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SPRAYING EXPERIMENTS FOR CONTROL OF AVOCADO ANTHRACNOSE

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The Haden variety makes up fully 90 percent of the plantings of named varieties of mango grown commercially in Florida. This fruit finds ready acceptance on the markets because of its excellent flavor, beautiful appearance, and good carrying quality in transit and storage. The shy-bearing habit of the Haden has been far from satisfactory to commercial growers, however.

We are unfamiliar, as yet, with all the conditions necessary for a proper setting of the Haden but a number of factors contribute to its lack of fruitfulness. Such adverse weather conditions as low temperatures and relatively high humidity during the flowering season operate in some instances to prevent fruit setting. There is considerable evidence that lack of opportunity for cross pollination with other varieties is highly important as a factor limiting fruit setting¹. It is probable that lack of pollination is responsible for the temporary setting of large numbers of seedless fruits, which usually drop prematurely or fail to attain commercial size and quality if carried to maturity.

Infection by the anthracnose, **Colletotrichum gleosporioides** Penz., has long been considered a factor of primary importance in causing unfruitfulness of mangos in Florida. The various manifestations of the disease include a leaf-spot, blossom blight, fruit russetting, and fruit rot. Attacks on the bloom and setting fruits are often severe. The injury caused by the disease is closely dependent upon humidity, the prevalence of rains or heavy dews greatly increasing its incidence.

The causal organism is one of the most widely distributed pathogenic fungi in Florida. It causes the well-known wither-tip of citrus, a ripe rot of avocado and papaya fruits, and is pathogenic on at least several other fruits. It grows and sporulates abundantly during wet weather on the dead twigs and leaves of many plants, including the mango, avocado, and Citrus species. It seems likely that the possibilities for infection are very great at all times, and all that is needed is a favorable period of moisture to produce the disease in abundance.

Anthrachnose can be controlled by spraying with bordeaux mixture. Stevens² has worked out a spray schedule which includes five applications of 8-8-100 bordeaux mixture timed as follows: (1) dormant spray; (2) open bloom spray, when two-thirds or more of the flowers are open; (3) three weeks after No. 2, when most of the fruits have set; (4) one month after No. 3; and (5) one month after No. 4. Blossom infection and anthracnose of the fruit was controlled fairly well by this schedule in average seasons, provided the fruit set normally. Even in dry seasons, when little anthracnose was present, the percentage of first grade fruit was increased, and sprayed fruit carried better in transit and storage than unsprayed fruit.

Bordeaux mixture made according to the 8-8-100 formula is a stronger fungicide than necessary to control attacks of anthracnose on the avocado. Heavy bordeaux residues retard the growth of such plants as the tomato and the potato and probably of other plants as well. Heavy spray residues non-toxic to scale insects and spider mites generally tend to markedly increase such pests. The so-called "insoluble" or "neutral" copper compounds are less objectionable than bordeaux mixture in these respects. There appear to be no spraying experiments reported on the mango with these neutral copper materials, with the exception of limited tests by Stevens with tri-basic copper sulfate in 1935. Bordeaux mixtures weaker than the 8-8-100 formula apparently have not been tried.

Laboratory tests indicated the 3-3-100 bordeaux mixture and certain of the neutral copper compounds were sufficiently toxic, when sprayed on glass slides, to prevent all germination of *Collectotrichum* spores. Field experiments to test these fungicides for control of mango anthracnose were started in the 1937-38 season.

Spraying Experiment

The experiments were conducted at the Coral Reef Nurseries, near Cutler, in 10-acre grove of Haden mangos. The sprays were applied in a uniform manner with power machinery at 400 to 500 pounds pressure.

An individual plot consisted of a single row of 22 trees. Each treatment was tested in duplicate plots. The various fungicides were compared in schedules which included a dormant spray in one case and no dormant spray in another. The dormant spray was applied when the buds were just beginning to swell. The second spraying in these plots, and the first spraying in plots not receiving dormant spray, was made when the first bloom spikes were well opened but before individual flowers were open (Plate 1). Successive sprayings were made at approximately 1, 3, 7, and 11 weeks after this first bloom spike application.

The entire tree was covered thoroughly at the dormant and first bloom spike applications, but thereafter attention was directed to covering only the bloom spikes and fruits thoroughly. Spreaders known to be efficient on other types of foliage were incorporated with the spray mixture unless already added in the manufacturing process, as is the case with some of the proprietary copper fungicides.

The mature fruits were examined as they were harvested, and were graded according to the severity of infection into three classes, as follows: (1) free of anthracnose; (2) stained or russeted; and (3) those showing active decay spots. Practically all of the fruits which set from the early or main bloom were examined from each plot.

The spray schedule and the results are shown in Table 1.

Discussion

The results indicate that it is unnecessary to apply a dormant spray. Considerable spraying had been done in previous years in the grove where the experiments were conducted, and there was comparatively little anthracnose on the old foliage. A dormant

spray causes little reduction of infection on bloom spikes and fruit under these conditions. It appears to be more practical to delay the first spraying until the bloom spikes have opened, but before individual flowers have opened.

The number of bloom applications necessary will depend largely upon the weather conditions during the blossoming period, and the uniformity with which the flower spikes open. They do not all open at the same time in the main bloom, and in some seasons, lack of uniformity of opening is more evident than in others. It may be necessary, in some seasons, to apply only two bloom sprays, while in others, three or four bloom sprays may be desirable.

The results show that 4-4-100 bordeaux is as effective as the 6-6-100 formula, and it is probable that stronger bordeaux mixtures would give no better results. The results obtained in the 1937-38 season indicate that 3-3-100 bordeaux is not strong enough to give good control.

Red cuprous oxide gave the best results of the three insoluble copper sprays tested. Sufficient tests have not been made with this spray to determine what concentration of the material is most practical to use. For the present, 3 pounds to 100 gallons of water appears to give as good control of anthracnose as 6-6-100 bordeaux mixture, and may be substituted in the spray schedule for bordeaux. Tri-basic copper sulfate 3-100 gave fairly good results in the 1938-39 season and is worthy of further trial. Copper silicate at 3 pounds to 100 gallons of water is apparently not strong enough to give good control. It is possible that better control would be obtained with this spray if its concentration were increased.

Scale counts from grapefruit, orange, and avocado trees sprayed with various copper sprays proved that scale insects increase at a faster rate after bordeaux mixture than after insoluble copper sprays. Field observations indicate that a similar situation occurs when the same sprays are used on the mango. This may be an important point for consideration in determining which fungicide should be used.

Summary

Mango anthracnose on the blossom spikes and fruit of the main bloom may be controlled to a large extent by thorough applications of copper fungicides properly timed.

Dormant sprays do not seem to be necessary in commercial groves which have been sprayed annually. The first application should be made when the bloom spikes are well opened but before the individual flowers have opened.

One or two additional bloom sprays are necessary to control blossom spike and early fruit infection, the number depending upon the weather and the uniformity of opening of the flower spikes.

Usually at least two post-bloom sprays are necessary to prevent serious late infection of the fruit.

It is not necessary to use bordeaux stronger than the 6-6-100 formula, and even 4-4-100 bordeaux seems to be strong enough.

Red cuprous oxide 3-100 may be substituted for bordeaux mixture with about equal results. Tri-basic copper sulfate 3-100 has given effective control of anthracnose in experiments of one season.



Plate 1. Stage of development of bloom spikes when first anthracnose spray should be applied.

Table 1. Mango spraying experiments, Coral Reef Nurseries.

Fungicide	No. of Sprays			1937-38				1938-39			
	Dorm.	Bloom	Post-Bloom	No. of Fruits	Free of Disease	Stained or Russetted	Decay	No. of Fruits	Free of Disease	Stained or Russetted	Decay
					%	%	%		%	%	%
Check	0	0	0	1221	37.3	50.7	12.0	523	21.7	53.3	25.0
Bordeaux 6-6-100	1	3	2	1348	88.2	9.9	1.9	621	84.4	14.2	1.4
Bordeaux 6-6-100	0	3	2	1478	87.8	9.9	2.3	676	83.4	16.1	0.5
Bordeaux 3-3-100 (Dorm. 6-6-100)	1	3	2	1278	82.6	15.3	2.1				
Bordeaux 3-3-100	0	3	2	2083	81.7	15.5	2.8				
Bordeaux 4-4-100 (Dorm. 6-6-100)	1	3	2					511	88.5	10.5	1.0
Bordeaux 4-4-100	0	3	2					729	83.4	13.7	2.9
Red cuprous oxide 2-100	1	3	2	2170	83.7	12.4	3.9				
Red cuprous oxide 2-100	0	3	2	1374	87.2	10.8	2.0				
Red cuprous oxide 3-100	1	3	2					811	86.1	12.7	1.2
Red cuprous oxide 3-100	0	3	2					578	86.5	11.2	2.3
Copper silicate 3-100 (Dorm. 6-100)	1	3	2	1527	73.8	19.4	6.8				
Copper silicate 3-100	0	3	2	1451	68.4	26.4	5.2				
Tri-basic copper sulfate 3-100	1	3	2					510	86.1	12.7	1.2
Tri-basic copper sulfate 3-100	0	3	2					598	79.1	16.6	4.3

Scale insects increase at a faster rate on trees sprayed with bordeaux mixture than on trees sprayed with red cuprous oxide or tri-basic copper sulfate.

1 Ruehle, Geo. D., and S. J. Lynch. Observations and the influence of other varieties on the yield of Haden mangos in mixed plantings. Florida Grower for July, 1939.

2 Stevens, H. E. Control of mango blossomblight and anthracnose. Proc. Florida State Hort. Soc. for 1936: 125-130.