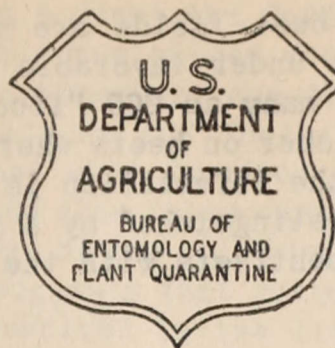


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THE SUGAR-BEET ROOT APHID AND SUGGESTIONS TO AID IN CONTROLLING IT IN CALIFORNIA

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The sugar-beet root aphid, or root louse, (*Pemphigus betae* Doane) is a serious pest of sugar beets in California and other sugar-beet-growing areas of the Western part of the United States. In the central valley area of California the damage appears to be most prevalent in the peat soil of the islands of the south delta of the Sacramento River, but beets grown in other parts of the State also have suffered severe injury in some years.

Nature of Injury

The beet root aphid, or root louse, as it commonly appears on the roots of sugar beets and other plants, is a small, wingless, yellowish-white aphid, which feeds almost entirely on the underground parts of the plants. Occasionally during the winter months aerial colonies have been observed on the leaves of beets growing in the greenhouse, but this departure from the normal subterranean habitat is unusual. Like other aphids, it feeds by piercing the plant tissues with its beaklike mouth parts and sucking the plant juices. The feeding causes a general weakening of the plant that results in a decrease in the yield per acre and also causes a reduction in the sugar content of the beet. Yellowing of the plant and wilting of the leaves often accompany heavy infestation by this insect. These symptoms, however, are not reliable indications of root-aphid damage, inasmuch as nematodes, and various diseases, such as southern sclerotium rot, also cause the plant to wilt, and yellowing of the leaves may be induced by excessive irrigation, by curly-top disease, or by a nitrogen deficiency in the soil. Therefore the only certain method of recognizing root-aphid damage is to examine the roots of the plants. The presence of root aphids is readily determined by the appearance of a bluish-white moldlike substance on the roots of the beets and in the surrounding soil. This substance is secreted by the insect, and the abundance of it is a fair indicator of the severity of the infestation.

Aphid populations in beet fields are relatively light during the spring and early summer, but under favorable conditions enormous numbers may develop before fall. As many as 200 "lice" per square inch have been observed by the middle of October on beets where the infestation was exceptionally heavy. Frequently the infestation is spotted, and in some fields these spots can readily be distinguished by a yellowish cast in the leaves of the infested plants that contrasts with the darker green of the rest of the field.

Under field conditions the root aphid seldom kills the plant upon which it feeds, the injury being more of the nature of stunting or retarding the growth of the plants. However, potted beets at the laboratory have been killed by this insect. In such cases the leaves wilt as though the plant were suffering from lack of water, the roots become shrunken and flaccid, and eventually the whole plant dies.

Seasonal History

The life cycle of the sugar-beet root aphid, like that of most aphids, is very complex, involving sexual and asexual reproduction and the development of winged and wingless forms of the mature insect. Different parts of the life cycle are completed on different host plants.

The life cycle of this insect in California is not yet fully understood. A brief summary of its life history, as worked out by Parker (3) in Montana, follows: The winter is passed chiefly in the egg stage on poplar, although some wingless females successfully overwinter in the soil. The eggs hatch in the spring, and the young aphids develop into wingless females (stem mothers), each of which gives birth to many living young, in a gall formed on the under side of the leaves of poplar (primary host). The young of the stem mothers develop into winged females (spring migrants), which emerge from the gall and fly to the beet fields, where they deposit young. Sugar beets and other plants (secondary hosts) are infested during the flight from poplar. Several generations of wingless females are produced on the roots of beets during the summer. In the fall some of the aphids on the beets develop wings (fall migrants). These winged females return to the poplars, on which they deposit tiny males and females, which are the true sexual stage in the life cycle of the root aphid. The males and females mate, and the latter lay fertilized eggs on poplar, thus completing the life cycle.

The poplars Populus balsamifera L. and Populus angustifolia James serve as primary hosts throughout their range, but neither of these trees is known to grow in the central valley of California. Other species of poplar, however, are common in this area.

Under the climatic and host-plant conditions of central California, it seems highly probable that the life cycle of the root aphid may differ from that given above. General observations in 1940 and 1941 have shown that it may survive and reproduce asexually throughout the year on the

roots of dock and sugar beets without the formation of a sexual generation. However, in the fall of both years winged forms developed on the roots of beets late in October and in November, and these apparently migrated from the beet fields into the canyons and foothills on the west side of the San Joaquin Valley, where they were found on cottonwood-poplar and willow. The winged aphids on beets, and also those captured on willow and cottonwood, were determined by E. O. Essig, of the University of California, as Pemphigus betae Doane. This strongly suggests that cottonwood-poplar, willow, or some other primary host may be involved in the life history of this species in California, although, as stated previously, such hosts may not be necessary to maintain the species. Experiments are planned to determine the possible role of primary hosts in California. Winged females have been observed to emerge early in April in cages placed over infested dock. Under conditions that obtain in California, the production of winged forms on dock and sugar beets could serve to facilitate the spread of this species to its wild host plants as well as to sugar beets, without a spring movement from poplars such as occurs in Montana (3), Utah and Colorado (2), where the winters are longer and much colder than in California.

Food Plants

The sugar-beet root aphid feeds on the underground parts of a wide variety of plants. Essig (1) gives the following list of food plants: Alfalfa, aster, beets, docks, flax, many wild grasses, goldenrod, knotweed, lambsquarters, poverty weed, wheat, and yarrow. With further study of this insect it is likely that other hosts will be found.

Undoubtedly the most important damage to cultivated crops occurs on the sugar beet, which is a favored host. Several species of perennial dock (Rumex spp.) are perhaps the most important of the wild host plants in the central valley of California. These plants are widely distributed and generally infested by the root aphid, which survives and asexually reproduces on them from year to year.

Control

No completely satisfactory control for the sugar-beet root aphid is known. Since it is a subterranean insect, control by chemical methods is difficult or impracticable at the present time. Cultural methods of control seem to offer the greatest promise. Observations made in 1940 and 1941 in the island section of the south delta of the Sacramento River indicate that the aphid causes more injury to beets following beets than where beets follow potatoes, wheat, barley, corn, beans, tomatoes, or other crops. Table 1 gives the percentage of infested fields on land planted to beets 1 year as compared with the percentage of infested fields on land planted to beets 2 or more years in succession. It also gives the average percentage of infested plants found in the infested fields of the two rotation classifications for the years 1940 and 1941.

Table 1.--Fields and plants infested by the sugar-beet root aphid on land planted to beets 1 year as compared with those infested on land planted to beets 2 or more successive years

Year	Infested fields on land planted to beets		Infested plants in infested fields planted to beets	
	1 year	2 years or more	1 year	2 years or more
	Percent	Percent	Percent	Percent
1940 *	29	88	32	73
1941 **	27	92	18	34

* Figures based on the examination of 15 plants in each of 22 fields.

** Figures based on the examination of 50 plants in each of 48 fields.

The foregoing figures show that 1-year fields are less likely to be infested than are 2-year fields. It should be noted that the figures relating to infested fields for the 2 years are not comparable because a larger number of plants per field were examined in 1941 than in 1940. It is likely that all fields are infested to some extent, the root aphid just being so scarce in some that it was not found in the sample.

Although the infestation was heavier in 1940 than in 1941, the data for both years indicate that infested fields were found about three times as often on land where beets followed beets in the rotation as on land where beets followed some other crop. The data for both years also show that the root aphid was approximately twice as prevalent in the infested 2-year fields as it was in the infested 1-year fields.

The following cultural practices are recommended as aids in controlling the damage caused by the root aphid:

(1) Arrange so that beets do not follow beets in the crop rotation. This is good farm practice for reasons other than the smaller amount of aphid damage in 1-year fields.

(2) Avoid planting beets on land where dock (Rumex sp.) was abundant the previous year. Dense stands of dock infested by the root aphid have been observed growing in grass land and pastures and in fields of alfalfa. Even when such land is plowed in the fall, the root aphid will survive on the fleshy roots of the dock and infest beets when they are planted.

(3) Confine livestock in fields after harvest to clean up the old beets remaining in the field. This is practiced by some growers, and has the advantage of utilizing a valuable source of feed, besides removing plants upon which the root aphid lives during the winter.

(4) Plow the land and keep it free from weeds and grasses by thorough cultivation at intervals for several weeks prior to planting.

(5) Kill dock plants along road sides, ditch banks, canal levees, fence rows, and other waste, abandoned, or uncultivated areas that may serve as outside sources of infestations in beet fields.

It is emphasized that the foregoing recommendations apply only to the central valley of California and other areas where similar conditions prevail. They are not applicable to areas where the winters are long and cold, and where "lice" overwintering in the soil are considered a very minor source of infestation compared with the flight of winged aphids from poplars to sugar beets that occurs in the spring.

Some information now available suggests that the time of preparing the seed bed in the spring, or the time of planting, may affect the amount of damage caused by the root aphid, but these and other possible aids to control must await further investigation before definite recommendations concerning them can be made.

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