

Our trees cannot simply pull their roots in one or the other direction. If the roots yield at all, they must be torn asunder. This actual loss of a good part of the root system, of large roots as well as the tiny root hairs, has more than one after-effect. Naturally the foliage of the tree makes demands for water which the injured roots cannot meet, and which necessitates both defoliation and watering. But we have observed another effect showing up some months afterward, in the development of decay and footrot around the crown of the tree. This appears to start in the severed and torn larger roots and to work up to the crown, where it girdles the bark, sometimes completely.

Another after-effect observed in the Miami area near the water has been called to my attention by Mr. K. Dahlberg, the Superintendent of Bayfront Park in Miami. Several weeks or months after the hurricanes of last fall, he observed trees which had apparently weathered the storms in good shape suddenly began to die. This was evidently due to the salt left by the tidal wave which swept ashore. Perhaps prompt and long continued drenching of the ground around trees which have had salt water around them would leach out this salt before the trees took in amounts large enough to be toxic.

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## CONTROL OF MANGO BLOSSOM-BLIGHT AND ANTHRACNOSE

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Two years ago I gave you a brief report of some recent spraying experiments for the control of bloom-blight and anthracnose of the mango. Our results at that time indicated that bloom-blight could be sufficiently controlled by proper spraying to insure a set of fruits and that the fruit could be protected from anthracnose infections during its early stages of development up to maturity. Four or five applications of Bordeaux mixture were sufficient to accomplish these results. We have continued our spraying experiments during the past two years, both in the Homestead section on the lower East Coast, and in the Fort Myers section on the West Coast. The results from these experiments agree very closely with those previously reported; namely, that four or five applications of Bordeaux mixture applied at the proper time will protect the fruits from anthracnose infection and increase the yield where blossom-blight is concerned.

Recent results indicate that mango fruits sprayed with Bordeaux mixture will keep longer after they are picked and that they will remain comparatively free from surface spotting until they are fully ripe. This is a decided advantage from the

market viewpoint. A majority of the mangos we see on the local markets, whether they are seedlings or the improved varieties, break down very rapidly when they become fully ripe. The surfaces of such fruits become covered with black spots or blotches, beneath which the flesh soon decays. Such fruits are not attractive and they are far from being palatable. Fully matured fruits which appear entirely free from surface spots when picked may develop this condition in four or five days when held on the fruit stands or until they are fully ripe.

Results obtained the past season from a few holding tests made with fruits from sprayed and unsprayed plots indicate that fruits sprayed with Bordeaux mixture will hold up longer and present a much better appearance than fruits from unsprayed plots. I believe this point will have an important bearing on the marketing of mangos, and it should be as fully recognized by the grower as it is evident to the purchaser or consumer.

### CAUSE OF BLOSSOM-BLIGHT AND ANTHRACNOSE

The blighting of the mango bloom and infections on fruits commonly referred to as anthrac-

nose may result from the attack of a fungus generally identified as *Colletotrichum gloeosporioides*. This fungus is widely distributed in Florida and it may be found on a variety of host plants.

The fungus also attacks the mango leaf, forming small angular brown-to-black spots between the veins. The spores, or fruiting bodies, are produced in these spots under favorable conditions, and infected leaves are probably the principal sources in carrying the disease over from one season to the next. Infection may readily spread from leaf to bloom and fruit under suitable conditions of temperature and moisture. Occasionally tender shoots of the mango are attacked by the fungus and the growth is killed back for several inches. This type of injury is more apt to occur on nursery stock or young seedling plants. It may attack more hardened wood, but in such cases it generally gains entrance through some wound or injury.

The fungus is frequently found on dead mango twigs where it probably exists as a saprophyte and such dead wood may become a source for harboring the fungus. Dead persistent stems, from which the bloom and fruit have dropped, are another convenient source for continuing the fungus. Attacks on the bloom and fruit are often severe and the disease is one of the hazards to mango production in Florida. Open flowers, flower buds, stems, and large sections of the bloom cluster may be killed by an attack of the disease in a few days' time under favorable weather conditions. The dry, dead, brown appearance of flowers and stems of the bloom cluster is a typical symptom of this phase of the disease. Young fruits that have just set may become affected early in their development. Small, dot-like spots first appear, later becoming purplish around the edges, and increasing rapidly to cover the entire surface of the fruit which becomes black or dark brown. Such fruits usually shrivel and drop in three or four days after infection appears. Fruits in this stage appear to be more susceptible to anthracnose and an attack during this period may cause a severe or total loss of the crop.

Spots may occur on the fruit at any time during the season from the time the bloom disappears

until the fruit is matured, or even after it is picked and fully ripened.

However, young fruits are more easily attacked and more rapidly destroyed and it is essential to provide some means of protection to such fruits during their early stages of growth in seasons favorable for fungus development.

The appearance of blossom-blight and anthracnose on the mango will depend largely upon weather conditions during the period of blooming and fruit setting. Both of these troubles may be classed as wet weather diseases. It is common knowledge, based, however, on observation, that a good set of fruit usually results if the weather is dry and warm during the period when the mango tree is in bloom and setting fruit. If damp, rainy weather prevails during this period, little or no fruit will set. This condition has been repeatedly observed by the mango growers of Florida, and others, which justifies the assumption that there is a direct relationship between weather conditions and the size of the mango crop that may result.

I do not believe that the failure to set fruit under humid conditions is entirely due to the fungus we are considering. It may kill a certain per cent. of the bloom and destroy a large number of fruits, but probably other factors are concerned that are just as responsible for failure of the fruit to set and produce a crop under humid conditions.

As yet we are unfamiliar with all the conditions necessary for a proper setting of mango fruits. No doubt temperature and humidity and their effects on pollination are basic factors in the setting of a mango crop; and these are problems still to be worked out. If the fruit sets normally at some time during the blooming period, it can usually be protected from fungus attacks by proper and economic spraying. If abnormal or imperfect fruits set temporarily no amount of spraying will insure a crop, as such fruits usually drop in due course of time.

#### MANGO BLOOM CLUSTERS

The mango bloom cluster is a complicated and more or less compact arrangement of flowers, buds, and branchlets. Bloom clusters vary from 8 to 18 inches in length and appear on the terminal ends

of the woody branches, extending well out beyond the leaves. Bloom clusters may be simple, that is, made up of a single panicle—a straight stem with numerous branchlets supporting the flowers—or compound—made up of several panicles arising from a common base. Bloom clusters of the Haden mango may produce from 1,000 to 5,000 flowers, the average cluster bearing about 3,000 flowers during the blooming period. It may require from three to six weeks for a bloom cluster to open all of its flowers, depending largely on the temperature during that time. The flowers open rapidly at temperatures between 70° and 80° F. As far as observations have gone, two types of flowers are always present on the bloom clusters—hermaphrodite and staminate—the latter usually exceeding the perfect type from three to ten times.

The hermaphrodite or perfect type of flower is easily distinguished by the small embryonic fruit which is visible at the center as soon as the flower opens. These flowers are usually borne at the terminal end of branchlets and they are generally the first to open. From two to three hundred perfect flowers are found in the average mango bloom cluster. Those located near the base of the cluster open first and the opening is progressive, those at the tip or apex of the panicle opening last. The fruit results only from the perfect type of flowers in the cluster, and under average conditions the set of fruit is very small in comparison to the large number of flowers involved. In a cluster bearing 200 to 300 perfect flowers, probably three to twelve fruits will finally mature. The large number of perfect flowers produced and the successive habit of opening flowers over a period of time afford a better opportunity to obtain some set of fruit, even under adverse conditions. This is frequently suggested in the location of fruits in the cluster that have permanently set. In some clusters we find all the fruits near the base, in others the fruit will be located in the middle region of the panicle, and in many cases fruits are only carried at the terminal end, or apex, of the panicle.

The staminate flowers are similar to the hermaphrodite flowers in every respect except that the embryonic fruit is rudimentary and not visible. Staminate flowers on the panicle begin to open a

few days later than the first perfect flowers and continue to open daily. These flowers open, shed pollen, and dry up or fall off in three or four days' time, and others continue until 1,800 to 2,500 such flowers have completed this process. Quite frequently many of these dead flowers lodge and remain in the bloom clusters for days. The compact make-up of the mango bloom cluster when it is in full open flower affords a favorable situation for fungus growth under moist, warm conditions.

If the blight fungus becomes established in this mass of dead and open bloom, during a rainy period of two or three days it may cause a considerable destruction of the bloom and young fruits for a time. However, since there is a succession of perfect flowers opening every day through the blooming period, many of these will set fruit that will escape disease until it can be protected with some spray application.

If the fruits set normally at some time during the blooming period, a sufficient amount of this can generally be protected by spraying to insure a fair crop.

#### CONTROL MEASURES

The results of our spraying experiments indicate that blossom-blight and anthracnose of the fruit can be reasonably well controlled by four or five applications of Bordeaux mixture. Probably the time of application is more important than the number of applications or the strength of solutions used. Thus far, 4-4-50 Bordeaux mixture, properly made and properly applied, has given the most satisfactory results.

A tentative spray program was outlined and followed in our experiments and this has been recommended for use to the Florida growers. The schedule includes five applications, as follows, and the applications are designated by numbers for convenience:

- Application No. 1 Dormant spray.
- 2 In-the-bloom.
- 3 End-of-bloom.
- 4 1 month following No. 3.
- 5 1 month following No. 4.

The dormant application is necessary as a clean-up spray, especially if the old leaves on the trees

show any great amount of anthracnose spots. The fungus starts activity on the older leaves first, later going onto the new growth, bloom, and fruit, and a thorough application of Bordeaux mixture on the old foliage will do much to retard the early progress of the disease. This application should be made just as the bloom buds appear, which ordinarily would be between December 1 and 20. Rather than omit the dormant spray, it can be made later when the bloom clusters are fully expanded, but before the flowers begin to open. It is important to prevent an early infection of the bloom cluster and the dormant spray seems to take care of this. The foliage should be thoroughly covered.

The second, or No. 2, application is made directly into the bloom, near the end of the bloom period when two-thirds or more of the flowers in a cluster are open. Many small fruits will be visible at this time and the object of this application is to protect this young fruit. The bloom clusters should be thoroughly covered with the spray, which is not a difficult matter as the panicles extend far out beyond the leaves.

The third application should follow No. 2 in three weeks. At this time the young fruits that are apt to remain have set and this application will protect them through the early stages of development.

Application No. 4 is applied one month after No. 3, and No. 5 follows one month later. These two sprays are to protect the fruit from spotting during the later stages of maturity. Where the fruit sets early and matures early probably four applications of Bordeaux mixture will give profitable control. It is probable that these later applications aid materially in preventing decay and break-down of the fruits after they are picked and become ripened.

The present spray schedule applies to fruit which sets from the first bloom. Mango trees frequently produce two or three periods of bloom during the season. The first bloom, which appears ordinarily in December or early January, is usually heavier and produces the more desirable fruit. Fruits from this bloom are earlier, usually larger, and of better quality. If a sufficient crop has set from the first bloom, a scattering second

bloom may appear a month later and sometimes a definite third bloom will follow this in four or five weeks' time. Very little consideration need be given to these later blooms, as far as spraying is concerned, if the first set of fruit is sufficient. If the first bloom is light and no fruit is set, the second bloom will produce the fruit and the spray schedule can be shifted to cover this crop.

In spraying the mango, attention should be given to the materials and equipment used. The Bordeaux mixture should be properly prepared and applied. We have used the home-made Bordeaux mixture throughout in our experiments, using quick lime in the preparation of the mixture. Usually some sticker is required, such as calcium caseinate, since the slick surface of the mango fruit does not retain the spray mixture very well. The spray should be applied in a fine mist and if guns are used this will require a pressure of 360 to 400 pounds for two leads of hose.

Except in the case of dormant spray, no particular attention need be directed to covering the foliage or interior of the tree. The bloom is all on the outside of the tree and it can be readily reached with the spray solution. The same applies until they are nearly mature.

In our spraying experiments during the past four years we have increased the percentage of first-grade fruit on sprayed plots over unsprayed plots from 17 per cent. in seasons when little or no anthracnose was present, to 54 per cent. in seasons when the disease was severe.

A certain amount of spraying will be necessary during any season to protect the crop and produce first-grade fruit. Apparently this can be accomplished just as efficiently with four or five applications of Bordeaux mixture as it can with double that number. Satisfactory results from any program of spraying that might be applied to the mango will depend mainly upon the time the applications are made and the thoroughness with which the work is done.

To assist the grower in planning a spray program for the protection of his mango crop, a mimeographed circular was published in February of this year on <sup>(1)</sup> Mango Anthracnose Control. A

<sup>1</sup>Mango Anthracnose Control. H. E. Stevens, United States Department of Agriculture, Bureau of Plant Industry. Mimeo. Cir. Feb., 1936.

TABLE I

MANGO SPRAYING EXPERIMENTS. PERCENTAGE OF DIFFERENT GRADES OF  
FRUIT

Treatment	No. Appl.	Coral Reef Nurseries						Homestead			Fort Myers					
		1932			1934			1935			1934			1935		
		1st	2d	3d	1st	2d	3d	1st	2d	3d	1st	2d	3d	1st	2d	3d
4-4-50 Bordeaux	2				84.5	14.6	0	80.6	17.3	1.9	40.6	52.0	7.4			
	3				95.7	4.7	0	85.1	14.5	0	68.3	29.3	2.4	56.4	39.1	4.3
	13							75.1	22.9	1.8	50.6	42.1	7.3			
	4							91.3	8.7	0	74.2	24.8	1.	72.3	26.3	1.3
	5										72.	22.5	5.5	75.1	23.5	1.3
	6	93.0	.7	0												
6-6-50 Bordeaux	3													70.7	26.6	2.5
	5													76.1	23.8	0
8-8-50 Bordeaux	3													64.5	34.6	.8
	5													76.3	22.6	1.0
Basic Copper Sulfate	3													47.4	48.2	4.2
	5													61.2	36.2	2.4
Checks		68.4	31.6	0	62.0	36.8	1.1	52.9	34.1	2.9	13.7	40.6	45.6	16.2	65.9	16.9
Wettable Sulphur	4										30.2	61.5	8.3			
<sup>2</sup> C-L-D 20/80	3				92.	5.	3.				7.5	62.5	30.			
	4				99.7	.3	0				31.7	60.5	7.8			
	5				97.9	2.1	0									
	6	96.5	3.5	0												

<sup>1</sup>The dormant spray was omitted. Other applications followed successively as outlined in schedule.<sup>2</sup>Copper-lime dust.

limited supply of these was sent to the county agents for distribution in the counties where mangos are grown. Additional copies may be obtained from our laboratory at Orlando, or by addressing the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

#### SUMMARY

The accompanying Table I summarizes the results of our spraying work on mangos on the lower East and West Coasts, for a period of three seasons. Copper lime dust 20/80, a wettable sulphur and basic copper sulphate, were given comparative tests in some of the experiments. The results are stated for comparison: Copper lime dust gave very good control under certain conditions, but it is difficult to handle in a large grove in a practical way, except under still atmospheric conditions. In the Coral Reef Nurseries the dust was applied to small trees with a hand duster, and it was applied under most favorable conditions. In the Fort Myers section the dust was applied with a power duster and the applications of dust were not so well controlled.

The percentages in the table are based on a classification of the fruits on the tree. They were graded as follows:

Free —Entirely without anthracnose spots.  
 Very Slight—Not more than three small spots per fruit.  
 Slight —From 3 to 12 spots per fruit.

Medium —1/3 to 1/2 of the surface showing spots.

Severe —All fruit more spotted than medium.

In order to compare more readily with the commercial grading, the fruits have been grouped into first, second, and third grades. Fruits that were free or very slightly spotted have been placed in the first grade column; the second grade includes those slightly and medium spotted; those severely affected are classed as third grade fruits, or culls. Where possible, from 250 to 500 fruits, or more, from each plot, were graded, which formed the basis for obtaining our percentages.

The results of the work may be summarized as follows:

1. Applications of Bordeaux mixture, properly and timely applied, will control to a large extent blossom-blight and anthracnose of mango fruits in Florida.

2. If the fruit has permanently set it can be protected up to maturity by a reasonable number of spray applications.

3. Four or five applications of Bordeaux mixture are generally sufficient to give good commercial control, increasing the amount of first-grade fruits 50 per cent. or more in seasons of attack.

4. The dormant application is necessary as a clean-up spray and as a protection to the bloom cluster in its first stages of development.

5. The stronger Bordeaux mixtures do not seem to give any better results than the 4-4-50 Bordeaux.

## AVOCADO SPRAYING RESULTS FOR 1934

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During the season of 1934 our spraying experiments for the control of avocado fruit spotting were continued in the Homestead section.

The same general plan of the experiment was carried out as in past seasons, making two or three applications of Bordeaux mixture at monthly intervals for the control of *Cercospora* spot and

black spot. Bordeaux mixture of 4-4-50 strength was used throughout the season, prepared from quick-lime. Calcium caseinate was added as a sticker and the spray was applied with guns, using a pressure of 360 to 400 pounds on two leads of hose. Four varieties were included in the experiment, the Waldin, Winslowson, Linda, and