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PRELIMINARY REPORT  
OF  
OBSERVATIONS ON THE "CROWN-KNOT,"  
BY  
JAMES W. TOUMEY,  
BOTANIST AND ENTOMOLOGIST.

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Tucson, Arizona, June 30, 1894.

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President, University of Arizona,  
Tucson, Arizona.



## PRELIMINARY REPORT

—OF—

### OBSERVATIONS ON THE "CROWN KNOT."

BY J. W. TOUMEY.

*SYNOPSIS: "Crown-Knot," a serious drawback to fruit culture in the Southwest; its physical character and anatomical structure; discussion of the causes producing it. Can it be prevented? Best means to counteract its injuries.*

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#### FRUIT REGIONS OF ARIZONA.

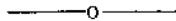
**T**HE fruit regions of Arizona, so far as the best conditions for culture are concerned, are not confined to any single portion of the Territory. The question of irrigation is the only one which limits the possibilities in this direction. In all localities where water for purposes of irrigation can be provided, various fruits may be grown, the kinds and varieties depending, of course, upon elevation and other natural physical agencies which may affect the climatic conditions.

With irrigation in Arizona almost in its infancy, the fruit industry is now confined to regions where successful irrigation enterprises have been the direct means of bringing more or less extended areas under cultivation. In all such districts, during the past few years, thousands of acres have been planted to fruit trees. Many orchards will this year bear for the first time, and for the next several years each season will more than double the acreage of fruit-bearing trees. At present, by far the greater percentage of these orchards is too young to bear, the trees being only one, two or three years old.

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This Bulletin, although adopted by the present Council, as No. 1, of Series II, of the Arizona Experiment Station publications, was prepared by its author and made practically ready for the printer, under the former administration of the Station.

In the valleys of the Salt and Gila rivers it is not unusual to see twenty to forty acres in a single orchard, planted to a single variety of fruit, with trees all of the same age. In regions where the fruit industry has reached such magnitude and where it is so rapidly increasing, it is of vital importance not only to the orchardist but to other citizens as well, that the orchards which are soon to become one of the chief sources of wealth, shall be kept in as thrifty and healthy condition as possible. Fungus diseases and insect depredations should not be overlooked. They may appear harmless at first, but in the end, when once established, may be of great injury or even totally destroy the orchards. At the first indication of injury it is greatly to our interest to make a careful investigation and endeavor to find some means of counteracting it. The purpose of this bulletin, however, is not to discuss fungus diseases or insect depredations, but to describe a peculiar "knot" which occasionally appears on the roots of nearly all our deciduous fruit trees, and which is, without question, THE MOST SERIOUS DRAWBACK TO FRUIT CULTURE IN THE SOUTHWEST.



### THE "CROWN-KNOT."

**A**LTHOUGH this knot is known here under a number of names viz: "black-knot," "root-knot," and "root-bunch," I follow Professor C. W. Woodworth\* in using the name "crown-knot" to designate the disease, if such it may be called. This name more nearly describes the knot in question; for, although it may come on any portion of the roots, or even a foot or two above the ground on the stem or trunk, it nearly always makes its appearance at the crown, i. e., just at or below the surface of the soil.

Although it has been known for many years and in various portions of the United States, this knot has produced serious injury, so far as I can learn, only to the fruit industry o

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\* Bulletin No. 93, California Agricultural Experiment Station.

the Southwest. With us, it is coming to be a disease of serious consideration. It is not confined to any one or two species of trees, but it affects peach, apricot, almond, pear, apple, and even the vine is not wholly exempt. Although infesting nearly all our deciduous fruits, it is most destructive to the peach, almond and apricot. The peach root is the most subject to it of all.

During the past year more inquiries have come to this department of the Station in regard to Crown-Knot than upon all other subjects combined. The prevalence of this complaint and its serious effect upon our fruit industry prompted the Arizona Experiment Station to investigate many of the orchards in the most extensive fruit regions in the Territory. Plantations were examined in the vicinity of Phoenix, Tempe and Mesa. In each of these places trees were found affected with Crown-Knot.

On February 20th, the writer visited Phoenix, and with Mr. J. E. Bettler, the County Horticultural Inspector, spent several days examining orchards in that vicinity. At that season the trees were dormant, but even in this state, those badly affected showed their diseased condition in the dark, dull and withered appearance of the twigs and buds, also in the thickening of the ends of the younger branches.

On April 3rd to 7th inclusive, Mr. Bettler and the writer again visited the fruit regions of the valleys of the Salt and Gila rivers. The investigations made at this time were more comprehensive than those made nearly two months before. In these I was greatly assisted by the County Horticultural Inspector, as before, to whom we are indebted for much information in regard to this knot. The largest and oldest orchards at Phoenix, Tempe and Mesa were examined for evidence of the disease.

In the peach and allied trees when thus attacked, the gum exudes in large quantities, and, although thin and watery at first, it soon assumes a granulated condition covering considerable portions of the trunk and larger limbs. A tree badly af-

ected can be readily distinguished from a healthy tree, even before the leaves appear. When the diseased trees have been once pointed out, the careful observer will have no difficulty in recognizing the distinction. When but slightly affected, or when the knots are on the deeper roots, so far as appearance goes, they are as thrifty as healthy trees. When the knot appears at the crown, it is not infrequently two or three times the diameter of the tree. In all such cases its physical effect seems to be TO SHUT OFF THE CIRCULATION OF THE SAP TO THE PARTS DIRECTLY ABOVE, AND AS A RESULT, AS SOON AS THE KNOT SURROUNDS THE TRUNK, THE TREE DIES.

Observations have been made on a great many trees having one side or a limb dead or dying. On cutting into the bark on the corresponding side, it was invariably found to be blackened and more or less dry from the ground sometimes to the uppermost limbs. On digging at the roots, large knots were found on the corresponding side. When the knots appear on the smaller and deeper roots, they may be present in great numbers and still the tree show but little evidence of disease; the remaining roots providing sufficient nourishment for the portion of the plant which is above ground. At the time of the last examination, it was observed that many of the badly diseased trees, examined in February, had bloomed profusely, put forth leaves and died later. The rapidly growing knots had checked the flow of sap to such an extent that the growth begun could not be sustained. The tree seldom dies from this cause until the knot nearly or completely surrounds the trunk. Not infrequently badly diseased trees live for several years, but in such cases THEY SELDOM BEAR, ARE WORSE THAN NOTHING AND HAD BETTER BE REMOVED.

Trees of all ages are subject to this knot, but it is much more destructive to young trees. One or two knots coming at the crown of a tree only a year or two old will kill it in time, as they usually develop sufficiently to entirely cut off the circulation. It is very important THAT ALL TREES SHOWING INDICATIONS OF CROWN-KNOT BE REJECTED WHEN SETTING OUT ORCHARDS. UNDER NO CONSIDERATION SHOULD ONE PLANT A TREE

SHOWING KNOTS ON THE ROOTS. IF THIS BE DONE, THE PROBABILITY IS THAT IT WILL DIE BEFORE IT IS OF SUFFICIENT AGE TO BEAR, AND ONE WILL HAVE LABOR AND EXPENSE FOR NOTHING.

It is impossible to give too much care and attention to the selection of trees. Not only would I advise the rejection of all trees showing the knot or any indications of it, but I would not purchase trees at a nursery where a large percentage is diseased. Knots have been observed on young peach seedlings, only two or three weeks from the pit and but five or six inches high; however, this is not frequent. They develop in the greatest number and most rapidly when the tree is from one to three years old. Orchards were visited where at least ten per cent. of the trees died during the past season from this cause, and from all appearances fully as many more will die during the coming season. This is a great loss, and if the knot can in any way be checked, or its growth retarded, even if it cannot be entirely overcome, it means a saving of many thousands of dollars to the fruit growers of this Territory.

The knot usually develops rapidly, and in its growing condition is softer and contains much more sap than the woody trunk. It is of the consistency of a turnip or potato, and when cut open is nearly as white. The exterior is roughened, brownish; and in the peach, apricot, and allied trees there are small openings through which gum exudes in large quantities, sometimes to such an extent as to saturate the ground to a distance of two or three inches from the knot. As a result of this, the soil on drying, is frequently in hard clods immediately surrounding the diseased portion of the plant. In its growing condition, when broken open and exposed to the air, it becomes darker, assuming a color approaching that of the exterior. When dried it is considerably harder, and nearly as light as cork.

In a microscopical examination of the growing knot, no regular, uniform structure was discernible. It is mostly composed of large, irregular parenchyma tissue, with now and then the rudiments of a fibro-vascular bundle scattered through

it. After a rather indefinite period of growth, the knot apparently loses its vitality, turns brown throughout and gradually decays. The process of decay seems to be a kind of "dry rot." The knot retains its original form, but may be broken from the tree by the hand and crumbled in the fingers like dry bread.

WHEN THE KNOT REACHES THIS STATE, THE TREE HAS PASSED ITS USEFULNESS, AND HAD BETTER BE DESTROYED.

Although Crown-Knot is the direct or indirect cause of the death of more of our young fruit trees than all other causes combined, I do not wish to give the impression that the death of all trees can be assigned to this. Many die from improper methods of irrigation and cultivation, and from improper planting.

On our heavy, irrigated soil I do not think it advisable to plant trees deeper than they originally were in the nursery. This applies more especially to the peach and other trees budded two to four inches above the ground.

Most trees are planted before the wound, caused by the pruning of the tree above the bud, is entirely healed. The wound comes in contact with the moist earth, and there is a tendency for decay to begin at this point. If from this or some other cause decay does begin, a specie of white ant (*Termes flavipes*, K.) is very sure to get in and destroy the tree. These small insects were found working in the roots of fully seventy-five per cent. of the trees examined which showed any indications of decay. Healthy, vigorously growing trees are seldom troubled by these pests. When the knot begins to decay, it is an inviting place for white ants, and not infrequently they hasten the death of the tree.

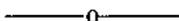
Although many theories have been propounded as to the cause of this knot, as yet, NO ONE HAS BEEN ABLE TO DEMONSTRATE A CAUSE WHICH DOES MEET WITH SERIOUS OBJECTION.

It is pretty definitely settled that it is neither a result of insect depredations or of fungus growth. As it is much more

prevalent in the Southwest than in other portions of the country, the most popular idea is, that the knots are caused by conditions of soil or climate. In microscopical examinations of these knots, in various conditions of growth, no evidence could be found of worms or insects; neither were there any indications of a fungus. Knots which are dead or beginning to dry or turn brown, frequently show fungus growth, but I have repeatedly failed to find any indications of such in the growing knot. Strong alkaline soil is maintained by many to be the cause of their development. Whether this can be assigned as a cause, we are unable to say. It is a known fact that nearly all the soil of the Southwest, and more especially irrigated soil, is more or less charged with alkali. In many places the quantity is so small that it has no apparent effect upon plant growth, but in other localities it is so charged with salts that nothing will grow but a few native shrubs and grasses. Between these two extremes we have all gradations as far as quantity of alkali is concerned. Although all our soils are more or less alkaline, it has by no means been proven that this is the cause of Crown-Knot. In these observations, although usually the knots are most numerous and destructive on trees growing in such soil, as badly diseased orchards as I have ever seen are on light, sandy soil, comparatively free from alkali. In other orchards visited, in the low places where the water was allowed to stand sometimes for a day or two at a time, the alkali came to the surface in greater quantities, and invariably the trees were injured with Crown-Knot. Whether this salt is the cause, or whether it is the lack of proper irrigation, or neither, has not yet been determined. Experience and observation have demonstrated that proper irrigation and cultivation have much to do in retarding its development.

THE TENDENCY OF MANY OF OUR INEXPERIENCED ORCHARDISTS IS TO IRRIGATE TOO FREQUENTLY AND TOO MUCH AT TIMES WHEN WATER IS PLENTIFUL, AND TO ENDEAVOR TO MAKE THIS TAKE THE PLACE OF CULTIVATION. This is a practice very destructive to the growth of all kinds of fruit trees, especially in heavy soils; for the tendency is after each irrigation for the soil to sun-bake, and thus pre-

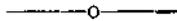
vent a free circulation of air through it. It should be thoroughly cultivated as soon as dry enough to permit. The hardened soil dries out rapidly, and as a result growth is retarded and the trees are more or less permanently injured. On the other hand, by a thorough cultivation with less water, the soil is kept loose, friable and in condition, under continued cultivation, to hold much of its capillary water for months. It would seem from our experience that the sudden retarding of growth, brought about by improper irrigation and cultivation, may have something to do with the growth of Crown-Knot, at least after it is once started. Orchards under proper irrigation and cultivation are most usually free from this disease, while others growing side by side, on apparently the same kind of soil, but neglected, are badly diseased.



#### CORRECTIVE MEASURES.

**A**T present the following remedies and preventatives are offered. They are mostly founded upon personal observation, and upon the experience of those who have been most successful in dealing with this knot. I wish to re-iterate the statement that under no condition should a tree be planted showing knots on the roots. Young trees badly diseased had better be taken up and destroyed by burning. It is thought advisable to burn such trees, because it is still an unsettled question as to whether Crown-Knot is contagious. When knots appear on older trees, they should be cut off. As they nearly always appear at the crown, it is but little labor to dig away the soil and expose the base of the trunk and a portion of the roots. The knots should be chiseled or pared off smooth, and the wound left exposed to the air and sunlight for some days. We have seen large knots cut off as described, and afterwards the scar healed perfectly, and the next year the tree showed no indication of the knot. If, in excavating around the crown, it is found that knots are growing on some of the accessible roots, it is best to sever such roots between the trunk and the knot

and destroy them. The wound made by cutting away the knot should be painted, or coated over with linseed oil. It has been suggested by some\* to apply an antiseptic to the wound. If such be used, we would suggest that it be applied a short time previous to the application of paint or oil. The antiseptic recommended is the Bordeaux Mixture.†



This should not be confounded with various other knots which sometimes occur on the roots of trees and vines, and which are the result of entirely different causes. In rocky soil roots coming in contact with obstructions make abrupt bends in order to get around them. Not infrequently smooth hard knots develop at such places. Knots of this nature are never as soft as the Crown-Knot, ARE MORE THE CONSISTENCY OF THE ROOT ITSELF, and are not likely to be mistaken for it.

Root knots—more properly termed root galls—caused by worms, bacteria, insects or fungus growth are found upon the roots of a great number of plants; however, as a rule, such knots are much smaller than the Crown-Knot. Galls produced by the phylloxera and other plant lice, as well as those produced by nematoid worms, are fair examples of such knots.

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\* Bulletin No. 99, California Agricultural Experiment Station.

† Bordeaux Mixture:—Dissolve one pound Copper sulphate (blue stone) in one gallon of hot water, or as much as may be necessary to dissolve it. Slack two-thirds pound fresh lime and add enough water to make a creamy whitewash; then slowly pour into the Copper Sulphate solution. Stir thoroughly and add enough water to make eight gallons.