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EXPERIMENTS FOR THE CONTROL OF FRUIT SPOTS OF THE AVOCADO

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All varieties of avocado grown commercially in Florida are more or less susceptible to infection by two common fruit-spotting fungi.

The first and probably the more important of these is a species of *Cercospora,* causing the spot usually referred to as Blotch. Blotch apparently does not cause a decay of the flesh of the fruit, but confines itself to the rind. The invaded area usually becomes cracked or fissured, thus allowing the entrance of secondary organisms which cause decay of the edible portion of the fruit. Infection of the fruits by *Cercospora* may take place very early in their development.

The second fruit spot of importance on the avocado is caused by the ubiquitous fungus, *Colletotrichum gloeosporioides.* Spots caused by this fungus are commonly called Anthracnose or Black Spot and do not appear until the fruit has well advanced toward maturity. The fungus is apparently unable to infect the unbroken skin of the avocado and only gains entrance to the edible portion through breaks in the rind or through lesions produced by other fungi. Blotch spots are the most frequent avenues of entrance for anthracnose.

Commercial practice for the control of both diseases, based largely upon the experiments of Stevens, consists in making one to several applications of bordeaux mixture to the trees after the fruit has set. The number of applications of spray is determined largely by the susceptibility of the variety to be protected and by the amount of blotch infection on the foliage. A highly susceptible variety, such as the Waldin, is usually sprayed three times for fruit spot control. The first application is made some time between May 1 and May 20, when most of the fruits are approximately one inch in diameter, and the second and third spraying may be made at four to six-week intervals thereafter.

It is usually unnecessary to spray a slightly susceptible variety, such as Collinson or Pollock, more than once, usually some time between May 15 and July 1.

Spraying with 6-6-100 or 8-8-100 bordeaux mixtures, three times during the season builds up considerable spray residue on the twigs, foliage and fruits. Such residues are harmful in that they interfere, more or less, with the photo-synthetic function of the leaves and they protect and cause an increase of certain dangerous insects, especially the scale insects. The use of weaker concentrations of bordeaux mixture or the substitution of other forms of copper in spray schedules for the control of diseases has proved to be a desirable practice on citrus crops. Spraying experiments for the control of avocado fruit spots with different concentrations of bordeaux mixture and with other

forms of copper were started in 1936 and are still in progress at the Sub-Tropical Experiment Station at Homestead. The results of some of these experiments are presented in this paper as a progress report.

METHOD OF PROCEDURE

The experiments were conducted in the vicinity of Homestead in groves which had a sufficient number of trees of the same age and variety, and approximated uniformity of vigor.

The fungicides tested included several proprietary copper sprays and bordeaux mixture which was made in the usual manner from pulverized bluestone and superfine hydrated lime. In all cases a spreader was added unless a spreading agent was already incorporated with the spray material.

The sprays were applied in a uniform manner with power machinery at 300 or more pounds pressure, and spray guns supplying a mist type of spray were used.

In most instances, all the fruits from each plot were examined at harvest time for the presence or absence of fruit spots. If a single Blotch lesion occurred on a fruit it was classed as infected. In some of the experiments, a comparison of scale build-up following the different sprays was obtained by examining the fruits and the bark of the trees for Dictyospermum scale. On the fruit, these insects usually occur either in the basin surrounding the stem or on the distal end. These are positions where spray material usually collects abundantly. On the bark, the insect prefers to gather on the branches near the base of the tree. In making examinations for scale on the bark, twenty-five fields approximately one square inch in diameter were examined in each tree with the aid of a 5x hand lens. If a single living Dictyospermum scale insect was found in a field or on a fruit, it was classed as infected.

It was found that a fairly close correlation exists between the percentages of infested fruits and the percentage of infested fields on the bark, so that for practical purposes, the fruit infestation may be taken as the scale index for a given plot. •

BORDEAUX MIXTURE VS. PROPRIETARY COPPER SPRAYS

Cuprous oxide was tested fairly extensively as a spray material for avocados and was compared with bordeaux mixture and other proprietary copper sprays. This material leaves very little visible residue on the sprayed parts. In the tests performed in 1936 and 1937, a form of cuprous oxide containing approximately 88 per cent copper expressed as metallic and used at the rate of one pound to 100 gallons was compared with a 6-6-100 bordeaux mixture, with the same spreader added in both cases. In 1938, cuprous oxide containing 49 per cent copper expressed as metallic and with a spreading agent incorporated with the copper by the manufacturer was used at the rate of two pounds to 100 gallons. In tests on the Waldin variety, the sprays were applied in May and applications were repeated in June and July. The fruits were harvested during September and October.

The results obtained for the control of fruit spots and the effects of the treatments on the

increase of Dictyospermum scale are shown in TABLE 1.

The results show that cuprous oxide will give as reliable control of fruit spots as bordeaux mixture with considerably less increase in Dictyospermum scale. The combination of wettable sulfur and bordeaux mixture in the 1938 tests increased scale less than the plain bordeaux but the reduction was probably insufficient to justify the added expense of adding the sulfur. However, red spiders were well controlled in the plot sprayed with the bordeaux-wettable sulfur combination spray, but became abundant in the other plots.

An experiment was carried out in 1938 on Linda avocados to compare tri-basic copper sulfate with bordeaux mixture for the control of fruit spots and to compare build-up of Dictyospermum scale following their use. The tri-basic copper sulfate was combined with wettable sulfur in one treatment and with a liquid spreader in another. The sprays were applied in May and applications were repeated in June and July. The results are recorded in TABLE 2.

TABLE 1

Control of fruit spots on Waldin avocado with bordeaux mixture and cuprous oxide and the effect of these sprays on Dictyospermum scale

SPRAY SCHEDULES			Percentage of fruits free of fruit spots	Percentage of fruits infested with Dictyospermum scale	Percentage of fields on the bark infested with Dictyospermum scale
Year	Materials and Concentrations	Dates			
1936	Control		25.0	....	....
	Bordeaux 6-6-100, non-casein colloidal spreader	May 15, June 24, July 22	96.4	....	....
	Cuprous oxide (88%) 1-100, non-casein colloidal spreader	May 15, June 24, July 22	96.2	....	....
1937	Control		18.5	4.0	22
	Bordeaux 6-6-100, non-casein colloidal spreader	May 11, June 17, July 19	97.0	63.0	74
	Cuprous oxide (88%) 1-100, non-casein colloidal spreader	May 11, June 17, July 19	96.3	32.2	33
1938	Control		13.4	11.0	26
	Bordeaux 4-4-100, non-casein colloidal spreader	May 11, June 14, July 19	98.2	56.0	69
	Bordeaux 4-4-100, wettable sulfur 10-100	May 11, June 14. July 19	98.0	54.0	59
	Cuprous oxide (49%) 2-100	May 11, June 14, July 19	98.0	34.0	51

TABLE 2

Control of fruit spots on Linda avocado with bordeaux mixture, tri-basic copper sulfate and tri-basic copper sulfate plus wettable sulfur, and the effect of these sprays on scale infestation

SPRAY SCHEDULES		Percent of fruits free of fruit spots	Percent of fruits infested with Dictyospermum scale
Materials and concentrations	Dates applied (1938)		
Control		none	11.7
6-6-100 bordeaux mixture, liquid spreader	May 9	93.2	53.1
6-6-100 bordeaux mixture, liquid spreader	June 15		
6-6-100 bordeaux mixture, liquid spreader	July 18		
3-100 tri-basic copper sulfate, liquid spreader	May 9	94.1	32.2
3-100 tri-basic copper sulfate, liquid spreader	June 15		
3-100 tri-basic copper sulfate, liquid spreader	July 18		
3-100 tri-basic copper sulfate, wettable sulfur 6-100	May 9	94.6	30.1
3-100 tri-basic copper sulfate, wettable sulfur 6-100	June 15		
3-100 tri-basic copper sulfate, wettable sulfur 6-100	July 18		

Fruit harvested December 7 and 8, 1938.

The results show that the tri-basic copper sulfate at three pounds to 100 gallons combined with a liquid spreader or with wettable sulfur will give as effective control of fruit spots as 6-6-100 bordeaux mixture. Scale build-up was greater following bordeaux mixture than tri-basic copper sulfate. The addition of wettable sulfur to the latter had little effect in reducing scale infestation on the fruit, but was effective for the control of red spiders.

An experiment for the control of fruit spots on the Taylor avocado was carried out in 1938 in a commercial grove. Cuprous oxide and tri-basic copper sulfate, and bordeaux mixture at different concentrations and with different spreaders were compared. The foliage of the trees was severely infected by *Cercospora.* The sprays were applied on May 14 and reepated on June 17. The fruit was harvested in January, 1939. All of the fruits that were harvested from several trees in each plot were examined just after they were picked. It is probable that the tops of the trees, which were very tall, were incompletely covered by the sprays, because fruits harvested from the tree tops were noticeably more severely infected than fruits which developed close to the ground. The results are recorded in TABLE 3.

The results again show that cuprous oxide and tri-basic copper sulfate can be relied upon to give about as effective cotnrol of fruit spots as bordeaux mixture. The 8-8-100 bordeaux gave slightly better control of infection than the 6-6-100 formula but this may have been due in part to the different spreader used. In view of the severely infected condition of the foliage, a third spraying in July should have proven desirable in this grove.

An experiment to compare 6-6-100 bordeaux mixture with weaker concentrations of this fungicide was carried out on the moderately susceptible Trapp variety at the Experiment Station in 1938. The sprays were applied in May and applications were repeated in June and July. The fruit was harvested over the period from August 29 to October 11. The results are shown in TABLE 4.

TABLE 3

Control of fruit spots on the Taylor avocado with various copper fungicides in 1938

SPRAY SCHEDULE: Materials and concentrations	SPRAY SCHEDULE: Applied May 14 and June 17, '38	Number of fruits examined	Percent of fruits free of fruit spots
Control		177	1.1
3-100 cuprous oxide (49%)		420	66.2
6-6-100 bordeaux mixture, liquid spreader A		389	68.9
6-6-100 bordeaux mixture, liquid spreader B		517	61.3
3-100 tri-basic copper sulfate, liquid spreader B		546	66.5
8-8-100 bordeaux mixture, dry colloidal spreader		244	75.0

Fruit harvested January 5, 1939

TABLE 4

Control of fruit spots on Trapp avocado in 1938 with different concentrations of bordeaux mixture

SPRAY SCHEDULE (Materials applied May 9, June 14, and July 18)	Percentage of fruits free of fruit spots
Control	38.4
6-6-100 bordeaux mixture	95.9
4-4-100 bordeaux mixture	97.4
3-3-100 bordeaux mixture	97.9

Fruit harvested August 29 to October 11

The results show that on the Trapp variety, the weaker concentrations of bordeaux mixture may give as good control of fruit spots as the 6-6-100 formula. It may be noted in TABLE 1 that 4-4-100 bordeaux mixture gave nearly absolute control on the highly susceptible Waldin variety in 1938. On the Trapps, build-up of Dictyospermum scale was less following the weaker bordeaux than following the 6-6-100 formula, but the difference was not great.

CONCLUSIONS

Cuprous oxide and tri-basic copper sulfate will give effective control of fruit spots of the avocado when substituted for bordeaux mixture in the spray schedule. Other commercially prepared neutral copper spray materials possessing good fungicidal properties will very probably give similar results. None of these materials requires the use of lime for neutralization. The advantage of such products in the saving of time and labor in preparation and the gain in uniformity and stability of the spray mixture is evident. Such sprays deposit less residue and promote scale increase less than

bordeaux mixture.

On varieties moderately susceptible to fruit spot infection and on highly susceptible varieties where the foliage has been kept practically free of *Cercospora* infection by effective spraying, the control of fruit spots may be accomplished by the substitution of 4-4-100 bordeaux mixture for the 6-6-100 formula in the spray schedule.

The addition of wettable sulfur to the copper sprays does not effectively suppress infestations of Dictyospermum scale but appears to be valuable for the control of red spiders.

The success of the spray schedules for the control of fruit spots will be proportional to the thoroughness with which the sprays are applied. Good coverage is absolutely essential for good control.

Fruit spots are more difficult to control in trees that are lacking in vigor from one cause or another. Adequately furnishing the moisture and nutritional requirements of the avocado is an aid for control of fruit spots.