CIRCULAR No. 129

(MAY, 1915)

THE CONTROL OF CITRUS INSECTS*

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FUMIGATION FOR SCALE INSECTS

Fumigation is the most satisfactory treatment for the control of scale insects on citrus trees. The denseness of foliage and compactness of growth of citrus trees make them well suited for a gas treatment within an enclosed tent covering. Most citrus growers are not so directly interested in the details of the fumigation processes because such work has been usually done by contract, by the local Fruit Growers Exchange, or by an association. However, the growers themselves should understand enough of the essentials of the fumigation work to pass proper judgment on the character of such work. As compared with other necessary operations in the citrus grove, such as cultivating, irrigating, pruning, and fertilizing, most growers know the least about fumigating. The following account aims to give a practical consideration of the more important facts of the fumigation process.

Fumigation by Contract.—A large part of the fumigation at the present time is done by individuals who make a business of such work. They possess one or more sets of tents and other necessary appurtenances, and contract to do the work for a stipulated amount. Usually this amount is for the cost of covering the trees, and an extra charge is made for the acid and cyanide. These chemicals are generally purchased, however, from the fumigator, who is in a position to buy the materials in large amounts and thus effect a saving in cost.

Fumigation by the Exchange.—The local exchange, an organization primarily for the marketing and selling of the crop, often does the fumigating for its members. In such cases the work is done about at cost plus the wear and tear on equipment.

Fumigation by Associations.—In some sections fumigation is carried on by an association of the growers, who effect an organization for the primary purpose of pest control. Successful organizations of this kind are the Co-operative Fumigation and Supply Company of Upland, and the Growers' Fumigation and Supply Company of Pomona. These associations also handle fertilizers and farm

* Paper No. 3, Citrus Experiment Station, College of Agriculture, University of California, Riverside, California.

implements. They have their own fumigation equipment, spray machinery, and materials for controlling pests, and the work is done under the supervision of a manager, who is elected by the members.

Fumigation by Private Individuals or Companies.—Where the holding of a single grower, or the holding of a company, is large, such individual or company has its own fumigating outfit, and the work is in charge of an employee who understands the process. Sometimes, also, two or more neighbors may very profitably go in together in securing the equipment and do their own work.

Fig. 1.—Beginning to pull the tent over the tree.

Tenting Material.—At the present time there are three chief grades of tenting material on the market for fumigation work. These are the 8-ounce special army duck, the 8-ounce double-filled duck, and the 6½-ounce drill. The first of these materials is by far the tightest cloth and is the most desirable. The other two allow about the same amount of leakage of gas, the duck being heavier and more substantial than the drill. The tenting material now in general use consists almost entirely of the 8-ounce double-filled duck and the 6½-ounce drill.

The two points to consider in the purchasing of tents is, closeness of weave and durability. The term "double-filled duck" is somewhat misleading because it is double-filled in one direction only, while the special army duck is double-filled in both warp and woof.

Fumigation tents may be purchased from the dealers in Los Angeles, properly marked and in any size desired. The commonest sizes are from 36 to 45-foot sizes, with larger ones up to 84-foot tents for large seedling trees. The size of the larger trees will determine the size of the tents to purchase. If there are but a few trees that are very much larger than the others, then two or three larger sized tents are desirable. The cost of a 45-foot tent will range between \$35 and

Fig. 2.—A row of tented trees as they appear at night, when the fumigation operation is carried on.

\$50, according to the grade of cloth. The number of tents to an outfit is about thirty, although double that number is often used.

Poles and Derricks.—Excepting with the very large sized tents, poles are used in lifting the tents over the tree. These are from 2 to 2½ inches in diameter, and should be of straight-grained pine. The length of the poles is usually 14 or 16 feet. A half-inch rope is stapled about 6 inches from one end of the pole, and is long enough to reach two or three feet beyond the opposite end. The tent is secured to the end of the pole by placing a fold over the end of the pole and then working a half hitch over the cloth with the rope. Where rings are fastened to the tents these are hooked over a metal pin on the end of the pole.

Chemicals used in Fumigation.—Sodium cyanide NaCN is now exclusively used in fumigation work because of its lower cost and greater source of supply. Sodium cyanide is now manufactured in this country, while the potassium cyanide, formerly used, came almost entirely from Germany.

The sodium cyanide for fumigation work is of 129 per cent purity. This percentage of purity is on the basis of 100 per cent potassium cyanide. A pound of 129 per cent sodium cyanide contains about one-fourth more cyanogen and will consequently produce one-fourth more gas than a pound of 99 per cent potassium cyanide. If 100 per cent purity was on the basis of the purity of each product, as should be the case, instead of on the basis of one product, namely, potassium cyanide, then 100 per cent sodium cyanide would contain one-fourth more cyanogen and produce one-fourth more gas than 100 per cent potassium cyanide, pound for pound. Much of the cyanide now in use for generating the gas in pots comes in the form of egg-like lumps and is known as cyanegg. Cyanide in this form is more easily handled, and the uniform sized lumps insure a uniform generation of the gas. The cost of sodium cyanide is 22 to 27 cents per pound.

The acid used in fumigation work is the commercial sulphuric acid (H_2SO_4) of 66 degrees Beaume, or about 93 per cent pure. The cost of this product is from $1\frac{1}{2}$ to 2 cents per pound.

In addition to the acid, water is necessary for the generation of hydrocyanic acid gas from the cyanide. If acid is used alone with cyanide, the acid will act for a time in generating the gas, but later a coating of the product from this reaction will protect the cyanide not yet acted upon. One of the purposes of the water is to dissolve this coating as it is formed, so that the acid will continue to come in contact with, and to act upon, the cyanide. A second use of water is in the heat produced when the acid and water are brought together, thus hastening the generation. A third use of the water is that it simply increases the volume of liquid, which is important in covering the cyanide when a small dosage is used, and particularly in flat-bottomed generating vessels. Where water alone is used, it will dissolve the cyanide, but there is no chemical reaction. This fact is taken advantage of in the generating machine on page 7.

Formula for Proportions of the Chemicals.—To insure the proper generation, and secure the maximum amount of gas, the cyanide, acid and water must be used in the proper proportions. For sodium cyanide these proportions are as follows:

FORMULA FOR GENERATION

Sodium cyanide	1 ounce avoirdupois
Sulfuric acid, 66° Beaume	$1\frac{1}{4}$ fluid ounces
Water	2 fluid ounces

The water is placed in the generating jar first, then the acid, and later the cyanide.

Dosage.—The dosage is based upon the distance around and over the tented tree. The simplest way of calculating this dosage, and one which seems to answer the purpose in practical work, for average sized trees, is to multiply the distance around by the distance over the tented tree, point off two places in the product, and then reduce this by one-fourth. This will correspond to the full schedule, as given on page 34, excepting that in the case of the very small trees the dosage is increased, and in the case of very large trees, decreased from that of the above calculation.

The amounts of acid and water used are according to the formula given. If a tree requires 12 ounces of sodium cyanide, then 12 plus

Fig. 3.—A commissary cart pulled by a horse; a common type in use in Southern California.

one-fourth, or 15 fluid ounces of acid, and twice 12, or 24 fluid ounces, of water will be needed. In practice, however, it is not necessary to make this calculation, for vessels are provided which are properly graduated for this formula. With these vessels, if a tree requires 12 ounces of cyanide, the acid pitcher is filled to the 12 mark with acid, and the water pitcher to the 12 mark with water.

Leakage and Care of Tents.—Even with the very best tents kept in the best condition, there is a large leakage of gas, but when the tents become badly worn and have numerous holes on account of tears and acid burns, the escape of gas is so great as to seriously impair the results. The tents are required to be inspected daily, and where

holes occur, these should be properly mended. In the case of small holes, the patch may be stuck on by means of sheet rubber and a hot iron, but large holes are best repaired by a tailor's sewing machine. The advantage of the machine over hand-sewing is not that it will be better done but the double thread of the machine does not leave the holes that the single-thread hand sewing does.

Practice.—A fumigating outfit consists of approximately thirty tents. More are often handled in the case of small trees, and fewer, if the trees are very large. Thirty-three or four earthenware generating pots and a commissary cart or tray, with minor appurtenances, such as scales, measuring vessels, rubber gloves, etc., are necessary. The crew required to operate the outfit consists of five men: two to pull the tents, one to measure the tented tree, kick in the tent, and indicate the dosage, and two to attend to the commissary and do the generating. Sometimes but four men are used. Where the portable generator, figure 4, is used, this number is sufficient. Such a crew and outfit will treat about 400 trees a night. The cost of fumigating varies from 20 cents to \$1.50 per tree, with an average cost of between 25 and 30 cents.

When the tent is placed on the tree by the tent pullers, the dosage man goes around the tree and kicks in the tent, at the same time reading the distance over and measuring the distance around by means of a tape which he has secured to the tent at the starting point. The cyanide man weighs out the amount of cyanide indicated, while the other man measures out the corresponding amounts of acid and water, and places them in the generating jar. He then carries this generating vessel and also the cyanide to the tent under which the charge is set, while the tent is held up by the other man. The man handling the acid is not permitted to touch the tent at any time. The acid, cyanide, water, scales, etc., are conveniently arranged on a cart (see fig. 3), or on a four-legged tray which is carried from tree to tree.

Generating Machine.—A machine for generating the gas is now on the market, which gives promise of coming into wider use. This machine consists of a central barrel-like drum which encloses a smaller vessel in which the generation of gas takes place. On one side and above is a vessel containing the cyanide which is dissolved in the required amount of water. On the other side is another vessel which contains the acid. The cyanide in solution and the acid are conducted into separate graduated glass cylinders for the dosage and then turned together into the generating vessel. As this is within a larger vessel, the only outlet is through a rubber tube, which conducts the gas under

the tented tree.* Only a minute or two is required for the generation. Some advantages of such a machine are: accuracy of dosage; economy of material; cleanliness of manipulation; one less man required in the crew; and freedom from acid burns on the tents.

Time of Exposure.—Forty-five minutes to one hour is the usual time the tents are left on the trees. This is about the time required

Fig. 4.—A portable machine for generating hydrocyanic acid gas.

for the pulling of a set of tents and making the changes. At the end of this period, the first tent is pulled on to the tree in the adjoining row, and so on through the set.

Season.—The season for fumigating extends approximately from July 15 to January 1. Fumigating earlier than the middle of July is not advisable because of the danger of injuring the young fruit. Even

* A new generating machine of different construction, and working on somewhat different principles, is being placed on the market for this [1915] season's work. (See fig. 5.)

this date is too early to fumigate for the black scale because it may not be the end of the hatching period. During most seasons it will be the middle of August or the first of September before all of the black scale will have hatched. For the citricola scale (*Coccus citricola*), fumigation should begin by July 15 or as soon thereafter as possible. This scale is most susceptible to treatment early in the season and so far as our present experience indicates, becomes very resistant after the first or middle of September.

Temperature.—Fumigation at too low or too high temperatures is likely to cause injury to the tree, and 35 degrees F has been set for

Fig. 5.—The cyanofumer, an improved portable generator.

the minimum and 70 degrees for the maximum in Southern California. Experience during the present season in Tulare County, however, shows that fumigation may be carried on in that section safely at a temperature of 80 to 85 degrees.

Wind.—Fumigation should not be carried on during a high wind, that is, wind enough to sway the tents. Neither is it advisable to fumigate in Southern California during those occasional periods when the atmosphere is spoken of as charged with electricity. Judging from the immunity of the trees which were fumigated at high temperatures

in Tulare County, this atmospheric condition appears to be a more important factor in burning than the high temperatures alone.

Fumigation is practiced for the control of the black, the red, the yellow, the purple, and the citricola scales, and in some cases possibly for the mealy bug. See also under discussion of each species.

Fig. 6.—Oranges spotted by fumigation.

SPRAYING FOR SCALE INSECTS AND MEALY BUGS

On account of the complaints that fumigation has not controlled the black scale, and in some cases also the red and the purple scales; and because of the expense involved, a very considerable interest in spraying has been revived during the past year or two. There has been, in our opinion, too much of a tendency to substitute spraying

for fumigation. As has happened before, as soon as growers are convinced through their own experience of unsatisfactory results, this method of control will again be on the decline.

The dense foliage of the citrus tree makes it particularly suitable for fumigating, while the dense foliage, together with the fact that the citrus tree is evergreen, makes it particularly unsuitable for spraying. It is not permissible to use a spray of sufficient concentration to kill all of the stages of scale insects on citrus trees because of danger of injury. The black scale may at the proper stage be killed when the

Fig. 7.—Spraying orange trees for scale insects.

spray strikes them, but the great difficulty in spraying citrus trees is to hit all, or even a sufficient number, of the scales to insure clean trees and fruit the following year. Herein lies the objection to and failure of spraying.

So long as there are even a few scattering scales on the trees there is sure to be more or less of the sooty mold fungus, which is so seriously objected to at the packing-house, and in the best of spraying work a few scales will always be left. Two applications of spray in a season are considered necessary, and when this is done, the cost about equals the cost of one fumigation. Moreover, the same spraying program will need to be repeated year after year. Fumigation, on the other

hand, if at all satisfactory, should not require repeating for two years at least.

We are aware of the fact, however, that in many instances fumigation has been carried on year after year, and still the trees and fruit are covered with the sooty mold fungus. Similar conditions, though much less frequent, have also occurred in the case of the red and purple scales. As stated under "Fumigation," we believe the uneven hatch has been chiefly responsible for poor work in fumigating for the black scale. In such cases, when fumigation has consistently failed to control the scale, then the grower is warranted in at least

Fig. 8.—A well equipped supply wagon for carrying water and the spray materials to the spray outfits in the field.

trying something else, and after fumigation, spraying is the next best, in fact, the only other means of artificial control.

While spraying should rarely if ever replace fumigation as a means of controlling any kind of scale insects in commercial orchards, there is still a field for spraying in the case of young trees, or trees about dooryards, where fumigation may not be convenient, or where the infestation is light or limited to occasional trees.

In the case of the mealy bug and the red spider, spraying is more satisfactory than fumigation.

Materials.—Many kinds of spraying materials have been developed in response to the recent increased interest in spraying. Thus far,

however, all sprays which have any established recognition for scale insects on citrus trees consist of either oil or soap or varying combinations. Lime-sulfur might be added to the above, since it has some slight value against the red and the yellow scales. It requires a rather strong spray to kill scale insects; hence such neutral materials as tobacco or dilute soap which are used successfully against such pests as plant-lice will not kill the more resistant scales.

The number of materials available for scale spraying is very small, when their killing power and cost is considered, and there is little merit in many of the numerous commercial compounds that appear periodically as panaceas for insect control. Some of these may kill the scales as well as the standard sprays, but many of them are likely to do injury to the citrus tree.

On account of the fact that the black and citricola scales are unarmored, the spray will come in direct contact with the insects. For this reason spraying will come nearer being a success with these two than with others. Red, yellow, and purple scales are armored scales, the scale covering protecting them from direct contact with the spray. With these scales, therefore, very poor results may be expected, since a spray strong enough to kill them cannot be used on the citrus tree without injury.

Water White Oil, or Kerosene Spray.—Of all the different materials that have been tried, and on which observations have been made, the kerosene or kerosene emulsion has been the most satisfactory. In the case of young trees, however, if much of the spray is allowed to run down the tree trunk, injury is likely to occur just beneath the surface of the ground. Trees that are growing in sandy soil are more likely to suffer from such injury than trees growing in heavy soils. The absorption is less in sandy soils, and thus more of the free kerosene is left about the tree trunk, causing injury to the bark and often girdling the tree beneath the surface.

Where much kerosene is allowed to run down the tree trunk the precaution should be taken to remove the soil immediately around the tree trunk as soon after spraying as possible, or at least by the following day, and replace this oil-saturated soil with fresh soil. In the case of young trees without fruit, the distillate spray, discussed in the following pages, is satisfactory to use. Practically no injury results to the tree beneath the surface when distillate is used. If large amounts of any oil are allowed to run down the tree it may result in injury, but there is no excuse for allowing this waste to occur.

In the coast sections there is usually little injury done to the fruit or foliage with the distillate spray, but in the interior sections and

elsewhere, where injury may occur to the fruit or foliage, the kerosene spray is the safest to use.

“W. W.,” or “Water White,” is the trade name of what is simply a low grade of kerosene, and is the kind used for spraying citrus trees. The cost in Los Angeles of the “W. W.” oil is 7 cents per gallon.

FORMULA FOR KEROSENE EMULSION

“W. W.” oil	15 gallons
Liquid soap	$\frac{3}{4}$ gallon
or	
Hard soap	4 pounds
Water	200 gallons

If liquid soap is available, it is preferable to hard soap, since no heating is required. Hard soap, preferably whale-oil, is cut in thin slices and dissolved in hot water. The soap is placed directly in the spray tank with 10 or 15 gallons, or more (the exact amount is not important) of water, and then the engine is started. The oil is now added slowly, and the materials are emulsified by being run through the pump under pressure. After a few minutes the rest of the water may be added, and the spray is ready to apply to the trees.

Distillate Spray.—In former years distillate spraying was very generally practiced in the orange groves of Southern California. However, because of the better results secured from fumigation, and because of the injury to the tree and fruit by the distillate spray, such treatment went very largely out of favor, though there is still more or less distillate used. The old distillate was a 28 degree gravity product, while the tree distillate that is now in use has been additionally refined and is of about 31 degrees gravity. This latter oil is not so likely to cause injury as the old oil, but it is more injurious than kerosene. This oil is used at a strength of 2 to 3 per cent, while the kerosene is used at a strength of from $7\frac{1}{2}$ to 10 per cent. Because of the greater dilution and also the lower cost per gallon, the distillate is much cheaper. The price of tree distillate in Los Angeles is five cents per gallon.

FORMULA FOR DISTILLATE EMULSION

Tree distillate 31°–32°	4 gallons
Liquid soap	$\frac{3}{4}$ gallon
or	
Hard soap	5 pounds
Water	200 gallons

These materials are emulsified in the same manner as explained for the kerosene emulsion on page 13. If the distillate is used without soap, the following is the formula:

FORMULA FOR STRAIGHT DISTILLATE

Tree distillate 31°-32°	4 to 6 gallons
Water	200 gallons

In the case of straight distillate, the oil is kept in suspension in the water by agitation and forms simply a mechanical mixture.

The distillate or distillate emulsion has been used in the cooler sections near the coast during the past few years with very little injury to the trees, but in the interior sections where the temperature is higher, there have been more complaints of the spray spotting the fruit. Hot weather and especially "northers" are the most important influences in augmenting oil injury on citrus fruit. Such injury on the fruit is characterized by brown spots, which usually appear on the surface most exposed to the sun. Defoliation is the usual kind of injury to the leaves.

While the addition of soap to the oil, as used in the distillate emulsion, insures a better mixing of the oil and water particles, and consequently reduces liability to injury, too much soap should not be used, for the soap itself may be responsible for the spotting of fruit. Soap spotting occurs on the under side of the fruit, generally where long contact with the fruit results in the injury, while oil spotting occurs on the upper side of the fruit as a result of quick evaporation or heat.

An additional oil spray that the Station tried during the past year for the first time on citrus trees is a lime-oil emulsion. Instead of using soap as the emulsifier, ordinary freshly slaked lime was used. The purpose of using the lime was to try to overcome the possible injury from the oil, and since soap, if used too freely as an emulsifier, will increase fruit spotting, the lime was substituted for the soap. A very satisfactory emulsion was made in this way. This combination has not been used extensively enough as yet to allow of definite recommendations. Possibly the presence of lime on the fruit may be objectionable. One of the uses of the lime was to employ it in large amounts in mealy bug spraying to coat over the egg masses and young. From 20 to 40 pounds to 200 gallons of spray were used.

Miscible Oils.—Miscible oil is a term applied to an oil that has been so treated as to mix readily with water. The base of a miscible oil is usually a distillate, and the emulsifier is some soap combination.

These oils are convenient to apply, since it is only necessary to add the required amount of water. The killing effect on the scales is as satisfactory as that of kerosene or distillate, but the greatest objection to some of these oils is that they are likely to do more injury—at least more than kerosene.

Soap or Washing Powders.—Under this head come such products as Goldene, Gold-Dust, Lighthouse, Pearline, Sea-foam, and others that have been recently used more or less for citrus spraying. These powders are manufactured for washing purposes and were first used by citrus growers for washing the fruit in the packing-house. Later, they came to be applied to the trees, and at present large amounts are being used for spraying purposes. These washing powders are all of about the same composition, and contain from 25 to 30 per cent soap and about 50 per cent sodium carbonate. The question has arisen concerning the desirability of applying sodium carbonate (black alkali). This is obviously an undesirable product to add to the soil, but in such amounts as it is used in spraying it is of no consequence.

These soap powders are used at the rate of 1 pound to 5 or 6 gallons of water, or from 35 to 40 pounds per tank of 200 gallons. The question as to whether the soap or the sodium carbonate is the chief insecticidal ingredient of such materials has not yet been determined. If the soap is the important part, then it would appear that it would be economical to purchase soap of greater purity; if the causticity of the sodium carbonate is the important factor, this or some substitute might be used alone. It is, of course, possible that the combination of the two ingredients is necessary. These and many other questions about spraying are under investigation by this station.

The use of these soap powders has become popular, indeed much too popular, considering their actual value. They are easily applied, since it is only necessary to put the material into the spray tank. They will kill many of the black scales in their younger stages, as many sprays will, but with the more mature scales, washing powders are not so effective as the oil and soap sprays. The supposed lack of injury to the fruit has been an important factor in their favor, but it is now very well known that these powders often cause spots on the fruit, so that in this regard they are in the same category as most of the other sprays discussed.

Applying the Spray.—The most important phase of the whole process of spraying a citrus tree is the thoroughness of application. Even when the spray is applied most thoroughly, there will be a good

many insects that are not touched. This is due to the numerous leaves that are bound to shield some parts from the spray. Since the scales are largely on the under side of the leaves at the time of spraying, the "uppershot" should be used almost entirely. By the time this spraying from below is finished, and the excess spray falls on the upper surfaces, very little direct "overshot" work is necessary.

Season for Spraying.—Since spray work against scale insects is chiefly valuable for the black and citricola scales, when these insects are young and susceptible, the season for spraying is limited. This will be, generally speaking, from August first to December first. Early spraying, that is, just as soon as all of the insects have hatched, is the most desirable time. If a second application is to be made, this may follow a few weeks later, but from our work this season, we believe that more time spent on a single application, making a single thorough job, is not only more economical but also more effective.

Equipment.—Except in the case of small trees, or in that of a few large trees, a power sprayer is necessary for citrus spraying. With a power sprayer a pressure of 200 pounds, or over, can be maintained with four nozzles on two leads of hose.

For scale insect spraying, the Bean mist, Bean whirlpool, or Friend Drive spray nozzles are satisfactory. Tests made with the Bean Mist and Whirlpool nozzles showed that the character of spray from each is about the same and that about the same amount of spray in a given time is thrown by each. This amount is 1 gallon or a little over per minute, per nozzle, when a pressure of 200 pounds is maintained. The mist nozzle throws the spray at an angle of 45 degrees from the horizontal, while with the whirlpool, the angle is 75 to 80 degrees. The 45 degree angle is preferable, because it enables better "undershot" work to be done. Tests made with the Bordeaux type of nozzle, such as the Bean Clipper, showed that the amount given off by each nozzle when a pressure of 200 pounds was maintained was 1.7 gallons per minute.

When spraying for mealy bugs, it is very important to use much force with the spray so that it will penetrate the egg masses and the cottony covering of the insects themselves. This cannot be done to the best advantage with the ordinary type of nozzle; but the M. A. C. nozzle answers this requirement very well. In order to get pressure, it is necessary to throw a large volume of spray. Tests with this nozzle showed that nearly 5 gallons per minute were given off. Where such large quantities are used, the spray may be diluted more than is called for in the regular formula. In fact, this nozzle is most satisfactory for applying pure water for the mealy bug. The water is

applied with such force that the insects are dislodged from the tree, and at the same time many are killed. Reinfestation from the live ones on the ground is prevented by applying tanglefoot or cotton bands to the tree trunks.

Amount of Spray.—The amount of spray necessary for citrus trees depends on the size of the tree and upon how thoroughly the work is done. For average trees the amount will be 8 to 10 gallons. Much less will suffice for trees under five or six years old, but as much as 15 to 25 gallons will be needed for large Valencias or for seedlings.

SPRAYING FOR RED SPIDERS AND MITES

Spraying is now very generally used throughout the citrus belt for the control of red spiders and mites. The other means of controlling these pests is by the application of dry sulfur. Dry sulfur is a satisfactory treatment for spiders and mites, but the results are more dependent upon proper weather conditions than is the case with liquid sprays. The unpleasantness of applying sulfur in the dry state, and the fact that fruit pickers complain of the sulfur several weeks after the application, have made this method of control much less popular than spraying. Where dry sulfur is used, the addition of hydrated lime, in the proportion of one part of lime to two or three parts of sulfur, is used to increase the adhesive power and as a diluent. The application is best made by means of a power blower shown in figure 10. The cost of applying dry sulfur is about one-half that of spraying.

In spraying, the essential ingredient to apply is sulfur because of its prolonged action. The commercial lime-sulfur is now very generally used for spiders and mites.

LIME-SULFUR SPRAY FOR SPIDERS AND MITES

Commercial lime-sulfur	4-5 gallons
Water	200 gallons

The lime-sulfur is added directly to the spray tank, which has previously been filled with water, and after a little agitation it is ready to apply to the trees. Some growers prefer to add flour paste, which increases the spreading of the spray and also makes it stick to the foliage better. The flour paste is made by using flour at the rate

of a pound to a gallon of water and bringing it to the boiling point. From 6 to 8 gallons of this is used to a 200-gallon tank. There is more or less trouble in making this paste, however, and some growers prefer to add the flour dry (6-8 pounds to 200 gallons) to the spray-tank. The addition of flour, or flour paste, is not absolutely essential for the control of spiders on citrus trees, and it is often omitted. Where the spiders are especially persistent, as in San Diego County, it is desirable to add 15 or 20 pounds of dry sulfur to the commercial lime-sulfur spray.

Fig. 9.—Lime-sulfur injury.

Time of Spraying for Spiders and Mites.—The general rule is to apply the spray when the spiders first become numerous and do damage. This is usually in May, June, or July, but during some years and in some sections treatment is needed at other seasons. While spiders and mites are widely distributed and may be found to some extent everywhere, treatment is not advisable until they are abundant enough to do conspicuous injury.

Lime-sulfur spraying should be avoided during very hot weather. Even if hot weather follows several days after the application is made, injury will result to the fruit and foliage. Lime-sulfur injury (see fig. 9), consists of brown and dried areas where the fruit is exposed to the sun. Atomic or milled sulfur and soluble sulfur have recently come into use, and these materials may cause less injury than the ordinary lime-sulfur. The use of atomic and milled sulfur has not been extensive enough, as yet, to make possible definite statements about their efficiency for spiders on citrus trees.

Fig. 10.—Applying dry sulfur and hydrated lime for red spiders.

THE BLACK SCALE

(*Saissetia oleae*, Bern.)

The black scale is generally distributed in all of the citrus sections south of the Tehachapi, and is the most important citrus insect pest in California. It is not a pest in the citrus sections of the San Joaquin or Sacramento Valleys, but it sometimes occurs abundantly on the scattering orange plantings in the coast valleys north of the Tehachapi. In Southern California it occurs most abundantly in the coast counties, but recently it has also become entitled to first place as a pest in the interior sections, as in Riverside, for example.

The black scale draws the sap from the tree and injures the smaller twigs, and also reduces the vigor of the tree. But probably the most important injury is due to the sooty mold fungus that grows in the honey-dew given off by the scale. This honey-dew and fungus interfere with the normal growth of the tree and also necessitate the washing of the fruit in the packing-house.

There is, as a rule, but one generation of the black scale in a season. The average number of eggs deposited is about two thousand. The young appear most abundantly during May, June, July, and August. However, since some of the scales may develop in less than

Fig. 11.—Black scale on orange twig.

a year, the insect may be found somewhere in different stages at all seasons. This uneven hatch, which is most common near the coast, is the most important factor accounting for poor results from fumigation. It is usually about September first before all of the scales have hatched, and thus the fumigation season should begin for this scale at about this date. Some groves will be found in every district in which there is a more complete hatch than in others, and, so far as possible, early fumigation should be done in such groves. A 75 per cent schedule (p. 32) is satisfactory for this scale if the insects are in the proper stage. Where there are still a few eggs, or scales that are well advanced, a full schedule (p. 34) is necessary if this

can be used with safety to the trees. In the coast districts, however, there is danger of doing too much injury to the fruit with this dosage, and thus a 75 or 85 per cent schedule is as high as it is safe to use. The season for spraying and fumigating is about the same; the earlier the work is done after all the insects are hatched, the more susceptible will be the scales.

THE RED AND YELLOW SCALES

(*Chrysomphalus aurantii*, Mask)

(*Chrysomphalus aurantii* var. *citrinus*, Coq.)

While the red scale is not so generally distributed as the black, it is nevertheless found in most of the citrus sections of Southern California. It does not occur in commercial plantings north of the Tehachapi. The yellow scale has much the same distribution in the south, but in addition it occurs in the Sacramento Valley.

The red scale attacks the branches, leaves, and fruit, while the yellow scale is but rarely found on the twigs and branches. These scales give off no honey-dew as is the case with the black scale, so that the injury they cause is due directly to the feeding and the presence of the scales themselves on the fruit.

There are never any eggs present with the red and the yellow scales, since the young are brought forth alive. This fact is taken to account for these scales being susceptible to fumigation at any season, since eggs are considered more difficult to kill. Every female may produce one hundred young, and these mature in three months. There are thus between three and four generations in a year. A single individual of this species produces much fewer young than the black scale, but because of the greater number of generations, the progeny from a single red scale is much greater at the end of the season than that of a black scale.

Good results from fumigation are usually considered easier to obtain with the red and the yellow scales than with any of the other scales, excepting the black scale when it is in the proper stage. However, there are certain refractory cases where fumigation, done apparently in a proper manner, has not been satisfactory against the red scale. A 75 per cent schedule (p. 32) is generally considered sufficient for this scale. Where the results of previous seasons have not been satisfactory and where climatic conditions will allow, the 100 per cent schedule (p. 34) may be used.

THE PURPLE SCALE
(*Lepidosaphes beckii*, Newm.)

The purple scale is scatteringly distributed in all of the counties south of the Tehachapi, excepting Riverside, San Bernardino, and Imperial. It does not occur elsewhere in California in commercial plantings.

From forty to eighty eggs are deposited by this scale, and about three months are required for the development of the young. The

Fig. 12.—Purple scale on orange leaf.

number of generations is about the same as that of the red scale, or between three and four.

The purple scale attacks all parts of the tree, and kills the smaller twigs and branches. No honey-dew is secreted by this species, and consequently there is no sooty mold, but the scales themselves occur on the fruit and are difficult to remove.

This scale is particularly resistant to fumigation. This is due to the fact that there is scarcely any season when eggs may not be found beneath the scale covering, and these are difficult to kill. For this reason the heaviest schedule of dosage should be used that is consistent with safety to the trees in the different sections. The 100 per cent

schedule (p. 34) should be used wherever possible. In the coast districts, where this is not desirable, an 85 per cent schedule (p. 33) may be employed.

THE CITRICOLA SCALE

(*Coccus citricola*, Campb.)

The citricola scale is a very recent citrus pest in California, and is one of considerable importance. It occurs in Riverside, San Bernardino, and Orange counties, in Southern California, and also in many of the citrus sections of the San Joaquin and the Sacramento valleys.

The young of this scale appear mostly in May, June, and July, with some extension at both ends of this period. The young occur mostly on the leaves until spring, when they move back to the twigs. Approximately one year is required for their development, and thus there is but one generation in a season. The injury is due to the feeding of the insects, and also to the sooty mold and the honey-dew, which impairs the health of the tree and makes washing of the fruit necessary.

The citricola scale becomes very resistant to fumigation after early in September. The fumigation season, when entirely satisfactory results may be secured, is therefore very short with this scale. From July 15 to September 15 is the best season. A 75 per cent schedule (p. 32) has often given satisfactory results against this scale, but in other cases live scales may be found with this dosage. In the interior sections, where it can be used safely, a 100 per cent schedule is more certain. In the coast districts an 85 per cent schedule (p. 33) may be substituted. In the San Joaquin citrus sections, a 110 per cent schedule ought to be employed, at least after the first two or three weeks of the season.

For spraying for this scale see under general head of spraying on page 9. The season is about the same as the fumigating season, though it may be prolonged until after September 15.

OTHER LESS IMPORTANT SCALE INSECTS

The *Soft Brown Scale* (*Coccus hesperidum*) always appears in isolated cases on small trees or on a few twigs of old trees, but usually disappears before treatment is necessary. This species is very similar to the citricola scale, but the massing of the scales on but a portion of the tree will usually distinguish the soft brown from the citricola scale, which occurs generally over the entire tree. The citricola scale when mature is also of a grayer color and is rarely found on the

leaves; while the mature soft brown scales are very likely to occur on the under side of the leaves.

The *Greedy Scale* (*Aspidiotus rapax*, Comst.) and the *Oleander Scale* (*Aspidiotus hederae*, Comst.) are circular gray scales that sometimes occur on citrus trees, and particularly on the old mature fruit. Their occurrence and injury, however, is not important enough to make control measures necessary, except in rare cases.

The *Cottony Cushion Scale* (*Icerya purchasi*, Mask.) may also occur in sporadic cases in commercial citrus planting, but as a rule the

Fig. 13.—The Citricola scale.

infestation is not permanent enough to require any treatment. Where the scales do not disappear in a reasonable time, a quantity of them should be collected and sent to the State Insectary, at Sacramento, with a request for a colony of beetles.

CITRUS MEALY BUGS

There are three or four different mealy bugs that attack citrus trees. The most important one and the one most widely distributed is the citrus mealy bug (*Pseudococcus citri*). This is a very important pest

that does injury by taking the nourishment from the tree, and also excreting honey-dew, in which the sooty mold fungus grows. Masses of eggs and the insects themselves may also occur on the fruit, and are particularly difficult to remove when they secrete themselves in the navel of the orange as they often do.

The eggs are laid in cottony masses to the number of 300 or 500, and the development of the young requires from one and a half to three months, according to the season. They are more or less dormant during the winter and are not seen in large numbers on the trees at this season, but with the appearance of warm weather in the spring and summer, they rapidly appear and reinfest the tree. Infestations of the mealy bug appear from time to time on a few trees and afterward disappear even though no control measures are employed. In other cases, however, infestations will persist for several years, and control measures are very necessary.

The distribution of the citrus mealy bug is general over the state, but it has not appeared as a pest, as yet, in the citrus groves of Riverside and San Bernardino counties in Southern California or in the San Joaquin section.

Mealy bugs are the most difficult to control of all the citrus insects. This is because they are almost wholly resistant to fumigation as ordinarily practiced, and because they are also very resistant to sprays. Their resistance to sprays is due to the large amount of cottony secretion protecting both the insects and eggs from the spray material.

However, of the available methods, spraying is the most satisfactory. Much force is important in applying the spray to these insects. None of the composition sprays that have yet been tried are better than kerosene emulsion, or distillate emulsion, but spraying for the mealy bug should be repeated frequently, about three applications in a season. Spraying with pure water and the use of the M. A. C. nozzles has also given satisfactory results (see p. 16).

RED SPIDERS AND MITES

Next to the scale insects and mealy bugs, red spiders and mites are the most troublesome pests on citrus trees. There are three species of importance: the citrus red spider (*Tetranychus mytilaspides*), the six-spotted mite (*Tetranychus sexmaculatus*), and the silver mite (*Eriophyes oleivorus*). The citrus red spider is very generally distributed and is responsible for the most injury. The six-spotted mite is more restricted to the coast districts and is probably most important in San Diego County. The silver mite is limited to a portion of San Diego County only.

Red spiders and mites cause the pale silver color on the leaves and fruit by withdrawing the plant juices. In cases of severe attack, leaves so damaged fall from the tree.

The two common species of red spiders attacking citrus trees have about the same life cycle. About thirty eggs are deposited, which hatch in eight to ten days, and twelve days more are required for the young to develop. The whole life cycle of the red spider, from the hatching of the egg to the death of the adult, occupies from thirty to forty days. There are several generations in a season, probably twelve or fifteen.

For the control of red spiders and mites see page 17.

Fig. 14.—Sears of thrips on orange.

THRIPS

(*Euthrips citri*, Moul.)

Thrips occur most abundantly in Tulare County. In Southern California, occasional injury from thrips occurs in the vicinity of Redlands and Riverside. The thrips do injury to orange trees by causing a leathery distorted growth of the leaves, and a scarred ring about the stem end, and other less sharply defined scars on other parts of the fruit. Spraying was carried on in many groves in Tulare in 1910, but the results scarcely justified the expense of the three, or even four sprayings that were necessary, and since that time practically no spraying for thrips has been done. The extent of injury during recent years has not been so great in that section, and it is no longer considered profitable to spray for this insect.

Thrips appear in the early spring, about April 15, and there is a succession of broods until November. About twenty days are required for their development, and the average life of the adult is about twenty-five days. Pupation does not necessarily occur in the ground but in old leaves, rubbish, and in blossoms.

THE ORANGE TORTRIX

(*Tortrix citrana*, Fern.)

The larva of this insect, which is about one-half inch long, bores into the fruit, though going no deeper than just through the rind. Fruit with such burrows is classed as culls, not only because of the

Fig. 15.—Showing the character of burrows in the orange rind made by the orange tortrix.

burrow itself, but because decay infection usually results therefrom. Many such fruits fall from the tree.

While in some limited sections in the early part of the shipping season, as much as 5 per cent of the fruit may be attacked by this insect, the damage has never been considered sufficient to warrant practicing any control measure.

FULLER'S ROSE BEETLE

(*Aramigus fulleri*, Horn.)

Fuller's rose beetle is a grayish brown beetle that measures a little more than a quarter of an inch in length. This beetle may be seen clinging to a twig, the under side of a leaf, or at the forks of the smaller branches, during the day. It feeds at night.

The injury (see fig. 16) is never of any consequence on old trees, but on young or budded trees, all of the tender growth may be attacked. On such trees protection is afforded by first jarring off the beetles onto the ground, and applying a cotton band to prevent their

Fig. 16.—Work of Fuller's rose beetle on orange leaves.

re-ascent. Not having functional wings, they cannot fly into the trees. A strip of ordinary cotton batting, three or four inches wide, is placed about the tree trunk and tied with a string around the lower edge of the band. The band is then pulled down over the string, thus forming a barrier to the beetles that attempt to crawl up the tree trunk.

DIABROTICA

This is a black and green beetle that does injury (see fig. 17) somewhat like that of Fuller's rose beetle. The tender growth on young orange trees is attacked. Little or no injury is done to the lemon. Since these beetles fly, they cannot be controlled in the same way as Fuller's rose beetle. They may, however, be jarred off the

Fig. 17.—Work of *Diabrotica* on orange leaves.

small trees onto a canvas in the early morning before they become active, and then killed. If the injury is extensive and severe, the young growth of the trees may be sprayed with arsenate of lead, using 10 pounds to 200 gallons of water.

APHIDES OR PLANT-LICE

In the early spring, some of the tender shoots of citrus trees may be thickly covered with plant-lice. The result of their injury is a

Fig. 18.—Cast skins of aphides on orange leaves.

curling of the leaves and a checking of growth of the shoot. Usually their attacks are confined to a few shoots so that their effect on the tree as a whole is not often serious. They may suddenly disappear, too, in the midst of a maximum infestation, and control work is not often necessary. If they persist and do injury to young trees or nursery stock, spraying with a soap solution (1 pound to 6 or 8 gallons of water) will check them.

FUMIGATION DOSAGE TABLES

The dosage tables on the following pages give the amount of cyanide for any sized tree. The 75 per cent or 85 per cent schedules are more generally used in the sections near the coast; while the 100 per cent schedule is often used in the interior. The 110 schedule has been used thus far mostly in Tulare County.

To obtain the dose for any given tree, find the distance over, in the column of figures on the left of the page; continue in this same horizontal column until directly under the figure for the distance around. The number at this point will be the amount in ounces of sodium cyanide for the given sized tree. To determine the amount of acid, add one-fourth, and for the water double the figure for the cyanide. This calculation is not necessary, however, in practice, as especially graduated vessels are in use, as explained on page 5.

75% SCHEDULE SODIUM CYANIDE

		Distance around, in feet																							
		16	18	20	22	24	26	28	30	32	34	36	38	40	42										
10		2	3	3	3	3																			
12		2	3	3	3	3	3																		
14		3	3	3	3	3	3	3	3	3	3	4	4												
16		3	3	3	3	3	3	3	3	3	4	4	4	4	4										
18		3	3	3	3	3	3	4	4	4	4	4	4	4	5										
20				20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50						
				3	3	3	4	4	4	4	4	4	5	5	5	5	5	6	6						
22						4	4	4	4	4	4	5	5	5	5	6	6	6	6						
24							4	4	4	5	5	5	5	6	6	6	6	7	7						
26								4	5	5	5	5	6	6	6	6	7	8	8						
28									5	5	6	6	6	6	7	7	8	8	8						
		30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64						
30		5	6	6	6	7	7	8	8	8	8	8	8	9	10	11	11	11	11						
32					7	8	8	8	8	9	9	9	10	10	11	11	11	11	12						
34						8	8	9	10	10	11	11	11	11	12	12	13	13	13						
36						8	8	9	10	10	11	11	11	11	12	12	13	13	13						
38							9	9	10	11	11	11	12	12	13	13	13	14	14						
		42	44	46	48	50	52	54	56	58	60	62	64	66	68										
40		10	11	11	11	11	12	13	13	14	14	14	15	15	15										
41		11	11	11	11	12	13	13	14	14	14	15	15	15	16										
42			11	11	12	13	13	14	14	14	15	15	15	16	16										
43				12	13	13	14	14	14	15	15	15	15	16	17										
44						13	14	14	14	15	15	15	16	17	17										
						50	52	54	56	58	60	62	64	66	68										
45						13	14	14	15	15	15	16	17	17	17										
46						14	14	15	15	15	16	17	17	17	17										
47						14	14	15	15	16	17	17	17	17	18										
48						14	15	15	16	17	17	17	17	18	18										
49						14	15	16	16	17	17	17	17	18	19										
											60	62	64	66	68	70	72	74	76						
50											17	17	18	18	19	19	20	21	21						
51												18	18	19	20	20	21	21	21						
52													19	19	20	21	21	22	23						
53														20	20	21	22	23	24						
54																21	21	22	23	24					

85% SCHEDULE SODIUM CYANIDE

		Distance around, in feet																									
		16	18	20	22	24	26	28	30	32	34	36	38	40	42												
10		2	3	3	3	3																					
12		2	3	3	3	3	3																				
14		3	3	3	3	3	3	4	4	4	4	4	5														
16		3	3	3	3	4	4	4	4	4	5	5	5	5	5												
18		3	3	3	4	4	4	5	5	5	5	5	5	5	5												
				20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50								
20				3	4	4	5	5	5	5	5	5	5	5	5	6	6	7	7								
22						5	5	5	5	5	5	5	5	6	6	7	7	7	7								
24							5	5	5	5	5	5	6	7	7	7	7	8	8								
26								5	5	5	6	6	7	7	7	7	8	9	9								
28									5	6	7	7	7	7	8	8	9	10	10								
		30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64								
30		6	7	7	7	8	8	9	9	10	10	10	10	11	12	13	13	13	13								
32					8	9	9	10	10	11	11	11	12	12	13	13	13	13	14								
34						9	10	10	11	12	12	13	13	13	13	13	14	14	15								
36						10	10	11	12	12	13	13	13	13	14	15	15	15	15								
38							11	11	12	13	13	13	14	14	15	15	15	15	15								
		40	42	44	46	48	50	52	54	56	58	60	62	64	66	68											
40		11	12	13	13	13	13	14	15	15	15	15	16	17	17	17											
41			13	13	13	13	14	15	15	15	15	16	17	17	17	18											
42				13	13	14	15	15	15	16	16	17	17	17	18	18											
43					14	15	15	15	16	16	17	17	17	17	18	19											
44							15	15	16	16	17	17	17	18	19	19											
							50	52	54	56	58	60	62	64	66	68											
45							15	15	16	17	17	17	18	18	20	20											
46							15	16	17	17	17	18	19	19	20	20											
47							15	16	17	17	18	19	19	20	20	21											
48							16	17	17	18	19	19	20	20	21	21											
49							16	17	18	18	19	20	20	20	21	22											
							60	62	64	66	68	70	72	74	76	78											
50							20	20	21	22	22	22	23	24	24	24											
51								21	22	22	22	23	24	24	24	25											
52									22	22	23	24	24	24	25	26											
53										22	23	24	24	25	26	27											
54											24	24	25	26	27	28											

100% SCHEDULE SODIUM CYANIDE

		Distance around, in feet																	
		16	18	20	22	24	26	28	30	32	34	36	38	40	42				
Distance over, in feet	10	3	3	3	3	3													
	12	3	3	3	3	3	3												
	14	3	3	3	3	3	3	4	4	4	4	4	5						
	16	3	3	3	3	3	3	4	4	4	4	4	5	5	5				
	18	3	3	3	4	4	4	5	5	5	5	5	5	5	6				
			20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	20		3	4	4	4	4	5	5	5	5	6	6	6	7	7	7	8	
	22				4	4	5	5	5	6	6	6	7	7	7	8	8	8	
	24					5	5	5	6	6	6	7	7	8	8	8	9	9	
	26						5	6	6	7	7	7	8	8	9	9	10	10	
	28							6	7	7	8	8	8	9	9	10	10	11	
								30	32	34	36	38	40	42	44	46	48	50	
	30							7	7	8	8	9	9	10	10	10	11	11	
	32										9	9	10	10	11	11	12	12	
	34											10	10	11	11	12	12	13	
	36											10	11	11	12	12	13	14	
	38												11	12	13	13	14	14	
		Distance around, in feet																	
		42	44	46	48	50	52	54	56	58	60	62	64	66	68				
Distance over, in feet	40	13	13	14	14	15	16	16	17	17	18	19	19	20	20				
	41	13	14	14	15	15	16	17	17	18	18	19	20	20	21				
	42		14	15	15	16	16	17	18	18	19	20	20	21	21				
	43			15	15	16	17	17	18	19	19	20	21	21	22				
	44					17	17	18	18	19	20	20	21	22	22				
						50	52	54	56	58	60	62	64	66	68				
	45					17	18	18	19	20	20	21	22	22	23				
	46					17	18	19	19	20	21	21	22	23	23				
	47					18	18	19	20	20	21	22	23	23	24				
	48					18	19	19	20	21	22	22	23	24	24				
	49					18	18	20	21	21	22	23	24	24	25				
											60	62	64	66	68	70	72	74	76
	50										23	23	24	25	26	27	27	28	29
	51											23	25	25	26	27	28	28	29
	52												25	26	27	27	28	29	30
	53												26	27	28	29	29	29	30
	54														28	28	29	30	31

110% SCHEDULE SODIUM CYANIDE

		Distance around, in feet																							
		16	18	20	22	24	26	28	30	32	34	36	38	40	42										
10		3	3	3	3	3																			
12		3	3	3	3	3	3																		
14		3	3	3	3	3	3	4	4	4	4	4	5												
16		3	3	3	3	4	4	4	4	4	5	5	6	6	6										
18		3	3	3	4	4	4	5	5	5	5	6	6	6	6										
				20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50						
20			3	4	4	5	5	6	6	6	6	6	7	7	7	8	8	9	9						
22					5	5	6	6	6	6	7	7	8	8	9	9	9	9							
24						5	6	6	6	7	7	8	8	8	9	9	10	11							
26							6	6	7	7	8	8	9	9	9	10	10	11							
28									7	7	8	8	9	9	10	10	11	11	12						
		30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64						
30	7	8	8	9	9	10	11	11	11	12	12	13	13	14	14	14	14	14	15						
32				10	10	11	11	12	12	13	13	14	14	15	15	16	16	17							
34					11	11	12	12	12	13	14	15	15	16	16	17	17	17							
36					11	12	12	13	14	14	15	15	16	17	17	18	18	19							
38						12	13	14	14	15	15	16	17	18	18	19	19	20							
		42	44	46	48	50	52	54	56	58	60	62	64	66	68										
40	14	14	15	15	16	17	17	19	19	20	21	21	22	22											
41	14	15	15	16	16	18	18	19	20	20	21	22	22	23											
42		15	16	16	17	18	19	19	20	21	22	22	23	23											
43			16	16	18	18	19	20	21	21	22	23	23	24											
44					18	19	20	20	21	22	23	23	24	24											
						50	52	54	56	58	60	62	64	66	68										
45					19	20	20	21	22	22	23	24	24	25											
46					19	20	21	21	22	23	24	24	25	25											
47					20	20	21	22	22	23	24	25	26	26											
48					20	21	21	22	23	24	25	25	26	27											
49					20	21	22	23	23	24	25	26	26	27											
											60	62	64	66	68	70	72	74	76						
50											25	25	26	27	28	29	30	31	31						
51												25	27	27	28	29	30	31	32						
52													27	28	29	29	31	32	33						
53														28	29	30	31	32	33						
54															30	30	32	33	34						

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1904. Twenty-second Report of the Agricultural Experiment Station for 1903-04.
1914. Report of the College of Agriculture and the Agricultural Experiment Station, July, 1913-June, 1914.

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182. Analysis of Paris Green and Lead Arsenate. Proposed Insecticide Law.	230. Enological Investigations.
183. The California Tussock-Moth.	234. Red Spiders and Mites of Citrus Trees.
184. Report of the Plant Pathologist to July 1, 1906.	241. Vine Pruning in California. Part I.
185. Report of Progress in Cereal Investigations.	242. Humus in California Soils.
195. The California Grape Root-worm.	243. The Intradermal Test for Tuberculosis in Cattle and Hogs.
197. Grape Culture in California; Improved Methods of Wine-making; Yeast from California Grapes.	244. Utilization of Waste Oranges.
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203. Report of the Plant Pathologist to July 1, 1909.	248. The Economic Value of Pacific Coast Kelps.
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208. The Late Blight of Celery.	250. The Loquat.
211. How to Increase the Yield of Wheat in California.	251. Utilization of the Nitrogen and Organic Matter in Septic and Imhoff Tank Sludges.
	252. Deterioration of Lumber.

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65. The California Insecticide Law.	109. Community or Local Extension Work by the High School Agricultural Department.
69. The Extermination of Morning-Glory.	110. Green Manuring in California.
70. Observations on the Status of Corn Growing in California.	111. The Use of Lime and Gypsum on California Soils.
76. Hot Room Callusing.	113. Correspondence Courses in Agriculture.
79. List of Insecticide Dealers	114. Increasing the Duty of Water.
80. Boys' and Girls' Clubs.	115. Grafting Vinifera Vineyards.
82. The Common Ground Squirrels of California.	117. The Selection and Cost of a Small Pumping Plant.
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88. Advantages to the Breeder in Testing his Pure-bred Cows for the Register of Merit.	121. Some Things the Prospective Settler Should Know.
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92. Infectious Abortion and Sterility in Cows.	123. Fundamental Principles of Co-operation in Agriculture.
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101. Codling Moth Control in the Sacramento Valley.	125. Aphids on Grain and Cantaloupes.
106. Directions for using Anti-Hog-Cholera Serum.	126. Spraying for the Grape Leaf Hopper.
107. Spraying Walnut Trees for Blight and Aphis Control.	127. House Fumigation.
108. Grape Juice.	128. Insecticide Formulas.