virus. Populations of each species in the 6 years of highest statewide population were compared for 3 geographical areas within the citrus belt. In West area where spread of tristeza is great, *Aphis gossypii* was most abundant and dominant. In Central area where tristeza spread is also great *A. gossypii* was seldom abundant but total aphid population was higher and *A. spiraecola* was dominant. In East area where tristeza is found occasionally but appears not to be spreading, all 3 species were present but aphid infestations were usually less severe. No direct linear relationship between tristeza spread and numbers of aphids was evident. It is recognized that factors such as abundance of trees acting as virus reservoirs, different strains of virus, and the possibility of aphid strains of greater transmission efficiency may also be involved.

## INTRODUCTION

Tristeza, a virus disease of citrus, has been known in Florida since 1953 but did not exhibit alarming spread until 1960. Recent high tree losses have occurred principally in 2 areas; one in the western part of the state, the other in central Florida (Knorr 1966). The virus may occur in many citrus varieties but in commercial plantings only trees budded on sour orange rootstock *Citrus aurantium* L. are damaged. Tests in several study areas have disclosed that tristeza virus is present in many citrus plantings and that more trees are becoming infected each year (Bridges 1966). Most of these trees are varieties that do not show decline but nonetheless serve as virus reservoirs.

Three species of aphids commonly form colonies on Florida citrus and feed on the foliage: *Aphis spiraecola* Patch, the spirea aphid, also called the green citrus aphid; *A. gossypii* Glover, known as the cotton aphid or melon aphid; and *Toxoptera aurantii* (Fonsc.) named the black citrus aphid in the U.S.A. All are known to transmit tristeza with varying degrees of efficiency (Norman and Grant 1956) and their suspected presence in large numbers is believed by some to be related to the recent rapid spread of tristeza. However, these 3 species also occur in the eastern part of the state where tristeza virus is known to be present but is not causing losses from tree to tree spread.

This paper presents data on aphid populations in the 3 areas concerned and explores possible relations to recent increases in tristeza.

## METHODS

The data on aphid populations were derived from 16 years of monthly records obtained as part of a continuous statewide ecological survey of

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Florida citrus groves (Simanton 1962). Trained survey men examined the same 5 trees in the same 130 representative citrus groves (with few exceptions) each month. If aphids were seen on up to 5% of new flush terminals, the rating was Class 1 (light); if 5 to 20%, Class 2 (moderate); and if 20% or more, Class 3 (heavy). Because species often are intermingled on the same tree, the order of dominance was recorded and this permitted the class rating to be proportioned by species. In this paper, aphids were considered "present" if the infestation ranked in any of the 3 classes but were considered "abundant" only if rated in the Class 2 or Class 3 categories.

The West, Central and East areas studied were each represented by 5 orange (*Citrus sinensis* (L.) Osbeck) groves, 2 grapefruit (*C. paradisi* MacF.) groves and 1 other variety selected from the 130 groves. The other variety was Temple (*C. temple* Hort. ex Y. Tanaka) in West and East but in Central (where no data on Temple were available) it was Dancy tangerine (*C. reticulata* Blanco) prior to 1960 and Jaffa orange later. The 8 survey groves in West and Central areas were all within 15 miles of the tristeza-affected groves, and a minimum of 40 miles separated each area.

## Description of Areas

West area, bordered by the towns of Elfers, Lutz, and Largo, includes the 4 groves described by Knorr (1966) in which 50% to 90% of the trees, totalling 2600 trees, have been destroyed by tree-to-tree spread of tristeza since 1960. A 1966 survey disclosed that about 7500 trees in the general area had perished.

Central area, which encompasses central Polk County in the vicinity of Lake Alfred, contains several groves with recent tristeza losses, including the 2 groves described by Knorr (1966) in which 30 to 35% of trees, a total of 2600 trees, were destroyed by tristeza since 1960.

East area encompasses groves from Fort Pierce to Scottsmoor, where sour orange is widely used as a rootstock. Tristeza is present owing to the use of infected budwood, but tree-to-tree spread is not taking place at present.

## Results and Discussion

Survey data disclosed that statewide aphid populations often varied considerably from year to year. In the 16-year period from 1951-1966 inclusive, the 1560 monthly examinations each year in the 130 groves revealed that populations were much higher in 1952, 1954, 1957, 1959, 1960, 1962, and 1963 than in the other 9 years (Fig. 1). These were the years in which total infestations were most numerous and also (except for 1959 and 1962) the years in which a greater number of moderate and heavy infestations occurred.

Seasonal abundance is portrayed in Fig. 2 which shows the mean percentage of groves infested each month in the 16 years from 1951 through 1966 inclusive, and the mean percentage of groves in which aphids were abundant. The majority of heavy infestations occurred in the months of March and April; however, in years of high population and in years when the growing season was earlier or later than normal, moderate and heavy infestations were numerous in February and May. In 1953, 1956, 1957, 1959 and 1966 higher than average populations occurred in late summer

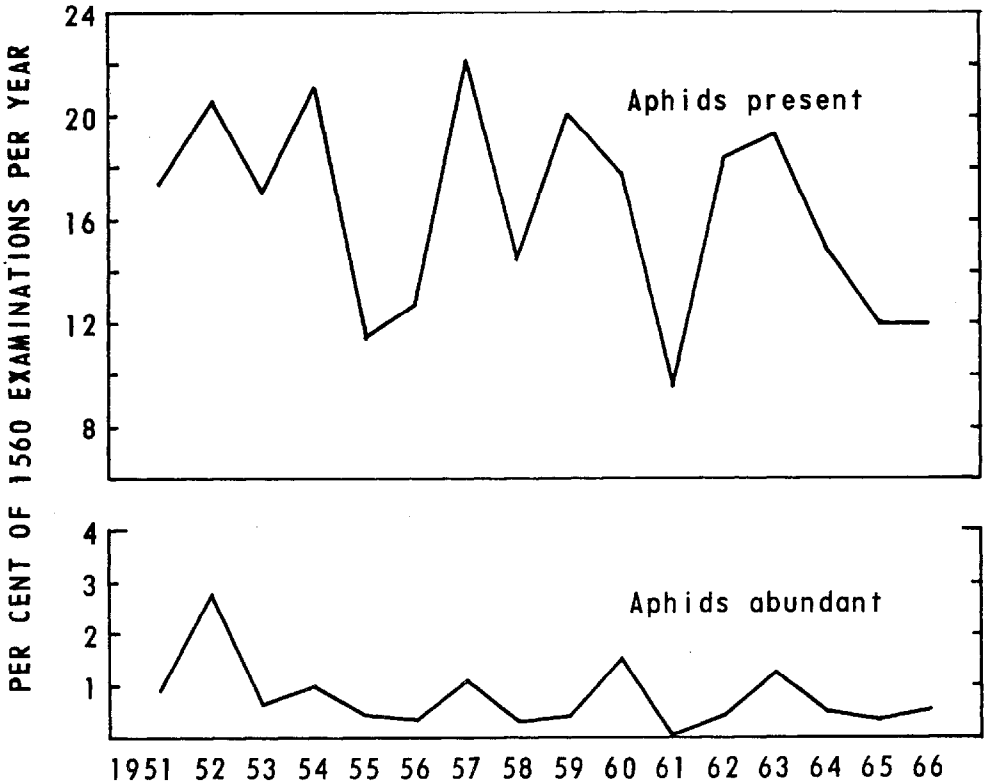


Fig. 1. Statewide prevalence of aphids each year as determined by monthly examinations in 130 survey groves.

but these were generally composed of light infestations except in August of 1966 when aphids were abundant in 4.6% of the 130 groves.

Since statewide data of Fig. 1 pointed to the years of high population and the data of Figure 2 indicated the months in which greatest aphid activity occurred, the examinations made during February through May in 6 high years were assembled to show aphid populations in the 3 areas of interest from the tristeza aspect. The mean population rating at the February, March, April and May examinations in each of the 8 representative groves was therefore a measure of population size for each area based on 32 examinations each year.

Table 1 shows the percentage of the 32 examinations that revealed aphids as "present" and "abundant." The per cent in the "abundant" category is a measure of intensity of infestation. Because of the demonstrated low transmission efficiency of the aphids involved (Dickson et al. 1956, Norman and Grant 1956) it is unlikely that much infection would occur unless aphids were numerous.

West area had more infestations in the abundant category (mean of 10.4%) and also showed the most variability (0 to 21.9%); however, the heavier infestations were prior to 1960. Central area had aphids abundant at 8.3% of examinations and had more in that category in 1960 and later than did West. It is noteworthy that East did not have as many records of abundant aphids (mean 5.2%) as the other areas and in none of the years were the heavier infestations numerous.

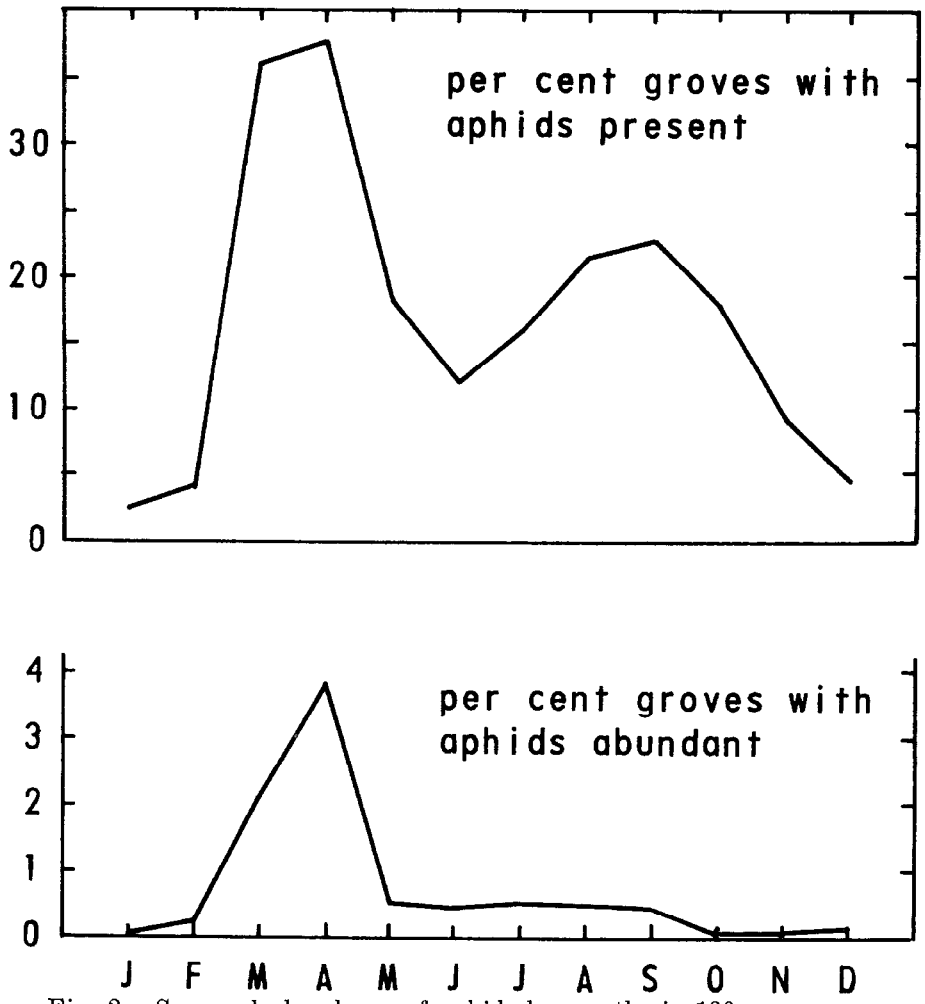


Fig. 2. Seasonal abundance of aphids by months in 130 survey groves; 16 year average 1951-66.

Table 2 gives the average population class for the 8 groves in each area at each examination in the 4 spring months. It is a measure of population size irrespective of intensity. The percentage of each species comprising the total aphid population is also given.

Aphids were present in all 3 areas in substantial numbers in most years. The 3-area average shows that *Aphis spiraecola* comprised about half of the population, with *Toxoptera aurantii* and *A. gossypii* each comprising about one quarter of the total. However, this proportion was quite different in West area where *A. gossypii* was the dominant species each year except 1952, and always at a higher level than in the other 2 areas. *A. gossypii* was reported by Dickson et al. (1956) as being the only vector in California and Norman and Grant (1956) and Norman and Sutton (1967) considered it to be the most efficient vector in Florida. The greater number of *A. gossypii* infestations in the abundant category might well be the reason for the high tristeza losses in the West area.

TABLE 1.—PREVALENCE OF APHIDS IN WEST, CENTRAL AND EAST AREAS AS OBSERVED IN 8 GROVES FROM FEBRUARY THROUGH MAY IN EACH OF 6 YEARS.

| | | Percent of 32 examinations showing: | |
|---|---|---|---|
| | | Aphids present | Aphids abundant |
| West | 1952 | 43.8 | 21.9 |
| | 1954 | 31.0 | 9.4 |
| | 1957 | 50.0 | 12.5 |
| | 1960 | 28.2 | 9.4 |
| | 1962 | 28.2 | 0 |
| | 1963 | 31.0 | 9.4 |
| | Avg. | 35.4 | 10.4 |
| Central | 1952 | 31.0 | 3.1 |
| | 1954 | 46.9 | 3.1 |
| | 1957 | 46.9 | 12.5 |
| | 1960 | 28.2 | 12.5 |
| | 1962 | 53.1 | 9.4 |
| | 1963 | 45.0 | 8.3 |
| | Avg. | 45.0 | 8.3 |
| East | 1952 | 43.8 | 3.1 |
| | 1954 | 56.3 | 9.4 |
| | 1957 | 37.5 | 9.4 |
| | 1960 | 50.0 | 9.4 |
| | 1962 | 34.4 | 0 |
| | 1963 | 21.9 | 5.2 |
| | Avg. | 40.6 | 5.2 |

*A. gossypii* was also common in Central area; in 1957 it reached a population rating of .16, but later it became scarce.

*A. spiraecola* was found by Norman and Grant (1956) to be capable of transmitting tristeza in field and laboratory experiments. It is considered to be a less efficient vector than *A. gossypii* but more efficient than *Toxoptera aurantii.* Central area had a higher average population of all species (.56) with especially high levels in 1962. (.66) and 1963 (.82). The high total aphid population may be the reason for tristeza spread in Central area.

The much lower tristeza loss from tree-to-tree spread in the East area is not adequately explained by the aphid population data presented although trends are indicative: East area had fewer infestations in the "abundant" category, and generally lower total aphid populations.

There are several reasons why a straightline relationship may not exist between aphid counts or species on the one hand and spread of tristeza on the other:

1) The incidence of trees acting as reservoirs of tristeza virus is very likely higher in West and Central districts, owing to the predominant use of tristeza-tolerant rootstocks like rough lemon, than it is in East districts where trees are predominantly on tristeza-intolerant sour orange. In 1965 the Florida Budwood Registration Program indexed random trees on rough

TABLE 2.—POPULATION SIZE OF APHID SPECIES IN 3 DISTRICTS IN 6 YEARS OF HIGH STATEWIDE POPULATION.

| | | Population class at each examination and percent of each species: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *A. spiraecola* | | *T. aurantii* | | *A. gossypii* | | *All species* |
| | | Class rating | Percent | Class rating | Percent | Class rating | Percent | Class rating |
| West | 1952 | .47 | 62.6 | .16 | 21.4 | .12 | 16.0 | .75 |
| | 1954 | .11 | 26.8 | .03 | 7.3 | .27 | 65.8 | .41 |
| | 1957 | .25 | 39.7 | .08 | 12.7 | .30 | 47.6 | .63 |
| | 1960 | .09 | 24.3 | .03 | 8.1 | .25 | 67.6 | .37 |
| | 1962 | .12 | 42.8 | 0 | 0 | .16 | 57.1 | .28 |
| | 1963 | .14 | 34.1 | 0 | 0 | .27 | 65.8 | .41 |
| | Avg. | .20 | 41.6 | .05 | 10.4 | .23 | 47.9 | .48 |
| Central | 1952 | .22 | 64.7 | .09 | 26.5 | .03 | 8.8 | .34 |
| | 1954 | .30 | 60.0 | .12 | 24.0 | .08 | 16.0 | .50 |
| | 1957 | .38 | 57.6 | .12 | 18.2 | .16 | 24.2 | .66 |
| | 1960 | .33 | 75.0 | .11 | 25.0 | 0 | 0 | .44 |
| | 1962 | .34 | 52.3 | .31 | 47.7 | 0 | 0 | .66 |
| | 1963 | .38 | 46.3 | .44 | 53.6 | 0 | 0 | .82 |
| | Avg. | .32 | 57.1 | .20 | 35.7 | .04 | 7.1 | .56 |
| East | 1952 | .23 | 50.0 | .13 | 28.3 | .10 | 21.7 | .46 |
| | 1954 | .41 | 59.4 | .12 | 17.4 | .16 | 23.2 | .69 |
| | 1957 | .30 | 61.2 | .14 | 28.6 | .05 | 10.2 | .49 |
| | 1960 | .27 | 47.4 | .24 | 42.1 | .06 | 10.5 | .57 |
| | 1962 | .16 | 48.5 | .08 | 24.2 | .09 | 27.3 | .33 |
| | 1963 | .11 | 52.4 | .08 | 38.1 | .02 | 9.5 | .21 |
| | Avg. | .25 | 54.3 | .13 | 28.3 | .08 | 17.4 | .46 |
| 3-area average | 1952 | .31 | 58.5 | .13 | 24.5 | .09 | 17.0 | .53 |
| | 1954 | .27 | 50.9 | .09 | 17.0 | .17 | 32.1 | .53 |
| | 1957 | .30 | 51.7 | .11 | 19.0 | .17 | 29.3 | .58 |
| | 1960 | .23 | 50.0 | .13 | 28.3 | .10 | 21.7 | .46 |
| | 1962 | .21 | 50.0 | .13 | 31.0 | .08 | 19.0 | .42 |
| | 1963 | .21 | 44.7 | .17 | 36.2 | .09 | 19.1 | .47 |
| | Avg. | .26 | 51.0 | .13 | 25.5 | .12 | 23.5 | .51 |

lemon that were growing adjacent to blocks of sour-orange rooted, tristeza-declining trees at Elfers; 100% were found to be infected (Bridges 1966). Tolerant trees infected with tristeza virus show no symptoms and therefore are not pulled out, whereas infected intolerant combinations are removed as trees become unprofitable. Thus, aphids in the West and Central areas are more likely to be viruliferous than aphids in the East area.

2) As Dickson et al. (1956) have mentioned, once tristeza affects a few trees in a grove, most trees succumb within 5 years. Their figures showed 1 infection for each 17,800 melon aphids moving from tree to tree and that the number of newly infected trees doubled from year to year on the aver-

age. Thus a single year of high aphid population could start a catastrophic spread of tristeza.

3) The reason for the low efficiency of *A. gossypii, A. spiraecola,* and *T. aurantii* in transmitting tristeza is still not known. Whereas a population of one individual per plant of *T. citricida* (Kirkaldy), the major vector in South America, has been shown capable of transmitting infection, a population of from 10 to over 200 individuals of *A. gossypii* per plant is required to establish infection (Norman et al. 1968). Although Norman and Sutton (1967) did not find differences in transmission efficiency among colonies of *A. gossypii* from 3 different localities in Florida, it is possible that strain differences exist. Watson (1967) reviewed known instances of this phenomenon in other aphid-disseminated plant virus diseases. If strain differences occur among Florida vectors, then correlations between the spread of tristeza and mere numbers of aphids would have little significance.

4) Tristeza virus is said to exist in strains ranging from virulent to very mild (Grant and Higgins 1957). Circumstantial evidence for occurrence of a mild strain was found in Orange County where 50 sour-orange rooted trees infected with tristeza for 6 to 11.5 years failed to develop symptoms of decline (Norman et al. 1961). If strains are a factor and if a mild strain predominates in a particular area, the role of aphid dissemination might be masked despite infection of trees on sour orange. This might be the situation in East area. Because of the rapid and general decline of trees in West and Central areas, a virulent strain presumably is involved.

While the population data presented do not prove the contention that the accelerated spread of tristeza in certain areas is due to high aphid populations, the findings are in accord with other information on the relation of vectors to spread of tristeza.

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