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ZINC TREATMENT OF PECAN ROSETTE

BY
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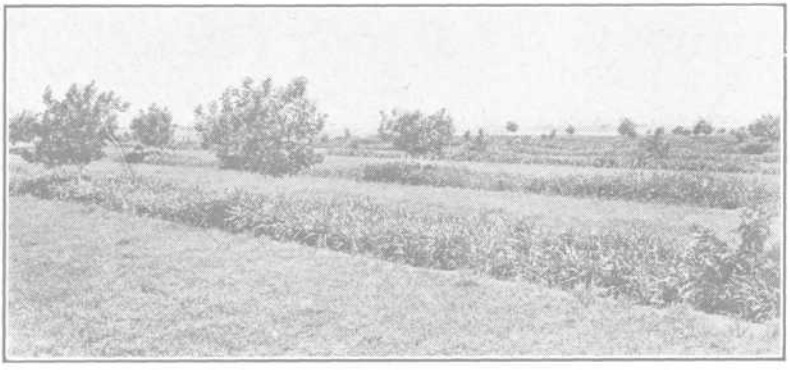

An 8-year-old pecan grove in the South Gila Valley. The small size and general lack of uniformity of the trees are largely the result of rosette.

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Pecan trees in some districts of Arizona are commonly affected by a disease known as rosette. The first symptoms of this are usually a slight yellowing or chlorosis of the newer top-most leaves. Affected leaves and leaflets generally remain small, de-

Photo by Fred Draper

Fig. 1. Characteristic rosette symptoms. A young tree in the Safford Valley.

velop prominent veins, are frequently misshapen, crinkled and brittle. Later in the summer, leaves so affected may turn brown or "burn" and fall from the tree. The new top-most shoots may die and in some cases the older wood is also included. Below

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this, relatively healthy growth often arises giving a cluster or "rosette" of branches which later become affected. Because of the various symptoms displayed by diseased trees, the disease is commonly referred to also as "burning," "die-back," and "frizzles," (Fig. 1).

Pecan rosette was one of the first serious troubles to develop with the commercial planting of pecans in the South. It was recognized as early as 1900 and according to Demaree investigations were initiated in 1902 by the United States Department of Agriculture workers in southern Georgia. The disease occurs throughout the older pecan districts from Texas to the Atlantic coast. In Arizona rosette seems to have been first reported from Sacaton in 1911, indicating that it has been present here for more than twenty years. Because of it, pecan plantings have been abandoned in the Santa Cruz, Casa Grande and other valleys of southern Arizona and pecan culture has been discouraged in the Safford and Salt River Valleys. In the Gila Valley from Florence to the Colorado River, rosette has been especially severe. Trees in the Yuma Valley have generally been free of rosette although some, particularly along the eastern side of the valley, have been rather severely affected. Rosette occurs in some plantings in California and New Mexico.

Studies of pecan rosette were initiated by the Arizona Experiment Station in the fall of 1931. From these, it was learned that the disease yielded to treatment with zinc. This was indicated in the annual report of the Arizona Agricultural Experiment Station for the year ending June 30, 1932, pp. 96-97, and discussed more completely in subsequent papers.[1, 2] Similar findings were reported more or less simultaneously by Alben et al[3, 4] in Louisiana, and Demaree[5] in Georgia. That a similar disease of other fruit trees might be susceptible to treatment with zinc was reported by California workers in December of 1931.[6] This paper was published in the early spring of 1932 but did not come to our attention until September of that year (correspondence with W. H. Chandler, Sept. 2, 1932).

The various data suggest that pecan rosette is a zinc deficiency disease—that the tree rosettes because there is not sufficient zinc available for its healthy growth. Such an interpretation of the

[1] Finch, A. H. Pecan rosette, a physiological disease apparently susceptible to treatment with zinc. Proc. Amer. Soc. for Hort. Sci. 29:264-66. 1932.

[2] Finch, A. H. and Kinnison, A. F. Pecan rosette: soil, chemical and physiological studies. Ariz Agr Exp. Sta. Tech. Bul. No. 47. 1933.

[3] Alben, A. O., Cole, F. R., and Lewis, R. D. New developments in treating pecan rosette. Proc. Nat'l. Pecan Asso. 1932.

[4] Alben, A. O., Cole, F. R., and Lewis, R. D. New developments in treating pecan rosette with chemicals. Phytopathology 22:979-81. 1932.

[5] Demaree, J. B. Progress of pecan rosette control. Proc. Georgia-Florida Pecan Growers Asso. 27:38-45. 1933.

[6] Chandler, W. H., Hoagland, D. R., and Hibbard, P. S. Little leaf or rosette in fruit trees. Proc. Amer. Soc. for Hort Sci. 28:556-60. 1931.

role of zinc is not yet beyond question, but furnishes a satisfactory working hypothesis.

There are two ways in which a zinc deficiency may be brought about, (1) by an insufficient amount of zinc in the soil and irrigation water and, (2) by conditions which make zinc, though present in the soil or irrigation water, unavailable to the tree, especially to the top-most parts. It is not known whether the occurrence of rosette in Arizona is because of a complete absence of zinc, or of a lack of its availability in the soil or growing parts of the tree. Supplying soluble zinc is probably an effective treatment in either case for it has consistently brought about improvement of affected trees. If zinc is present but unavailable in Arizona soils, then cultural methods making it available may in time be worked out. Zinc occurrence and factors governing its availability constitute an important and necessary field of investigation.

Zinc may be applied to pecan trees in three ways: (1) application of a soluble salt to the soil or irrigation water, (2) placing the dry chemical in holes bored into the tree trunk, or injection of a zinc solution into the trunk, and (3) spraying the foliage with a zinc solution. For all of these the most satisfactory form to use is the commercial zinc sulfate, a white flaky material soluble in water. This form, having the formula $Zn\ SO_4.\ 5H_2O$, has given good results. The cost has been approximately four cents per pound in 350 lb. barrels. Other forms having more or less water of crystallization are available and should give equally satisfactory results.

SOIL APPLICATIONS

In experimental work previously reported, soil applications were not tried. When the investigations of rosette were started, it was not known that the disease was related to a mineral deficiency but this was suspected. To test effectively for a mineral deficiency it was thought best to use many different chemicals and to apply them, not to the soil where they might become fixed and unavailable to the tree or where any response of the tree to them might be slow and indefinite, but rather to apply them directly to the above-ground parts where the response would be at once apparent. Accordingly, many different chemicals were placed in holes bored into the tree trunks and leaves were dipped into or sprayed with many different solutions.

When it was learned that rosette yielded to zinc, experiments on its control by the application of zinc to the soil were initiated. These have progressed for one season in various parts of the State and with trees of different ages and sizes. The results indicate that rosette may be effectively treated by applications of zinc sulfate to the soil.

This treatment has been most effective when the zinc sulfate is concentrated in a small area near the tree rather than broadcast over a large area. Placing the material in a circular trench one to

two feet away from the tree and 6 inches deep has given good results (Fig 2). Applications from December to May have been satis-

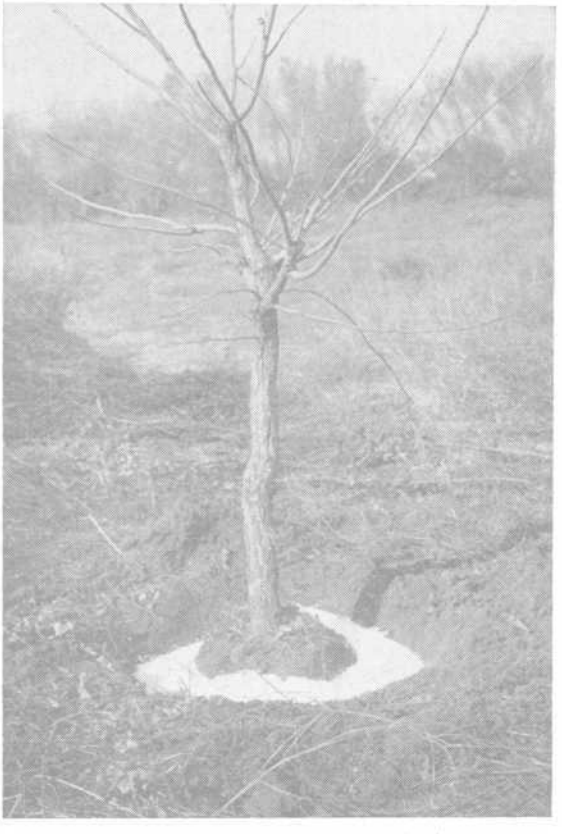

Fig. 2. Soil application of zinc sulfate for rosette control. Zinc applied in this way has given uniformly good results in the alkaline soils of Arizona. Thus far there has been no case of injury to pecan trees from toxic action of the zinc sulfate.

factory. Later treatments were not always effective in time to overcome the disease in early summer. The amount required was found to vary considerably in different localities and is perhaps related to the growth-condition, size, and age of the tree, to soil moisture, texture and zinc fixing-power and probably to other factors as yet unknown. Some experimentation on the part of each grower will be necessary to determine the best amount for him to apply. A suggested amount for trees of a given diameter is shown in the accompanying table. Results thus far indicate that zinc sulfate is not highly toxic to pecan trees growing in the alkaline soils of Arizona, and will probably not harm the tree

unless applied considerably in excess of the amount suggested in the table. On the other hand, if too little is applied and a complete cure is not effected a second application can be made. In making treatments apply the smaller amount first.

The soil application can be made without respect to irrigation schedule, but the soil surrounding the zinc sulfate must be moistened in at least a part of the irrigations that follow to make it available to the roots.

In comparison with other methods of treatment, the soil application is most expensive because of the cost of the material. The amount of labor involved is largely dependent on the character of the soil. If the soil is mellow it is easier to dig the trench than to bore holes into the tree trunk. This method has the advantage that no injury is done to the trunk. Trees treated in the winter and spring have remained healthy through one growing season. How much longer they will continue to do so is unknown. The soil treatment has a further possible advantage in that after several applications have been made the zinc content of the soil may increase and the zinc fixing-power be satisfied to the extent that future applications may be less frequently required.

SUGGESTED AMOUNTS OF ZINC SULFATE AND APPROXIMATE COST FOR SOIL AND TRUNK APPLICATIONS.

Diameter of trunk. Inches.	Soil treatment. Zinc sulfate Pounds.	Trunk treatment. Holes.			Approximate cost. Cents per tree for zinc sulfate.	
		No.	Diam. Inches.	Depth. Inches.	Soil application.	Trunk application*
1	1–3	...	....	.....	4–12	....
2	5–10	2	⅜	1½	20–40	.4
3	5–10	2	½	2½	20–40	.4
4	5–10	3	½	3½	20–40	.6
5	10–15	3	½	3½	40–60	.6
6	10–15	4	½	3½	40–60	.8
8	10–15	4	½	3½	40–60	.8
10	10–15	5	½	3½	40–60	1.0

*The estimated cost per tree for trunk treatment is based on the price of commercial zinc sulfate obtained in large quantities. When the purer form carried by drug stores is purchased in pound lots the cost will be six to twelve times greater. Corks cost somewhat less than one cent each.

TRUNK APPLICATIONS

In this method holes are bored in the tree trunk using an ordinary carpenter's bit. The hole is filled firmly with zinc sulfate crystals and stoppered tightly with a cork. The commercial zinc sulfate can be used satisfactorily as taken from the barrel but grinding is helpful. The product carried by drug stores is finely ground and packs into the hole readily.

The holes should be at least 6 inches and preferably 12 inches apart up and down the trunk. When only two holes are used they should be bored at right angles to each other. When more than two are used the circumference of the tree is divided equally between them. The reasons for spacing the holes are, (1) it provides for a more even distribution of the zinc to the upper parts of the tree, and (2) there is some injury to the bark around the holes. If the holes are well spaced a girdling effect is avoided.

Some trees treated by the trunk method during the winter and pruned at the same time to correct misshapeness died before the following spring. It therefore seems safer to make the treatment after the trees have leafed out. There has seemed to be less injury to the bark around the hole when the treatment was made in the spring rather than in mid-summer. Placing the zinc sulfate in the hole in a way that it will not touch the inner bark helps to reduce this injury. There has been no serious burning of the foliage from zinc treatments during two seasons of experimentation.

For applying the zinc sulfate, the writers have found the following to be satisfactory: A small piece of tin, fashioned trough-like with one end small enough to fit into the hole across the bark, is used. This is filled by dipping it into a container of zinc sulfate. It is then inserted into the hole and the contents pushed and packed in by use of a stick having a diameter somewhat less than the hole and a length of 6 inches or so. The hole is almost filled allowing only space for the cork which is pressed tightly in place. A No. 5 cork fits a ½-inch hole, and a No. 2 cork fits a ⅜-inch hole. The material is absorbed from the hole in two or three days.

A special "gun" for placing the zinc sulfate in the trunk could probably be devised as has been done for the similar use of iron salts. This might not be worthwhile unless there are a great many trees to be treated. Also, it has been found best to put as much zinc sulfate as possible in each hole thereby reducing the number of holes bored into the tree. Any mechanical device to place zinc sulfate in the holes must pack it tightly. None has been tried by the writers.

The amount of zinc sulfate required for treatment can be roughly estimated by calculating that one pound will fill fifty holes. This amount can be purchased at a drug store for from twenty-five to fifty cents. Experience indicates that if the number of holes suggested in the accompanying table are used and well filled with the material, generally satisfactory improvement will result. An excess of the zinc sulfate in the trunk can cause burning and death of leaves and even of branches. If too little is placed in the trunk the resulting improvement will not be so complete or lasting. In such cases a second treatment has been effective. This is done by boring new holes. Refilling old holes is usually not satisfactory.

No serious results from the trunk treatment have yet been observed. However, some bark dies above and below and, to a

less extent, on each side of the hole. This provides a point of entry for boring insects. There is also danger of wood-rotting fungi entering although this is probably not great under the arid conditions of Arizona. It might be serious in more humid districts. Also, the hole itself weakens the tree. There is usually some leakage which stains the trunk below the hole. For these reasons, the soil treatment is preferred to the trunk treatment even though the trunk method is less expensive and produces a quicker response.

A question is always raised as to the length of time that the trunk treatment will remain effective. In the spring of 1932 trees in the South Gila Valley were given treatments comparable in amount of zinc applied to that suggested in the table. They became healthy at once and remained so without further treatment throughout 1933. How much longer they will continue healthy without retreatment is unknown. Trees given small amounts of zinc in the trunk have been made healthy for only a few months. As is the case with soil treatments, the effectiveness of any stated amount of zinc in the trunk will be found to vary. It seems to be particularly influenced by the growth condition of the tree. In trees having some poorly growing branches it has been necessary to treat these limbs themselves as well as the trunk.

During experimentation, in which the effect of a number of different chemicals on rosetted trees was being tested, the injection of solutions into the tree trunk was used. Trees having a trunk diameter of 3 to 4 inches became healthy after being injected with one pint of a 1 per cent solution of zinc chloride. Because of the practical disadvantages of this treatment no efforts have been made to develop it into a commercial practice.

SPRAYING

In experimental work already referred to, the spraying of affected leaves was used as a method of applying various chemicals in an effort to find one that would effect a cure of diseased parts. Solutions of zinc sulfate and of zinc chloride accomplished this.

However, spraying for commercial control of rosette in Arizona has certain obviously practical disadvantages. Because of these, no field experiments with spraying have been undertaken. In the first place, there are no insects or diseases in Arizona to necessitate a spray program for pecan orchards. To apply zinc by spraying would involve the purchase of expensive equipment, and the spraying of trees for the single purpose of controlling rosette. Secondly, a spray is only effective to the tissue which it touches, and only young tissue is satisfactorily improved. Leaves must be sprayed while young. To accomplish this in Arizona, where new growth is produced for a considerable part of a long growing season, three or possibly four spraying applications would likely be necessary. This would be quite expensive and

difficult to carry out. By comparison, the soil treatment is simple, does not call for frequent repetitions and is not unduly expensive.

In the southern pecan districts where spraying for insect and disease control is a necessary part of orchard management, some form of zinc can be included in the regular sprays and will surely become an economical and important part of a rosette control program.

In Arizona, spraying of nursery trees, which may be done with an inexpensive hand sprayer, may have some use. For this a solution of zinc sulfate, one pound to 50 gallons of water, is suggested. This has been quite satisfactory without a spreader, but a small amount of liquid glue, skim milk or commercial spreader may be added. The spray application should be so timed as to keep the young growth covered as it unfolds.

LIMITATIONS OF ZINC TREATMENT

With the striking results obtained from the use of zinc in treating rosetted trees, there has been some tendency on the part of growers and others to look upon it as a cure for many troubles. Zinc has been applied by various growers to overcome such conditions as: dropping of young nuts, pre-harvest germination and failure of nuts to ripen and fill, winter injury to the trees and other problems.

The use of zinc will be found helpful only in overcoming rosette. It will provide for health in the tree in so far as removing these symptoms are concerned. To that extent it will improve fruiting. However, problems of blossoming and setting, sizing, filling and maturing of the nuts may be encountered with trees that are completely free of rosette symptoms and to which the addition of zinc has had no observed effect.

SOME ECONOMIC ASPECTS OF ROSETTE CONTROL

It is yet too soon to conclude that pecans can be satisfactorily grown in districts where rosette has been serious. However the uniformly excellent response of trees in these districts to both soil and trunk treatments affords hope. It is also possible that after several soil applications have been made and the zinc content of the soil increased, fewer treatments will be necessary. Furthermore, new information will develop which may enhance the effectiveness of the treatment. The addition of materials, as gypsum, sulfur, or iron sulfate, or the devising of cultural methods, to make zinc more available in the soil may come to play an important role in rosette control.

To pecan growers in particular and to the people of Arizona in general, the question arises at once: "What effect will rosette control have upon the economics of the pecan industry?" It is impossible to foresee the answer to this question but two aspects at once present themselves for consideration.

1. *Will pecan production in the South increase?* As is well known, rosette occurs commonly throughout the southern pecan

districts. To whatever extent it is accountable for low yields, production may be increased. However, the yields from trees made healthy by treating with zinc will likely be no greater than is now the case for non-rosetted trees. To greatly increase production and quality of nuts in the South it will be necessary to remove insect and fungus—disease depredations and to find a practical solution for the problems of blossoming, setting, sizing and filling of nuts. These latter must be accomplished in the face of generally poor soil and growing conditions and a variable soil moisture content as provided only by rainfall.

2. *Extension of pecan producing areas in Arizona.* In comparison with the South, Arizona has only negligible losses from insects and fungus diseases. A winter injury problem of young trees is serious in some districts. Problems of fruiting are present and must be solved. However, in Arizona growing conditions are favorable and because of irrigation a desirable soil moisture content can be maintained. Removing rosette, which has been the chief obstacle to pecan growing, would seem to make possible the development of a very important industry in the Salt River, Safford, Casa Grande, Santa Cruz and other valleys of southern Arizona. These valleys have other conditions favorable for successful growing of pecans which are probably not excelled anywhere.

In the development of such an industry it must be recognized that, with the accomplishment of rosette control in the South and with general improvements in orchard management there, some increase in pecan production will occur. It is probably equally true that, because of variable soil moisture and generally poorer growing conditions—factors beyond control of the grower, the South cannot consistently produce large yields of high quality nuts, as is possible in the Southwest. This then is Arizona's opportunity! Arizona must attain economical production of high quality nuts. Only a few varieties having the best quality should be grown.

SUMMARY OF PRESENT RECOMMENDATIONS FOR ROSETTE CONTROL

1. During January or February, all dead and misshapen parts of rosetted trees should be pruned out. In young trees efforts should be made to build a central leader.
2. Zinc sulfate should be applied to the soil any time from January to May. Trunk treatments should be made preferably during May and early June. Zinc sulfate should be applied in not more than the smallest amounts suggested herein to start with. More or less may be used as indicated by experimentation to be best suited for the particular conditions in question. Proceed cautiously, zinc sulfate is a toxic material and can cause injury.
3. Zinc treatment is not to be considered as a perfected practice. Much remains to be learned.