

DISEASE CONTROL OF AVOCADOS AND MANGOS

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The control of diseases of the avocado and mango is just as necessary for the production of a profitable crop as the problem of culture, fertilization or marketing. The value of these crops depends largely upon the quality, quantity and appearance of the product produced. It is generally conceded by the commercial growers of these crops that disease control is essential for satisfactory returns, if such can be accomplished in a practical and economical way. It has been our privilege during the past three years to study the diseases of the avocado and mango especially with reference to working out more practical control measures. A summary of our results is included in this paper.

In general the Florida growers are familiar with the necessary sprays to use in controlling diseases and the methods of applying them. Their interest is more in the number of applications necessary and the time they should be applied for effective results. These are some of the problems we are trying to solve in our field spraying experiments. There is no one general spray program that can be made to meet economically and effectively the grove conditions throughout the state. Different localities may require different methods of procedure, and different diseases are treated differently, in regard to time of spraying and number of applications.

In the development of most of the fungus diseases of plants there is usually a limited period in which the leaf, twig or fruit, may become infected. This period may vary from two to three weeks to as many months. If the fruit or leaf can be protected during this period by a coating of a suitable fungicide, the disease can be prevented. If, on the other hand, infection has taken place before the spray is applied, the spray applications will not prevent the disease from appearing later on. Spray applications will not remove and may only slightly retard infections that occur before the spray is applied.

AVOCADO DISEASES

There are a number of diseases that occur on the avocado in Florida, but only a few are of sufficient importance to justify the expense of control measures. These directly affect the fruit and, consequently, the returns from the crop. Avocados, like citrus and other fruits, are sold largely on their appearance. Fruits that are decayed or blemished by disease naturally fall into lower grades and give lower returns. The chief aim of the grower is to produce fruit of desirable appearance, as well as quality, in order to satisfy the market demands and we believe this can be done at a nominal cost by proper and efficient spraying.

The principal diseases largely responsible for injury to the fruit during its period of development and shipment to markets are scab, blotch or *Cercospora* spot, black spot

and fruit rots. These can be controlled or held in check if proper precautions are taken in time.

FRUIT ROTS

Several types of fruit rots have come to our attention during the past three years that affect the mature fruit after it is exposed for sale or held for consumption. These rots may appear in the form of decay at the stem end of the fruit, or the side or blossom end may be affected. These decays usually develop rapidly and the affected fruit may be completely destroyed by rot in two or three days' time. These types of rot are more familiar to the consumer than to the person who grows the fruit and they constitute a very poor advertisement for Florida avocados.

The rots that occur on the sides or blossom end of the fruits are usually due to secondary fungi that enter through some break or opening in the rind. A species of *Colletotrichum* is usually found associated with such rot which belongs in a group of fungi responsible for producing the ripe rot of several other tropical fruits.

The stem-end-rots are produced by a different group of fungi and they show a striking similarity to the stem-end-rots of citrus fruits both in their causes and manner of development. The decay first starts at the stem end of the fruit as a small black or brownish discoloration surrounding the stem. This continues to spread until the entire fruit is decayed which may be a matter of three or four days. The fruit usually remains firm for a day or two longer and shows no outward indication of the fungus attack, except the change in color. The meat, however, has become rancid and unfit for food. Later the surface of the infected fruit becomes covered with grayish green tufts of the fungus growth.

Three different fungi are found associated with these rots. A species of *Diplodia* which appears to be identical with the one causing stem end rot of citrus fruits, and two species of *Phomopsis*, entirely different from *Phomopsis citri*, are causes of stem end rot of avocados.

At present the fruit rots probably cause no great amount of loss to the avocado crop as a whole, but the effect on the consumer must not be overlooked. These rots will bear watching and in time a system of control may have to be developed to take care of these troubles.

AVOCADO SCAB

Avocado scab is widely scattered throughout the regions in Florida where the avocado is grown. It is a fungus disease that attacks the young, tender tissue of leaves, shoots and fruits. It affects a number of the avocado varieties grown in the state and it may cause serious injury to fruits of the Lula, Taylor, Trapp and individual seedlings of the West Indian group. The Fuerte, Winslowson and Mexican seedling are frequently attacked by scab and many other varieties that make up our commercial plantings are more or less affected by the disease.

During the past season the disease was noted as severely attacking fruits of the Lula,

Taylor and Fuerte, occurring abundantly on the Wislowson and scatteringly on fruits of the Gottfried, Simmonds, Eagle Rock, Spinks, Waldin, Pollock, Pinella and Linda.

The development of scab is largely influenced by weather conditions at the time new growth or young fruits are forming. It is very similar to citrus scab in general appearance and effect on the host, and the fungi causing these two diseases are similar in many respects. Cool, moist conditions and young, tender growth are necessary requirements for scab development in either case, and the periods in which leaves, twigs or fruits may be infected are usually of short duration. Spots, appear on the leaves in 12 to 14 days after the fungus comes in contact with the succulent tissue and a few days later, under favorable moisture conditions, these same spots bear countless spores which continue to spread the disease. This process may be repeated several times during the critical period that the fruit might be infected, if sufficient moisture is present in the form of rains, heavy dews or fogs.

APPEARANCE OF AVOCADO SCAB

The disease appears as definite patches or spots on the young, tender leaves and shoots, severe attacks causing the leaves to curl or become distorted. Infection takes place only on the tender, succulent growth and as the leaf tissue hardens it becomes immune to attacks of the fungus. The spots are generally small, circular to irregular in outline and they may vary from one-sixteenth to one-eighth of an inch in diameter. They are purplish brown to dark brown in color and they may appear scattered over the surface or grouped together forming irregular areas. The spots penetrate the leaf tissue and become visible on both sides of the leaf. They are usually more prominent on the upper surface of the leaf, in which case the under surface of the spot may be slightly bulged and marked by a purple discoloration. The centers of the older spots are composed of dry, dead tissue, more or less spongy and brownish in color. As the infected leaf matures and the spots become older, the dead centers of tissue may fall away leaving small holes in the leaf. Old infected leaves are the principal sources from which the disease is spread each season.

On young shoots, twigs and leaf petioles the spots appear darker and more elevated. They are more or less oval in shape, with comparatively smooth surfaces and in general outline may resemble one of the soft scale insects.

On fruits the same oval, raised type of spot is found that occurs on twigs. The spots may be scattered individually over the surface when infection is slight or they may be clustered together forming irregular scabby masses when infection is more severe. Severe attacks on fruit frequently cause a roughened or russet condition of the rind, very similar to the effect produced on grapefruits severely affected with scab. Such markings are usually light brown in color, marring the appearance and shape of the fruit and reducing its size.

The injury from avocado scab on the fruit is superficial and does not affect the quality of the matured fruit. However, the outward appearance is marred and this directly affects the grade and value of the fruits. It is probable that the disease is responsible for a considerable dropping of young fruits, especially when infection occurs about the time

the fruit has set. Severe attacks may cause dwarfed and misshapen fruits, greatly lowering the grade.

The greatest damage from scab results in injury to the fruit and most of the spraying is done to protect the crop. Certain varieties of nursery stock are often severely attacked by scab and a certain amount of spraying will be necessary to protect such plants. Very little attention is given to keeping the foliage of grove trees from scab and no special applications are made for this particular purpose. In our experimental spray plots it has been noted that the foliage on trees, sprayed two or three times a year with Bordeaux mixture for scab control over a period of three years, has become remarkably free from scab infections. This would indicate that the spray applications necessary to protect the fruit will also materially reduce the amount of scab in the grove. This condition, however, will hold only so long as the spraying is continued.

CONTROL

Attacks of scab on fruits can be controlled where spray applications are made at the proper time. Two or three applications of 3-3-50 Bordeaux mixture ordinarily give sufficient protection to the fruit during the period in which it might become infected. Locality and weather conditions have considerable bearing on the amount of scab that may develop in any season and the number and time of applications should be modified to suit the local conditions. The Bordeaux mixture should be properly prepared, using the active quick lime for best results.

Based on the information obtained from our experiments during the past three years the following recommendations are made for controlling avocado scab under ordinary conditions:

(1) A dormant application of 3-3-50 Bordeaux mixture just previous to the opening of the bloom cluster. This is especially desirable if old leaves show scab infections and if the weather is cool and damp at the time the buds begin to burst forth. Thoroughly cover the old foliage, as this application is intended to destroy spores formed on old leaf lesions.

(2) A second application of 3-3-50 Bordeaux mixture should be made at the end of the main flush of bloom, when most of the petals are off and the small fruits are becoming visible. The critical period for scab infection on fruits is from the time the bloom drops until the fruit is from six to eight weeks old, and a coating of Bordeaux mixture is necessary as early in this period as possible, especially if the weather is damp and cool when the young fruit is appearing. If the weather is dry and warm during this period, very little scab will develop.

(3) A third application of 3-3-50 Bordeaux mixture should follow the second application three or four weeks later.

These three applications should control scab satisfactorily under ordinary conditions if the spray is properly applied to cover uniformly the foliage and fruits. While the dormant application insures better results, it may be omitted from the spray program in preference to any of the other applications.

FRUIT SPOTS

The fruit spots of the avocado at present include Blotch or Cercospora Spot and Black Spot or Anthracnose. Both are fungus diseases that are widely scattered over the avocado producing sections of the state. In many localities they cause a considerable loss from culls or low grade fruit each season if control measures are not employed.

Blotch or Cercospora Spot is caused by a species of Cercospora that attacks the leaves and fruit of a large number of our leading avocado varieties. The disease is becoming more serious each year and it severely affects the foliage of many of the Mexican and Mexican-hybrid strains. During the past three years almost complete defoliation has been noted of Gottfried, Fuerte, Mexican seedlings, Nimilio, Taylor and the Wagner trees. Numerous infections on leaves are usually more evident in late summer and defoliation takes place in early fall. Severe attacks of the disease have been noted during the past season on the fruits of the Gottfried, Fuerte, Mexican seedlings, and West Indian seedlings, Pollock, Trapp, Winslowson, Waldin, Lula, Taylor, Linda and Eagle Rock.

The fungus affects the growing leaves, fruits, fruit stems and young; shoots, forming characteristic spots in each case. Infections on the fruit usually develop much later than those of scab and growing fruits may become infected until they are nearly mature. There is a period of four or five weeks after the fungus has entered the fruit before any indication of the disease is visible. Attacks on fruits are confined to surface spotting, which only affects the rind and mars the outward appearance.

APPEARANCE OF THE DISEASE

The Cercospora fungus produces small, angular spots on the leaves, brown to dark brown in color. The spots may be scattered, or run together forming large irregular patches of dead tissue. Severe infections cause the leaves to drop prematurely, often resulting in heavy defoliation. Spores of the fungus develop in successive crops on the dead leaf spots during moist periods and such sources of infection may be present in the tree during the entire developing period of the fruit.

The fungus attacks the fruits early in their period of development and they appear to be susceptible until they approach maturity. Fully developed spots on the fruit appear as small, slightly sunken, irregular surface blotches. They are usually brown or dark brown in color and often show at their centers a white tuft of fungus growth bearing spores. Mature spots vary in size from one-eighth to one-fourth of an inch in diameter. They frequently coalesce to form larger areas.

These spots on the fruit first appear as small, greenish-white dots which slowly develop into circular, hard, brown areas of dead tissue that are cracked and fissured. Through such cracked surfaces rot-producing fungi such as the black spot organism, frequently enter as the fruit matures, causing secondary decay. The Cercospora fungus apparently does not enter or cause a decay of the flesh. It mars the outward appearance and forms openings for the entrance of other organisms that produce decay.

ANTHRACNOSE OR BLACK SPOT

Anthracnose or Black Spot of the avocado is caused by; a fungus belonging to the Colletotrichum group. It is a weak parasite and only attacks fruits nearing maturity. It is apparently unable to enter the unbroken skin of the avocado and only gains entrance to the flesh of the fruit through some opening or break in the rind. If the fungus once gains entrance through the rind, extensive decay of the flesh quickly follows, forming a characteristic black to brownish globular mass extending to the seed. Black Spot completely destroys the market value of fruits affected. It appears to be a secondary invader, generally following injuries due to Cercospora spotting, and it does not appear until the fruit has well advanced toward maturity.

On, the surface of the fruits the spots may be scattered, mostly circular in outline, black to dark brown and usually one-fourth to one-half inch or more in diameter. Under moist conditions the larger spots may be sprinkled with numerous small, waxy, flesh-colored spore masses that break through the skin. The spots may spread rather rapidly, hastening the maturity of the fruit which soon drops. In many cases Black Spot forms around older Cercospora spots, in which case the centers may be dark brown and cracked. The black color of the spot and rot of the flesh beneath is always typical of Black Spot.

CONTROL

Both Cercospora Spot and Black Spot can be controlled by proper spraying with Bordeaux mixture. Since Black Spot usually follows Cercospora spotting and both occur together on the same fruit, the treatment for Cercospora will generally eliminate any appreciable amount of Black Spot. It is probable that if Cercospora infections are prevented, no Black Spot will develop.

In our experiments during the past two years, three applications of 4-4-50 Bordeaux mixture applied at monthly intervals have given very satisfactory results in controlling both of these troubles. It is necessary to make the first application sometime between May 1st to May 15th for best results. The fruit probably becomes infected by Cercospora early in its development, but the disease is rarely visible until six or eight weeks after the fruit has set. It requires about four or five weeks after the fungus has infected the fruit for any spots to become visible and another week or ten days may elapse before these spots bear spores. These spores are capable of re-infecting the same fruit and producing another succession of spots about one month later and this process may be repeated at periodic intervals until the fruit is nearly mature.

It is believed that by protecting the fruit through May, June and July, most of the injury resulting from Cercospora Spot and Black Spot can be avoided. In fact, two applications of Bordeaux at monthly intervals applied in May and June have given good results in controlling Cercospora on early fall maturing varieties producing over 90% fruit of first commercial grade. Where the first application was delayed until June and then followed at monthly intervals for two or three applications, the control was very poor, dropping to 50% or less of first grade fruit. This indicates that the major portion of the infection had occurred in May or early June. As a result of our experiments during the past two years

we suggest the following spray program for the control of Cercospora and Black Spot:

1. A thorough application of 4-4-50 Bordeaux mixture between May 1 and May 15. Foliage and fruit should be thoroughly and evenly covered.
2. A second application of 4-4-50 Bordeaux mixture should follow not later than one month after the first application.
3. A third application of 4-4-50 Bordeaux mixture should follow not later than one month after the second application.

These recommendations apply to fruit maturing in late summer until the end of October. If severe spotting is noted on the leaves in late August or September, such trees should be given a dormant spray of 4-4-50 Bordeaux mixture in late January or February as a preliminary clean-up before next season's bloom.

MANGO DISEASES

The principal diseases of the mango in Florida come under the Anthracnose group. A species of Colletotrichum has been associated with and considered the cause of leaf spot, bloom blight, shedding of fruits, fruit spot and ripe rot. What seems to be the casual fungus is widespread in Florida and attacks other host plants, but is particularly severe on the mango.

On the lower East Coast and along the West Coast where the mango is grown, bloom blight is a serious trouble on the first blooms that appear and it is only occasionally that a satisfactory crop will set. Fruits from blooms that appear in late December or January mature earlier and are of better quality than fruits from blooms of a later period, and it is desirable to produce as much of this grade of fruit as possible.

The budded varieties, such as Haden, Mulgoba, and others, are apparently much more susceptible to bloom blight than the common seedling varieties. Often the seedlings will produce good crops when Haden or other budded varieties in the same section fail to set any fruit. This is generally attributed to attacks of the fungus on the bloom and the young fruit just as it sets, causing it to shed off. If there are periods of rain, fogs or heavy dews during the time the mango is in bloom, the blight becomes active and may soon destroy all chances of a crop for that season.

Spraying has been practiced against this disease for a number of years with varying results. We have known of cases where twelve to fifteen applications of Bordeaux mixture were made in order to secure a setting of fruit and then only partial success was attained. This is entirely too many spray applications for economical production, even though the better grades of mango are considered very valuable.

We have conducted a few spraying and dusting experiments during the past two years with the object of controlling the Bloom Blight and spots on the fruits. Our results from these have been somewhat variable. However, indications are that four or five applications of Bordeaux mixture applied at the proper time will give as much control as twice that number applied in haphazard fashion.

We have in progress spraying experiments to determine the proper time of application

and the number of applications necessary to give economical and satisfactory control. In these experiments 4-4-50 Bordeaux mixture, copper lime dust and a wettable sulphur have been used at different periods. The experiments have not been completed and the results checked, but at the present time, three and four applications of Bordeaux mixture have shown striking results in securing a setting of fruit and keeping the fruit free from spots. Our first applications were made at the time the bloom clusters began to open, but before any individual flowers were open. The second application was made into the open bloom about twenty days later. Many small fruits had set at this time from the first flowers that had opened. The third application was made three weeks later when all the blooms had opened and fallen. A fourth application was put on one month after the third. A fifth application was made about one month after the fourth.

A recent inspection of the plots showed a very much greater amount of fruit set and better condition of the fruit on the plots sprayed with three or four applications of Bordeaux mixture as compared with the unsprayed plots and those treated with copper lime dust and the sulphur spray.

Our results thus far would indicate that four applications of Bordeaux mixture applied at the proper time will aid materially in setting a crop of mango fruit and protecting it through the critical period for anthracnose infection. However, the results of one season cannot be taken as final, and the experiment must be repeated several times under varied conditions.