Review of Factors Affecting the Abundance of the Corn Leaf Aphid[1]

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In recent years the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), has become increasingly abundant and more destructive. The rates of infestation and losses for the past seven years are given in Table 1. The loss in yield aveage 5.2% for the past seven years and the average bushel loss was 22,000,000. Questions concerning this insect's importance and the need and methods of control are becoming more urgent. A review of what is known about this insect and factors affecting its abundance is necessary before attempting to answer these questions. The corn leaf aphid is indigenous to the United States and was first described from New York by Fitch (7) in 1856. It is now known to be distributed world wide. In addition to being a primary destructor of corn yields, it is also the known vector of several virus disease, one of which, the Maize Dwarf Mosaic, is of importance to Indiana producers. Everly (5) gives a detailed review of the history and injury caused by this aphid.

Reproduction

Aphids are among those insects that have a tremendous potential for increasing abundance. The corn leaf aphid reproduces by the unfertilized female producing living young. According to Davis (3) the corn leaf aphid will start producing young when 11 days old and may give birth to as many as 95 over a 21-day period. The average production is 34. He also reported the aphid to have 9 generations in central Illinois and first appeared about June 11. However, recent investigations in connection with the Maize Dwarf Mosaic problem in southern Indiana indicated that the corn leaf aphid appears in late April or early May and will have at least 11 generations a year. Based upon an average progeny production of 34 and 11 generations, one corn leaf aphid could produce 7,020,000,000,000,000 progeny in one summer. Fortunately aphids are exposed to many environmental hazards and relatively few of this potential number survive. However, it is the most important factor in their abundance. A few aphids in the protective whorl of a corn plant can produce a great number of progeny by the time of tassel appearance.

Overwintering

An insect that overwinters in an area of occurrence often has a distinct advantage for population buildup over those that migrate into the area. Up to the present time there is no positive proof that the corn leaf aphid overwinters in Indiana. It is known to occur during winter months in northern Mississippi and central Oklahoma. Wilder-

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muth and Walters (11) reported that in Arizona 25% of colonies of this aphid survived when exposed for a short period of time to temperatures as low as 13° F. Recent observations of the corn leaf aphids in a field of barley near Evansville, Indiana, indicated that this aphid may overwinter in southern Indiana under favorable conditions. Corn leaf aphids in all stages of development were found on monthly samples of barley plants, except those in early March and April. Positive identifications were made by Dr. Louise M. Russell of the U. S. National Museum.

One theory of the occurrence of this aphid in Northern latitudes is its distribution by air currents from the south during late spring and early summer. It is thought that the increasing abundance of the aphids in the areas of overwintering, coupled with the maturing of host plants, results in the development of great numbers of winged forms. Since aphids are relatively incapable of extensive flights, these winged individuals leave the host plants and are carried by updrafts into the low jet streams that move from south to north and in a short time may be carried as far as 600 or 700 miles. Thus primary infestations in Indiana may be due to "fall-outs" of these insects. Factors causing this fall-out are not completely understood, but there is evidence that cold fronts may inactivate the insects or the exhaustion of food reserves resulting in their dropping out of the jet streams and settling on plants. Should these plants be suitable for colonization the aphids will survive. If not, they probably die as their food reserves are not adequate for much additional movement. Observations in the vicinity of New Albany, Indiana, in early May, 1965 and 1966, found the corn leaf aphid colonizing Johnson grass. At the same time aphids found on small corn were dead winged forms, due to the unsuitability of young corn for aphid establishment. Undoubtedly this first appearance will vary from year to year as conditions vary at the point of origin of migration in the south. However, it does point out that this insect appears in Indiana in late April, and possible development on hosts other than corn may account for variations in yearly abundance and losses.

Host Plants

A total of 67 host plants have been recorded for the corn leaf aphid. Most of these belong to the grass family, but a few, ragweed, plantain and dock, are "broad-leaved" plants. Native grasses include crab grass, bluegrass, barnyard grass, Foxtail grasses, Johnson grass and wild cane. These latter two are very abundant in southern Indiana. Cultivated crops include oats, barley, millet, rye, sorghum, corn, sudan grass, wheat, and broomcorn. With this number of hosts, early migrants could build-up in great numbers without recognition and subsequently migrate to corn.

Biotypes

Biotypes of the corn leaf aphid are known to exist. Cartier and Painter (2) have isolated a biotype that is restricted to certain varieties of sorghum. Everly and Miller (6) showed that corn leaf aphids from different geographical areas of the United States responded

differently to the three most suitable host crops. Thus the origin of the migrating population may be a factor in the abundance as well as the destructiveness of aphid populations on corn plants in different years.

Predators and Parasites

Predators and parasites are an important influence on populations of the corn leaf aphid. Predators include larval and adult ladybird beetles, larvae of lacewing flies, syrphid flies and possibly soldier beetles. The latter were very abundant on aphid infested corn plants the fall of 1966. A parasitic wasp is also very abundant when aphid colonies become large and numerous.

There are several factors limiting the effectiveness of predators and parasites of the corn leaf aphid. The location of the developing aphid colonies deep in the whorl of the corn plant protects the aphids from all but very small predacious insects. It is not until the corn tassel emerges from the whorl and exposes the aphid colonies that predators and parasites become important. In addition, predators feed on many species of aphids and other insects, and a heavy population of aphids on a nearby legume crop could limit the number of predators moving into an aphid infested cornfield. This mass movement of predators and parasites at the time tassels emerge and expose the aphids makes insecticide treatments at this time an undesirable practice. For maximum benefit insecticides should be applied two weeks prior to tassel appearance.

Soil Fertility

While little is known about the influence of soil nutrients on aphid populations, highly fertile soils produce more succulent and larger plants. Some exploratory investigations by Branson and Simpson (1) indicate that high nitrogen applications increase aphid abundance. In the past five to ten years, production practices have greatly increased the amount of nitrogen applied to corn crops. This practice may in part be responsible for the increased aphid populations in recent years. In addition, high fertility levels stimulate plant development so corn plants are in a more suitable condition for colony establishment at an earlier stage of plant development.

Host Plant Resistance

Host crop resistance to corn leaf aphid establishment and development have been known for many years (8, 10). Huber and Stringfield (9) showed a high correlation between aphid resistance in corn and European corn borer resistance. Dishner and Everly (4) tested both seedling corn and barley and found significant differences in aphid populations among the inbreds and varieties tested. Other workers have reported field observations of differences in aphid infestations on corn. In the field today, even though no direct application of this resistance to aphids has been attempted, aphid populations are affected by the kinds of corn grown. In 1959, Everly (7), in a field of seven different commercial hybrids, reported a wide range of infestation and

tolerance. These data are reproduced in Table 2. It will be noted that the hybrid Crow 432 had an average amount of severely infested plants but had relatively few barren plants and a low percentage of nubbins, whereas DeKalb 411 averaged slightly less heavily infested plants but had 23% barren and 28% with nubbin ears. Under a comparable aphid infestation, Crow 432 suffered less loss than DeKalb 411. This represents a high degree of tolerance in the Hybrid Crow 432. Resistance is shown in hybrid DeKalb 423, which averaged 35% heavily infested plants and a loss of 22% as compared to Crib Filler 163G with 68% of the plants severely infested and a loss of 50%. In these two hybrids, the loss increased proportionally to the population, and the antibosis exhibited in hybrid DeKalb 423 not only affected the aphid population but also resulted in less injury.

How much selectivity by aphids may play a part in aphid abundance is problematical. Most insects show preferences for hosts either as a source of food or for their progeny. In areas where cornfields are small and numerous, a high degree of selectivity by winged aphids is possible. On the other hand, the relative poor mobility of winged aphids makes selectivity in areas of high corn production, where acreages are large, of minor importance. However, until a method is developed for manually infesting corn plants in the field with aphids and obtaining a decree of consistency of establishment, the question of selectivity of hosts by the corn leaf aphid will not be resolved. As a factor in corn leaf aphid abundance, plant resistance in the genetic background of corn hybrids in use today, plays a part in determining aphid abundance.

Summary

Of the seven factors discussed, two, the biotic potential and high soil fertility, act toward increasing aphid abundance. Predators and parasites and host plant resistance are effective in reducing aphid abundance. Three factors, aphid biotype, host plants and overwintering, can either increase or decrease aphid abundance.

TABLE 1. Estimated losses in corn yield in Indiana associated with corn leaf aphid infestation. 1959-1965

Year	% Plants Infested	% Loss in Yield	Bushel loss in yield
1959	43.5	3.2	14,815,000
1960	24.0	3.7	14,677,000
1961	20.2	3.0	7,789,000
1962	23.0	3.6	12,368,220
1963	53.9	6.3	26,232,960
1964	65.4	9.0	39,702,900
1965	65.0	7.5	37,909,900

TABLE 2. Infestation and losses to commercial dent corn hybrids from infestations of the corn leaf aphid. Bourbon, Indiana. 1959[a]

Hybrid	% Severely infested[b]	% Plants with no ears	% Plants with nubbins	% Loss in yield
Crow 432	47	7	18	16
DeKalb 423				
Plot A	32	14	12	20
Plot B	38	18	12	24
Crib Filler 166G	39	9	25	22
Indiana 610	26	21	14	28
Crib Filler 151G	60	29	30	44
DeKalb 411	45	23	28	47
Crib Filler 163G	68	34	33	50
Averages	45	19	22	30

[a] Based on the examination of 2 samples of 50 plants each in each hybrid.
[b] All hybrids were 100% infested. The data in this column represents the percent plants showing severe infestation—stunted tassels, upper leaves dead and discolored with sooty mold growth and massive areas of cast aphid skins.

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