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DIAGNOSIS OF INJURY TO AVOCADO FOLIAGE

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In recent years, evaluations of insecticide treatments have been made in certain avocado orchards by determining the relative amount of leaf injury in the treated plots as compared to the untreated checks. These field comparisons may be made as long as a year after treatment and it is essential to be able to distinguish between the types of injury caused by different insects and particularly to be able to distinguish between injury from insects as compared to injury from other causes. It became apparent that much of the injury that has formerly been considered to be caused by insects was actually caused by what appear to be physiological disorders that result in injuries similar to those resulting from insect feeding. Although this type of injury has never been found to be as serious as the injury resulting from the more severe infestations of insects, it is more widely distributed and usually more abundant. It appears that the ability to distinguish insect injury from that which results from other causes would be of value to the avocado grower as well as the pest control operator and the entomologist.

INJURY TO YOUNG LEAVES. Usually most of the insect injury to foliage is caused by the larvae of two species of moths: the amorbia *(Amorbia essigana* Busck) and the omnivorous looper, *Sabulodes caberata* Guenee, although June beetles, Fuller rose beetles, snails, and other pests may cause similar injury.

In the spring the larvae of amorbia may sometimes be found feeding on the young terminal leaves after having webbed them together (Fig. 1, above). Their injury consists primarily of small holes in the leaves, but also to some extent the margins of the leaves are eaten. As the leaves increase in size the holes become larger and result in a rather typical type of injury (Fig. 1, below).

The amorbia shows a marked varietal preference. For example, in May, 1955, in an avocado orchard near La Habra, California, over half of the terminals were infested on the Anaheim variety, approximately 25 per cent on the Hass variety and only an occasional terminal was infested on the Fuertes.

An injury to young terminal foliage that is similar in appearance to that which is caused by the amorbia can often be found in any avocado district and is illustrated in Fig. 2. This injury has been generally attributed to insects, but it has been definitely established that neither insects nor fungi are involved. The malady seems to be physiological in origin. A striking example of this injury was observed on two-year-old avocado trees of the Hass variety in April, 1955- Nearly all the young terminal growth was affected as severely as indicated in Fig. 2. However, this type of injury may be seen on trees of all ages. It does not seem to be the result of adverse weather conditions, for it is just as prevalent in a humid glasshouse *as* outdoors. When Figures 1 and 2 are compared it can be seen that the injury from amorbia consists primarily of holes eaten into the

leaves whereas the injury shown in Fig. 2 appears as if the leaves were eaten from the margins toward the midrib of the leaf. Only a few holes can be seen. The margins of the injured leaves have a narrow yellowish border.

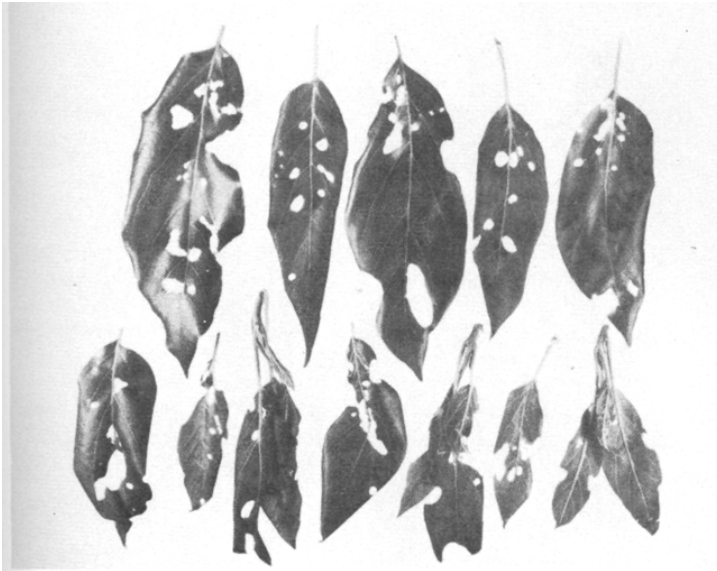

Fig. 1. Above, terminal avocado leaves injured by the amorbia. Some are still webbed together, with the larva inside. Below, injured leaves at various periods after they were fed upon by the amorbia larvae.

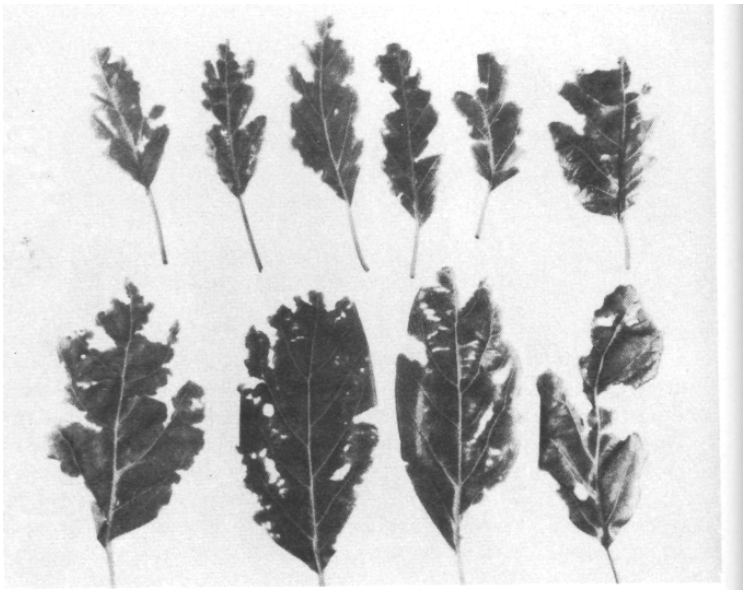

Fig. 2. A malformation of the terminal leaves of young avocado trees caused by a necrosis that is apparently physiological in origin and is not caused by insects, mites or fungi.

The malformations of the leaves often appear to originate from necrotic tissue that

becomes apparent when the tiny leaves are first unfolding from the terminal clusters. This type of necrosis is mainly marginal, and influences the pattern of growth the leaf is to take in its subsequent development. Some of the injured leaves have a tendency to fall when barely touched, and these will be found to have a blackish discoloration in the region of the abscission layer. It would seem that such a degree of injury to young terminal foliage would retard the growth and development of the tree.

INJURY TO MATURE LEAVES. Figure 3 shows the characteristic feeding injury of the omnivorous looper on mature leaves. Injury caused by other foliage feeders is somewhat similar in appearance. Note that the insects have a tendency to eat the foliage right up to the midrib and larger veins, leaving these conspicuously isolated. Another reliable indication of insect injury results from the feeding of the first instar larvae of the omnivorous looper and the amorbia. They feed only on the surface of the leaf, leaving a thin membrane and network of veins; in other words, they "skeletonize" the leaf. Some of this type of injury is shown on the leaf at the extreme left in Fig. 3.

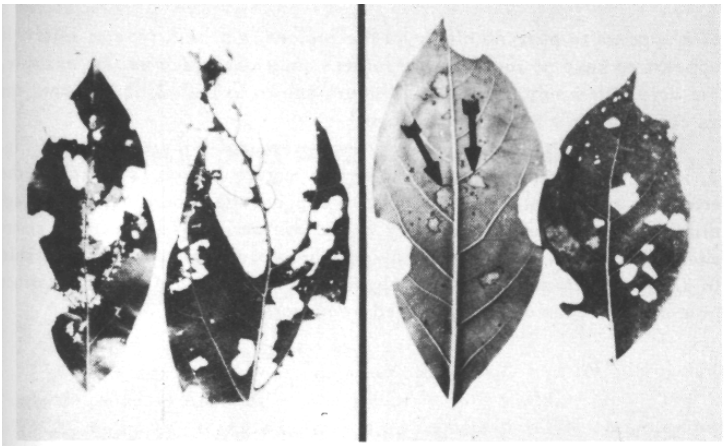

Fig. 3. Left, injury to avocado leaves caused by the omnivorous looper. Right, lower and upper surfaces of avocado leaves showing injury caused by the dropping out of necrotic areas. The location of three of the necrotic areas, before they dropped out, is shown by the arrows.

Fig. 3, right, shows the type of injury on the older leaves caused by necrosis. The necrosis is plainly marked in definitely delineated areas both on the lower surface (left) and upper surface (right) of the leaf. Three of the necrotic areas are shown by the arrows. When these drop out they leave the holes that have in the past been mistaken for insect injury. If the edge of the leaf tissue left by the holes is examined carefully it usually will be found to have retained a narrow margin of necrotic tissue. In the case of the leaves in Fig. 3, right, none of the missing leaf tissue was lost because of insect injury. Even the large marginal areas that are massing fell off because of necrosis.

The necrosis is less apparent when a tree is viewed from the outside. One must get under the tree to see the most striking evidences of injury. Sometimes an average of 25 to 50 per cent of the leaf surface on the leaves in the interior of the tree is lost because of this malady.

The cause of the necrosis is not known. It is not caused by insects or mites and plant pathologists have assured us that it is not caused by fungi. Once the observer has had his attention called to this type of injury he will find it to be common everywhere. The writer has found it in all parts of southern California, including the areas farthest removed from any possible influence of smog. The vigor or lack of vigor of the tree appears to have no effect on the incidence of this type of injury. It appears to have no relation to weather conditions, such as, for example, the dry north winds, for, like the injury shown in Fig. 2, it is found just as commonly in a humid glasshouse.

As in the case of the injury to young terminal foliage, shown in Fig. 2, right, the occurrence of the injury to mature leaves is called to the attention of entomologists primarily to suggest the importance of distinguishing it from true insect injury in the evaluation of insecticide treatments. It appears that it would also be helpful to the growers to be able to recognize these apparently physiological injuries as being distinct from similar types of injury caused by insects.