

BULLETIN NO. 139

APRIL, 1907

A L A B A M A

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

INJURIOUS INSECTS AND THEIR CONTROL.

By

WARREN T. CLARKE,

Entomologist

Opelika, Ala.:
The Post Publishing Company,
1907.

STATION COUNCIL.

C. C. THACH	President
J. F. DUGGAR	Director and Agriculturist
B. B. ROSS	Chemist and State Chemist
C. A. CARY.....	Veterinarian and Director of Farmers' Institutes
E. M. WILCOX.....	Plant Physiologist and Pathologist
R. S. MACKINTOSH	Horticulturist and State Horticulturist
J. T. ANDERSON.....	Chemist, Soil and Crop Investigations
W. T. CLARKE	Entomologist

ASSISTANTS.

C. L. HARE	First Assistant Chemist
A. MCB. RANSOM	Second Assistant Chemist
T. BRAGG	Third Assistant Chemist
D. T. GRAY	Assistant in Animal Industry
C. M. FLOYD	Superintendent of Farm
C. F. KINMAN*.....	Assistant in Horticulture
L. N. DUNCAN.....	Assistant in Agriculture
W. GILTNER.....	Assistant in Veterinary Science
H. P. STUCKEY.....	Acting Assistant in Horticulture
O. H. SELLERS.....	Stenographer and Mailing Clerk
P. H. AVERY.....	Fourth Assistant Chemist

The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

*On leave.

INJURIOUS INSECTS AND THEIR CONTROL.

By

WARREN T. CLARKE.

The agriculturist, no matter what crop he may be interested in, usually finds that he has to take into account and overcome, if may be, the ravages of insect pests. Sooner or later the question of means of control is sure to present itself to him, and on the solving of this question will depend the possible profit or loss in his farm operations. An intelligent knowledge of the fundamental principles governing the study of insect pests and an acquaintance with the best and most economical ways of applying these principles becomes therefore each day more necessary. The orchardist, the grower of field crops, the truck gardener, each of these must, to a certain extent, work out the problem in his own environment. The fact recognized that some insect is destroying entirely, or greatly reducing, the value of his crop is not sufficient knowledge upon which to base remedial measures. An acquaintance with the way in which the insect makes the damaging attack is necessary, and then the general character of the remedy to be used under these observed conditions must be known for effective work to be done.

It is not in the intention nor scope of the present Bulletin to give a complete treatise on the injurious insects of this state nor to lay down rules of procedure that will be entirely applicable in every case of damage that may arise. Indeed, there are questions in the control of certain insect pests that are today not solved, so we can only at present call attention to well known principles of procedure in such cases. On the other hand, there are many such questions that have received, either here or elsewhere, an ad-

equate answer, and, in a brief way, we may call attention to certain such specific cases.

METHOD OF INJURY.

The injury done by insects to cultivated crops may, for the present and in a general way, be considered as resulting from the insect's effort to get food. There are, undoubtedly, injurious effects to the plant frequently accompanying this food-getting effort that cause more damage to it than can be laid to the mere loss of material taken by the insect. However, the primary damage, from which these other causes of loss spring, is done by the insect in feeding upon the plant. It therefore becomes of importance to know just how the insect feeds, so that the character of the damage may be understood and further, that economical and practical means of control may be applied. The insect's method of eating largely determines the character of the control means to be used. Insects feed upon plants in one of two ways, and on these feeding methods the whole series of injurious insects can be divided into two great groups. Either the insect that is causing damage to our crops has *biting mouth parts* and obtains its food by eating out portions of the attacked plant, from the fruit, the leaves, the branches and trunk, or from the roots, or it has *sucking mouth parts* and obtains its food by piercing the tissue of the part of the plant attacked, and sucking the sap. These two very different methods of feeding are readily recognizable. The work of the leaf eating caterpillars, cut-worms; the damage caused by certain leaf attacking beetles; the feeding marks of grasshoppers upon twigs and branches; the gnawing out done by mole crickets in Irish potatoes; the burrowings and minings of various borers; these forms of damage are characteristic of the work of insects with biting mouth parts. It does not require a high degree of expert knowledge to determine the facts as to eating methods in such cases as these, yet on these facts will depend, in large measure, the method of control most likely to be effective. On the other hand, we shall find that the meth-

mode of attack of the insects with sucking mouth parts is quite as characteristic and easily recognized.

POISONING.

If we determine that the insect in which we are interested, is of the biting type, devouring foliage, perhaps, then we know that it actually takes in particles of the plant as food, and we can infer that if poison is placed on this foliage it will become a part of the insect's diet and cause its death. On this determination will depend our use of such poisons as Paris green, arsenate of lead and similar toxic agents. These are known as internal or stomach poisons, are effective only when taken into the digestive tract, and do not trouble the generality of insects when in contact with them externally.

Spraying With Paris Green.—Paris green is an insoluble compound of arsenic and copper, and has received more attention and use in farm practice than has any other arsenical. If properly prepared it should carry but an extremely small percentage of free arsenic, and under these conditions it is generally not injurious to foliage, while being a very effective insecticide. It may be used as a spray in water or may be dusted on the plants or trees to be protected. When used as a spray the mixture should be made as follows:

Paris green	1 pound
Stone lime	4 pounds
Water	200 gallons

Mix the Paris green to a paste in a small quantity of water and then put in the spray tank with nearly the total amount of water to be used. Slack the lime in enough water to break it down completely, being careful, however, not to use enough water to "drown" it. Strain the milk of lime thus obtained through a sieve into the spray tank. Keep the whole mixture thoroughly and constantly stirred while spraying. In using this material as a spray, care must be exercised not to put too much upon the tree to be protected. While enough should be sprayed on to cover the leaves

and fruit with a film of the material, if the operation is continued beyond this point and dripping ensues, the leaf edges, and occasionally the entire leaf, will be destroyed by what may be termed arsenical burning. This is caused by an excessive amount of the arsenical being deposited where the running together and dripping occurs.

Dusting Paris Green.—Paris green is also used successfully in certain cases by dusting it upon the plant. This method is especially to be recommended where low growing plants, such as Irish potatoes, are to be protected from leaf-eating insects. When the dusting method is employed the poison should be mixed with some diluting material, such as hydrated lime (lime dust) flour or even fine roadside dust. The poison should be used in not greater quantity than four pounds of Paris green to fifty pounds of the dilutant and generally one half this strength will be found effective. The mixture can be successfully and economically applied to such low growing plants by placing it in a bag made of some loosely woven material and then shaking the bag over the plant that we desire to protect. The work should be done in the early morning while the plants are yet wet with dew so that the poison will stick to them. This is of course a primitive way to distribute poisons in the dust form but there are very effective dusting machines made and obtainable by those who desire more up to date appliances.

Arsenate of lead.—The arsenate of lead is also an insoluble arsenic compound and in the matter of possible damage to foliage is rather to be preferred over the Paris green. It is slightly more expensive than the latter material but requires no lime for its preparation and, when fresh, is somewhat easier to mix with water than is Paris green. It can be used as a spray at the rate of one and one-half pounds arsenate of lead to one hundred gallons of water. At this rate its insecticidal value is good. Arsenate of lead is sold under various trade names and is commercially prepared for spraying purposes. It is not made in a dry form and cannot be used in the dusting method.

Poisoned Baits.—The use of arsenicals either as a spray or in the dust form is to be recommended then, in the majority of cases where the injury is distinctly caused by some leaf or twig eating insect with biting mouth parts. There are, however, exceptional cases where neither the dusting nor the spraying method will answer the purpose satisfactorily. This is especially true where so-called “cut-worms,” larvæ of certain moths, are causing the damage. When our problem is the control of these insects in vegetable patches or truck gardens, then the most satisfactory results will be obtained by what are known as “poisoned baits.” These depend for their killing principle upon either ordinary white arsenic or upon some one of the arsenical compounds as Paris green, London purple, or lead arsenate mixed with or put upon some food that is especially liked by the insects in question.

A quite effective poisoned bait may be made by dipping succulent leaves, such as cabbage leaves, in water in which either arsenic or some arsenic compound has been placed. The amount of the arsenical used may vary quite largely and the result still be satisfactory.

The writer has found the following proportions effective: One quarter pound white arsenic, or one half pound Paris green, to five gallons of water. The mixture should be kept well stirred and the leaves to be poisoned dipped in it. These leaves should then be placed on the ground near the plants to be protected. The work should preferably be done in the late afternoon for usually cut-worms feed in the evening and at night, and the bait will be more attractive to them when fresh. When such succulent leaves are easily obtained in quantity, the method above outlined is recommended.

In many instances, however, such leaves cannot be obtained and when this is the case a poisoned bait made as follows will be found to be thoroughly satisfactory:

Bran	40 pounds
Molasses	2 or 3 gallons
Arsenic (powdered white)	3 pounds

Water 5 or 6 gallons

Mix the bran and arsenic together thoroughly while dry so that the poison will be well distributed in the whole mass. Add the molasses, mixing it and the poisoned bran well together. To this add enough water to make a fairly consistent mash. When a handful of the material will hold together in a ball, not too stiffly, enough water will have been added. Spread this bait about in small heaps near the plants that are to be protected. Usually cut-worms will feed rather greedily upon this material and their destruction ensues. This bait can be freshened by sprinkling a little water upon it as it lies on the ground. If Paris green is used instead of arsenic the weight of the former poison should be *five* pounds in the formula.

Caution.—Care should be exercised in all instances where arsenic or any of its compounds are used for insecticidal purposes. Domestic animals, cows, horses, swine, hens, turkeys, geese, etc., should not be allowed to feed or browse where these poisons are used. The materials should not be left where human beings might accidentally obtain a poisonous dose. No danger to human beings exists when the arsenic compounds are properly used as a spray to protect fruit or trees from insect ravages. The amount of the poison present on sprayed fruit is usually too small to constitute a dangerous factor. Obviously, no possible danger can exist so far as the edible product is concerned when poisoned baits are used.

MECHANICAL METHODS OF DESTROYING INSECT PESTS.

The use of poison sprays and baits, while generally valuable in the control of insects with biting mouth parts, is not effective in all such cases that may arise. When we have to deal with insects of this type, but which feed upon the internal parts of the plant, the use of these poisons is of no value inasmuch as it is impossible to place the poison in the situation where the insect is feeding. This restriction applies mainly to those insects known as "borers," the most destructive representative of which class that we have to deal with in this state being

the well known Peach Tree Borer. Where our problem consists of an attempt to control such pests as these, then mechanical means, so far as our present definite knowledge goes, must be resorted to. Using the insect just referred to, the Peach-Tree Borer, as representing this class of insects the mechanical means to be used, resolve themselves, finally to the actual cutting out and destruction of the individual insects. This may be accomplished by the use of very primitive tools, a good strong knife, indeed, doing effective work when properly handled or more elaborate implements may be employed. The so-called "Porter Hook," invented by Mr. C. M. Porter, of Douglas, Ga., will be found to be one of the most effective of "worming" tools. It consists essentially of a handle some twelve inches in length into which is firmly set a curved or "hook" blade. This blade is about six inches in length, not including the shank which is inset in the handle, and is well curved so that the straight distance from base of handle to point of blade is four and one half inches. The destruction, by mechanical means, of the borers being here considered can best be done in the fall or early winter. "The larvae are at this time—some eighty-odd per cent. of them—extremely small, and are, for the most part, still on the outside of the tree feeding on such tender spots as they may have located between the ridges and crevices of the bark, and generally involved in a mass of gum and excreta. This, and most of the larvae with it, may be cleaned away by a few rapid sweeps with a steel hook" (i.e., the Porter hook or some similar implement). "The mass of gum, with its content of wriggling caterpillar life, should be thrown or jerked from the hook to a distance of several feet from the tree, in order that the larvae may find it difficult to return and be subjected to capture by predatory agencies. The process of "worming" thus executed is most expeditious and economical and may be conducted on an extensive scale with most satisfactory results."*

Whatever mechanical means may be employed for the

*Georgia Experiment Station Bulletin 73.

destruction of this or other borers, care must be exercised by the operator not to excessively wound or cut the tree. As much damage may be done the tree by careless or inefficient manipulation as would have been done by the borers that may have been destroyed in the operation.

The time above given and the method of work outlined does not, of course, apply to all the various species of borers attacking the different growths in which we may be interested. The general statement, however, may here be repeated that the work of control resolves itself into the careful cutting out, or probing for, the borer and the destruction of the individual pests and we may further emphasize the fact that the use of the arsenical poisons in such cases offers small hope of any success.

Certain injurious insects, notably the plum (or peach) curculio (*Conotrachelus nenuphar* Herbst.), have a habit of dropping to the ground and feigning death when disturbed. This habit is taken advantage of to destroy the insect. Sheets of cloth, upon light wooden frames, are placed beneath the affected trees which are then rather violently shaken or jarred. The disturbed insects fall on to the sheets and are collected from these and destroyed. The work should be done in the early morning when the insects are least active. The jarring process to be at all successful must be begun as soon as the insects are first noted upon the trees and fruit and must be continued until jarring fails to bring down enough to pay for the labor involved. This purely mechanical means of destroying these pests while being fairly satisfactory, so far as it goes, does not fully answer the question of their control. The writer has had occasion to note quite satisfactory results in controlling this pest by *spraying*. In the instance in question, the peach orchard was being sprayed with Bordeaux mixture to control the "brown rot" (*Monilia fructigena*.) The Bordeaux mixture was properly made by dissolving four pounds of copper sulphate (bluestone) in twenty gallons of water and by carefully slacking five pounds of clean stone lime and stirring the milk of lime or lime paste thus

obtained in twenty gallons of water. The copper sulphate solution and the lime water mixture were then poured together through a strainer into the spray tank and to the resulting Bordeaux mixture was added one pound of lead arsenate dissolved in a small quantity of water. The whole mixture was kept thoroughly stirred while being sprayed on the trees.

In the case noted this operation of spraying was repeated three times during the season and mainly to control the "brown-rot." The first application was made just before the blossoms opened and no poison added to the mixture; the second application, this time with the poison added, was made when the fruit had set, while a third application, again with poison, was made some three weeks later. The control obtained indicated considerable value in the method as above outlined. This spraying method of control, however, cannot as yet, be considered as superceding the method of mechanical control of the series of insects now being considered and until further data is at hand jarring for the curculio is the practice to be recommended.

The two methods of mechanical control of insect pests outlined in the preceding paragraphs, that is the destruction by individuals of borers and the shaking down and destroying in numbers such insects as the curculio, indicate lines of work that may have to be employed in certain specific cases. Necessarily the method of work employed will be governed by a study of the insect itself and its habits of life.

TRAP CROPS.

While the methods of work heretofore outlined offer means of control for many insect pests, when these methods have been adapted to the local conditions where the work is to be done, yet there are certain insects that cannot be reached by any of the ways noted. Such of our truck gardeners as are interested in the production of early tomatoes know the damage done by worms to the "bottom" or earliest crop of this vegetable. When this portion of the crop can be brought off uninjured the largest profit accrues to the grower.

The insect causing the greatest part of the loss to this portion of the tomato crop in this state, is the larval or caterpillar form of a moth scientifically known as *Heliothis obsoleta*. In the caterpillar form it is best known as the boll worm of cotton or as the corn worm. It is a destructive enemy of corn and especially of sweet corn and seems to prefer this latter to any other diet. The appearance of the larva or "worm" is familiar to all who have handled sweet corn "in the ear." This food preference can be successfully taken advantage of to control this pest in tomato fields where the saving of the "bottom" crop is a matter of importance, by planting sweet corn as a trap crop. The method to be used is as follows: Prepare the land fully four weeks before the tomato plants are to be removed from the frame and put out in the field. As soon as the land is prepared plant rows of sweet corn about twenty feet apart across the field. The corn should be planted in hills in the rows, these hills being a convenient distance apart for cultivating, so that they may not interfere with this operation after the tomatoes are set out. The sweet corn should be well up and growing before the tomatoes are placed in the field. The adult moth laying the eggs from which are produced the damage causing "worms" are attracted by the sweet corn and oviposit upon it and the tomatoes, in very large measure, escape injury. Of course no paying crop of corn need be expected under these conditions for the product will be too "wormy" to market. It will, however, have well served its purpose as a trap crop and can, at the proper time, be cut for fodder.

This "trap crop" method of controlling certain pests that are not controllable in any other way, deserves study and use upon the part of the truck gardener. It is, however, not to be considered as offering a ready means of relief in every case of insect injury that may arise.

FARM PRACTICE.

Closely related to the "trap crop" method of control of certain insect pests, in a method that may be designated under the rather broad title of "farm practice." There are

some insects which, owing to the fact that their place and way of feeding does not admit of it, cannot be well controlled by any of the methods outlined in the previous paragraphs. In certain such cases a study of the life history of the injurious insect indicates that by changes in our time of planting and method of work we can bring on the crop before or after, as the case may be, the pest is most active and hurtful. By this means, though the insects are not destroyed, we avoid the damage that might otherwise be great. One of the insects causing damage to corn in this state is commonly known as the "bud worm." This is the larval form of a beetle known scientifically as *Diabrotica 12-punctata*. This beetle is about one quarter inch in length, is yellowish-green in color, with the wing covers marked with twelve black spots. The head and the greater part of the legs is black. It is very fond of cucurbits and is frequently found in numbers on the blossoms of such plants as cucumbers and squashes. The larva ("bud worm") is white or yellowish in color, quite slender and soft bodied. It usually feeds upon the corn roots, though, as it grows older, it may eat directly into the stalk and destroy the plant. It is from this last form of attack that it has received the name, "bud worm." It has been noted that early planted corn is most likely to suffer from the attack of this pest. The method of farm practice suggested by this fact is obviously then *plant as late as possible* to avoid this injury by the "bud worm." In this connection it is as well to say that late planting will not entirely do away with this pest. A system of rotation of crops is highly desirable where this insect is present. This rotation should not include beans or cucurbits as both of these are acceptable food for the *Diabrotica*. Cotton may be used in the rotation with safety. There are undoubtedly many insect pests now present in our state whose damaging work would be much lessened by some such simple change in practice as that just noted. Where the method would be applicable, however, would be a matter to be determined by the study of individual cases.

Under this heading of "farm practice" we wish to call especial attention to an insect that will in the course of three or four years be of immense importance to the cotton growers of the state. Reference is here made to the Mexican Cotton Boll Weevil, an insect which has not yet made its appearance in Alabama, but whose arrival can be predicted with a fair degree of certainty. While the exact date of the introduction of this pest to this country is not known, yet it must have come here a short time before the year 1894, when the attention of the Bureau of Entomology of the U. S. Department of Agriculture was first called to it. It was then present and harmful to cotton in some seven or eight counties of Texas. Since that time, in spite of all control efforts, it has spread over a larger and larger territory until now the limit of its eastern dispersion is within thirty miles of the Mississippi river. Besides the enormous loss to the cotton crops in the states at present most affected by this pest, Texas and Louisiana, many thousands of dollars have been spent by these states and by the Bureau of Entomology in studies of the insect and in devising ways and means of control. These studies have developed, among other important items, the fact that the Mexican Cotton Boll Weevil hibernates as an adult. This means that a certain proportion of the full grown weevils live in the cotton fields, or in adjacent situations, through the winter and from these overwintering individuals are produced the first of the new series of weevils the following spring. A further important fact is that this weevil is confined to the cotton for its food. Based on these two facts is the method of control of this pest that has proved most satisfactory and it is one of "farm practice" purely. The method is in brief, as follows: First, plant as early as can be and avoid possible frost injury, using seed of some early maturing variety of cotton. Second, by thorough cultivation and the use of fertilizers force the cotton to early maturity. Third, as soon as the crop is made remove by cutting out, raking to windrows and burning, all cotton plants. While this procedure involves a change in

practice in cotton growing in this state yet it is a change that would benefit the industry were the Boll Weevil never to get here.

By this method an excessively long period of time results in which no cotton is available as food for the weevils and the number successfully hibernating is much reduced. It is not in the intention of this bulletin to enter very deeply into the subject of the Mexican Cotton Boll Weevil. It is sufficient for our present purpose to merely call attention to the great importance of the method of "farm practice" as applied in this and similar cases of insect attack where other methods offer scanty or no relief.

INSECTS WITH SUCKING MOUTH PARTS.

Our attention so far has been drawn to the insects that have biting mouth parts and that obtain their food by actually eating out portions of the attacked fruit or plant. There is, as was noted in our opening paragraphs, a series of insect pests whose method of eating is quite distinct and different from these so far spoken of. These insects have mouth parts so adapted, structurally, that they pierce through the outer covering of the plant or fruit attacked, and suck out the sap or juice. They do not use as food any of the outer part of the plant and as a consequence none of the poisoning methods heretofore spoken of are of any avail in their control. Another point of dissimilarity between these insects and the group designated as having biting mouth parts is that while the latter insects move about from place to place and do not, as a rule, gather together in fixed colonies, the series with sucking mouth parts have this bunching together, gregarious habit, strongly developed. Not only is the colonizing habit characteristic of these insects but in the most injurious representatives of the group we find that when the sucking mouth parts have been inserted in the plant tissue and feeding begun the individuals remain fixed in the chosen situation throughout the balance of their lives. This habit of restricted motility, as it may be termed, is especially evident among the so-called scale insects (*coccidae*) and in the

nearly related group of insects, the plant lice, (*aphididae*.)

The methods of control that are successful with these insects are based upon this life habit of restricted motility and in the main consist of the use of what are known as "contact insecticides." These insecticides depend for their killing power, not upon the introduction of some toxic agent to the digestive tract of the insect, but upon the effect that the agency used may have upon the insect when in contact with it externally. They may be caustic in their action, actually destroying the tissues of the insect, and so bringing about its death, or they may be oily in their nature and depend for their killing power upon entering the body of the insect through the breathing pores. These are situated upon the sides of the body, and through them and their connecting tubes, (*tracheae*), air is carried to all parts of the insect's body. While the exact action of the oily sprays upon the insect's respiratory system is problematical; still the value of these sprays depends upon their effect on this system. A third class of contact insecticides depend for their value upon their tendency to loosen the insect from its situation upon the plant and permit the action of the weather upon the thus exposed pest to cause its death. Each of the methods above outlined has its value in particular cases and under certain conditions.

CONTROL OF SCALE INSECTS.

The two pests among the scale insects causing the greatest losses in this state are the so-called San Jose Scale (*Aspidiotus perniciosus* Comst.) and the New or West Indian Peach Scale (*Aulacaspis pentagona* Targ.) The San Jose Scale is well distributed throughout the whole state while the West Indian Peach Scale is not quite so widespread in its distribution. Both insects belong in the group known as the armored scales which means that the living creature is covered over with an armor like shell which is composed of the cast skins (*exuviae*) of the insect and of a waxy material secreted by it. In both cases the individuals are extremely small and it is only their great numbers that make them a dangerous pest. It is not our in-

tention at the present time to enter into an extensive description of either of these insects. For a fuller discussion of the subject the reader is referred to Circular No. 1, issued from this department in October, 1906. It is enough to say here that the same means of control are applicable and recommended for both insects.

These consist solely of contact sprays and the one in most general use, and at present most satisfactory, is the so-called Lime-Sulfur-Salt spray. This may be made by the following formula:

Lime	30 pounds
Sulfur	20 pounds.
Salt	5 pounds.
Water	60 gallons.

*Preparation.**—"For preparing the wash two vats or boilers are necessary, and if the spraying is to be done on a large scale, one of these, at least, should hold a couple of hundred gallons. If a smaller number of trees are to be treated, iron kettles will answer the purpose. Of course the preferable way of cooking the wash is by means of live steam.

Many ways have been suggested for mixing the materials, but the results are the same in every case, so long as the mixture has been subjected to the required amount of boiling. It is largely a matter of convenience, then, that determines the particular method, and the one found to best answer this requirement is as follows:

First, place two or three inches of water in the boiler, and to this add the sulfur, which has previously been made into a paste by mixing with hot water in order to remove the lumps, or sift the dry sulfur through a mosquito wire netting and stir in thoroughly. Then add about one fourth of the lime, and when the violent boiling has ceased add another fourth, and so on until the required amount of lime has been added. Hot water should be added with the lime as needed, so as to make the mixture a creamy consistency. Too much water will "drown" the lime while

*From Alabama Agric. Exper. Station, Circular No. 1, Oct. 1906.

on the other hand too little, will cause incomplete slaking of the lime. In this way the heat generated by the slaking lime is taken advantage of, and by adding the sulfur first, plenty of time is given for removing the lumps.

By the time the lime is thoroughly slaked the fire should continue the boiling, so that the time of boiling begins with the addition of the lime. The salt and about one-fourth of the water should now be added and the whole boiled from one to two hours, keeping it frequently stirred in the meantime. At the end of this period screen into the spray tank, add the necessary amount of *hot* water and apply to the trees hot.

The wash, when properly made, is a heavy reddish-brown liquid, very caustic and having a strong sulfur odor. The heavier materials settle upon standing, leaving a lighter liquid both in color and weight.

Application—On account of the heavier ingredients of the wash quickly settling to the bottom, means should be provided for agitating the mixture in the spray tank. This is best done, of course, by the power outfit. In the absence of this a gearing may be attached to the wheel of the wagon and the mixture agitated while going from one tree to another. A still simpler way is to stir frequently by means of a hoe or paddle.

The nozzle should be of the stopcock type, which will permit of ready cleaning. The type of spray should be a rather coarse one which will thoroughly wet the insects.

* * * * *

Thoroughness in application cannot be too strongly urged, and *no part of the tree should escape treatment.*

Time of application.—The Lime-Sulfur-Salt wash is for winter use only. It must not be used when trees are growing for very grave injury will be the result if it is applied at that time. When the trees are dormant it can be safely used upon them. Such weather conditions in the winter as will permit work in the orchard will be satisfactory for applying the Lime-Sulfur-Salt wash."

The difficulty attendant upon the preparation of this wash has led to a large amount of experimentation with

other washes. Among the many materials used in this experimental work, the so-called "soluble oils" seem to offer the most promise and where winter work with the Lime-Sulfur-Salt preparation has been impossible, then it is advisable to use this material. It is known under different trade names and under the designation, "Scalecide," a quite desirable contact insecticide is sold. The spray made with this material can be used with safety in the spring and its results, when so used, are fairly satisfactory.

The main point to be observed in the use of this and all other contact insecticides is thoroughness of application. To be effective the material must come in direct contact with the insect to be destroyed.

PLANT LICE.

Another quite destructive series of insects with sucking mouth parts are the so-called "plant lice," the Aphids. These are soft bodied creatures, quite small, though generally larger than the scale insects, and are more easily destroyed than are the latter pests.

Certain species of aphids are well known to our truck gardeners, as for instance, the cabbage louse, (*Aphis brassicae*), while certain other series are quite destructive to orchard products and even to trees. When the attack of these insects is confined to the above ground parts of the tree or plant they can be quite readily destroyed by a spray made as follows: Dissolve one and one-half pounds of ordinary kitchen or laundry soap in one and one-half gallons of water. This can best be done by shaving the soap into boiling water and keeping the water boiling until the soap is fully dissolved. Remove from the fire and pour into the strong suds thus made one gallon of kerosene oil, stirring vigorously while pouring. Continue this vigorous stirring for fully ten minutes. The result should be a fairly stable creamy emulsion with no free oil. To the Kerosene Emulsion thus made add eighteen gallons of water and the spray is ready to be applied. It will be found quite effective as a destroyer of the majority of plant lice with which the grower will have to deal.

There are certain species of plant lice that attack not only the above ground portions but also feed upon the roots and root crowns of the trees. When our problem is the control of such insects as these, special methods of procedure are necessary. The best known of these pests is the Woolly Aphis of the apple—an insect that is familiar to all who are interested in the growth of this fruit. Very briefly we may say that the general method of procedure in such cases as these is to work in about the tree and root crown such materials as wood ashes or tobacco dust. These materials have a tendency to either destroy the insects or discourage their attack at the point where it is most damaging, the root crown. Special cases of this character, however, demand special study and treatment.

In the control of certain of the insects with sucking mouth parts no spraying or other method of ordinary procedure is of use and we are reduced to the practice of "hand picking" or jarring the insects off of the infested plants in our control efforts. This is true of the larger representatives of the series, as for example, the so-called "squash bug," (*Anasa tristis*,) where spraying is of little or no value and control is obtained only by the removal and destruction of the individual insects.

There are many other insects of the type with sucking mouth parts to which attention might be called but we believe the purpose of this paper is served in citing the instances above noted.

Whether the insect causing damage is of the biting or sucking type, a reasonable study of it and its activities allows us to apply remedial measures far more economically and with a greater hope of success than would be the case without this study. The purpose of this Bulletin will have been served if it brings about a closer study of the insect causes of loss in this state and a more intelligent application of remedial measures.