Max Badgley

The potato aphid, a sometimes serious pest of tomatoes (above), can cause curling and stunting of leaves and stems, reducing fruit set and, in severe cases, killing the plant.

A midge predator of potato aphids on tomatoes

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It may be a valuable natural control

Larva of the predaceous midge *A. aphidomyza* may play an important role in controlling potato aphid infestations. Aphids shown here are dead from predation.

The potato aphid is an occasional and sometimes serious pest of tomatoes. Natural enemies of the potato aphid, *Macrosiphum euphorbiae* (Thomas), include syrphid fly larvae, ladybird beetles, lacewings, and various hymenopterous parasites, but these insects generally do not prevent economic damage. One natural enemy seldom mentioned is the predaceous midge, *Aphidoletes aphidimyza* (Rondani). In 1984-85 studies at the University of California South Coast Field Station, Irvine, we found that predation by larvae of this midge played an important role in controlling potato aphid infestations in processing tomatoes.

The potato aphid

The potato aphid is relatively large, up to 3 mm (1/10 inch) in length, and is either pink or green. Since the aphid has a wide host range, alternative host plants are probably present as a source of infestation near most tomato plantings. Infestations occur when winged females migrate into a field and produce colonies of wingless aphids. Each adult female produces about 30 aphids.

The timing of these infestations is not related to tomato plant age. Unlike many other aphid species, the potato aphid is most abundant during the summer, when a generation can be completed in as little as eight days. Aphid colonies develop primarily on the undersides of leaves, and individuals feed by inserting their stylets into phloem tissue and withdrawing plant sap.

Damage from the potato aphid takes several forms and affects all tomato varieties, but not to the same extent. Curling and stunting of leaves and stems, the most obvious damage, is typical of that caused by many aphids. This damage reduces fruit set and, if severe enough, can kill the plant. In addition, as a by-product of feeding, aphids excrete honeydew, which acts as a growing medium for sooty mold. The black-colored mold, on the foliage, reduces the light available for photosynthesis and, on the fruit, causes discoloration and acts as a solar heat sink, increasing the severity of fruit sunburn.

Despite the potential severity of damage, economic threshold levels have not been established for the potato aphid. Control measures are begun when physical damage to the plants becomes apparent, and various chemical sprays effectively reduce aphid numbers when coverage is adequate.

Although the potato aphid only occasionally attains pest status, it is important to understand how its populations are usually kept under control in order to predict periodic damage. Many factors, including fortuitous biological control, play a role in preventing most insects from becoming pests. While biological control in row crops often has been thwarted by low damage thresholds and the inherent instability of the cropping systems, the predaceous midge could be important in the natural regulation of potato aphid populations. Preservation of this important predator would benefit tomato production by (1) decreasing potato aphid damage and subsequent control costs, and (2) in reducing the amount of pesticide used for potato aphid control, helping to preserve natural enemies of other tomato pests.

The cecidomyiid predator

Aphidoletes aphidimyza is very common throughout the United States; the larvae prey on at least 60 different aphid species. The delicate long-legged adult midge is brown, about 3 mm in length, and feeds on honeydew excreted by aphids and other homopterous insects. It is active in the afternoon and early eve-

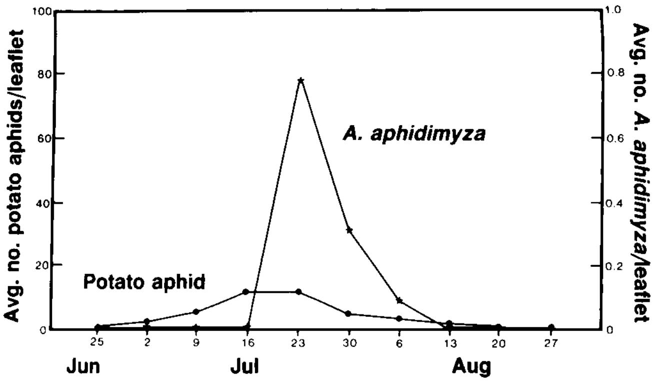

Fig. 1. Predatory midge population increased quickly to high levels in 1984, after which potato aphids decreased.

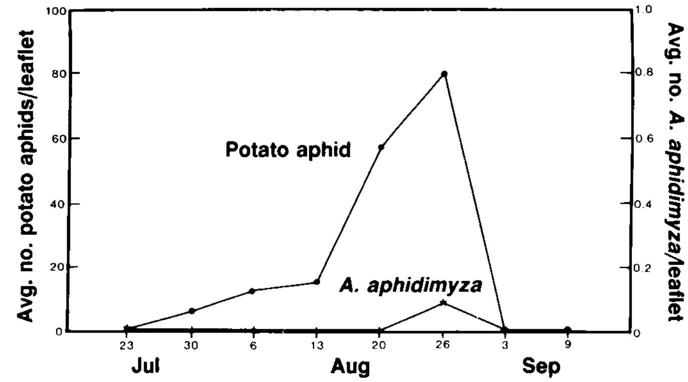

Fig. 2. In 1985, the midges were much less numerous and weren't found until after potato aphids had reached high levels.

ning, preferring a dark humid environment like that found near the soil surface and on the undersides of leaves.

The midge lays orange, elongate eggs, about 0.3 mm long, singly or in groups of as many as 40 amid aphid colonies. The predaceous larva emerges in two to three days and can crawl about 60 mm (about 2 inches) in search of suitable aphid prey. It feeds by piercing the soft tissue in the aphid leg joints, injecting a toxin that paralyzes the prey, and sucking the body fluids. The larva takes 30 to 60 minutes to consume one aphid, and in its lifetime can kill from 10 to 30 aphids, depending on the species and age of the aphids.

The orange larvae, which reach 4 mm (2/10 inch) in length, are easily seen among live and shriveled dead aphids on a leaf. There is disagreement about the total number of larval stages, or instars, but after passing through at least three stages lasting about four days each (at 70°F), the larvae drop to the ground and pupate in the top 3 cm (1 inch) of soil. The adults emerge in 10 to 14 days, mate, and lay up to 70 eggs in a one-week lifespan.

Several elements of the midge's biology and behavior enhance its effectiveness as a natural enemy of the potato aphid. The predator's wide geographic range and ability to feed on many aphid species ensure its presence in most tomato growing regions. A wide host range would ordinarily decrease the probability of effective predation on one prey species, but potato aphid populations grow in summer when many other aphid species decline. This could enhance the importance of the potato aphid as a food source for the midge and increase the likelihood of early colonization of the aphid by the predator. Adult predaceous midges also can find aphids at low densities. They lay eggs only in aphid colonies, and the number of eggs laid increases with increasing aphid density. The larvae, too, exhibit density-dependent behavior. When more aphids are available than a larva can consume, it will kill more individuals while only partially extracting the body fluids of each aphid. Generally, larval development is accelerated when aphid density is high.

Experiments

Ideally, the effect of the predaceous midge should be tested by excluding it from potato aphid populations while leaving other elements of the natural enemy complex unaffected. This is virtually impossible under field conditions, since migration of any specific predator is difficult to control. Our evidence for effective predation of the potato aphid by the midge is based on field observations of the two populations.

In studies at the South Coast Field Station, we used seedlings of the processing tomato variety Peto-98 transplanted on June 18, 1984, and July 18, 1985, with 1.5-meter (5-foot) row and 45-cm (18-inch) plant spacings. Plots 15 meters (50 feet) long by four rows wide were replicated five times. We made weekly counts of aphids and natural enemies on one leaflet from each of 25 plants per plot. The leaflets sampled were fully expanded and were randomly selected from the upper third of the plant.

In 1984, the midge population increased to high levels early, with a subsequent drop in the potato aphid population (fig. 1). The maximum average number of aphids was 12 per leaflet with 0.8 midge larva per leaflet. The potato aphid caused no apparent damage to the tomatoes, and colonies of aphids which had been decimated by the midge were commonplace. Other natural enemies of the potato aphid were seldom encountered.

In 1985, we did not find the midge until after the potato aphids had reached very high levels, and even then its numbers were considerably below 1984 levels (fig. 2). The maximum numbers per leaflet were 80 potato aphids and less than 0.09 predaceous midge. The tomatoes were heavily damaged in spite of a late buildup of other natural enemies.

Conclusions

Certainly a two-year study, one with and the other apparently without the predaceous midge, *Aphidoletes aphidimyza,* present during early potato aphid buildup, does not constitute a valid check for the predator's effectiveness. Also, our observation of predator abundance and activity is not proof that the midge was the primary cause of the 1984 aphid decline. However, our data and the midge's characteristics, which are unique among the aphid predators, suggest that it is an important predator of the potato aphid.

This predaceous midge has been studied throughout temperate regions, and it is now used in aphid management programs in greenhouses, fruit trees, and row crops. In outdoor crops, natural populations of the predator are monitored to predict their effectiveness in controlling aphid infestations and, when feasible, care is taken not to hinder predatory activity. Evidence has been found of resistance in this midge to organophosphate spray compounds, which would enhance its utility in pest management programs. The presence or extent of resistance in any one population cannot be taken for granted, however.

In situations where this midge can be found early in a potato aphid infestion and no other types of disruptive treatments are necessary, it is possible that the predator will be able to control the aphids unassisted. Further studies of the relationship between *A. aphidimyza* and the potato aphid are warranted to provide information needed to predict and enhance this natural control.

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