

The number of this Circular should be 15 instead of 17

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SPRAYING APPLES.

BY

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RETURNS.

During the past summer season, working in seven different and widely separated orchards in southeast Kansas in coöperation with the Bureau of Entomology and interested fruit growers, the Agricultural College has been able to increase the average yield of merchantable apples four bushels per tree by spraying alone. This means when sold as orchard run a net profit of \$1.62 per tree, or \$97.20 per acre; and when properly graded, packed and marketed, nearly double that amount. These returns are neither the best nor the poorest, but represent the average good derived from spraying in all the orchards. An average of thirty-seven per cent more fruit per tree was produced on the sprayed blocks than on those unsprayed. Nor do the good results of the spraying appear fully in the actual increase in merchantable fruit, but are to be found also in the increased proportion of high-priced grades. The merchantable fruit from sprayed trees showed an average of fifteen per cent more No. 1's and seven per cent more No. 2's than that of the unsprayed trees.

These seven orchards included both home and commercial types, and were composed of all the varieties recognized as standard in Kansas. One home orchard under treatment consisted of approximately 200 trees distributed through thirty-three varieties.

In determining the effect of the spraying on insects and fungi more than a quarter of a million of apples were individually examined. In 1909 very few or no apples were grown in these orchards, consequently the proportion of infested apples from unsprayed trees was very much less than has been the case where crops of apples are borne in successive years. The twenty-seven per cent of unsprayed fruit injured by codling moth was reduced by spray-

ing to five per cent; the fifty-two per cent injured by curculio to twenty-nine per cent; the eighteen per cent injured by scab to one per cent; the twenty-three per cent injured by apple blotch to seven per cent; the twenty-one per cent injured by sooty blotch to two per cent. The thirteen per cent of the fruit which was found absolutely free from insects and fungous injury on unsprayed trees was, by spraying, increased to sixty per cent. Bordeaux mixture burned twenty-five per cent of the apples treated, while lime-sulphur burned only six per cent.

It is the purpose of the authors of this circular to point out the value of proper spraying, and to state the methods by means of which owners of home and commercial orchards may achieve as good or better results. A more complete statement of this whole matter is made in Kansas State Experiment Station Farm Bulletin No. 175.

RECOMMENDATIONS.

It should go without saying that the orchard from which one expects to get fine apples should be well pruned, well cultivated, and well fed. No amount of spraying will make trees which do not set apples, either because of lack of proper growing conditions or frost, produce fruit. Spraying is intended merely to insure a large percentage of the apples which do set against the ravages of insects and of fungous diseases. To render spraying worth while, all measures which look toward a strong set of apples must be taken.

NUMBER OF SPRAYS.

In view of the fact that these sprays are intended to destroy fungous diseases which develop throughout the growing season, it appears that at least four sprays should be used, and that they should be concentrated at the beginning of the season in such a manner that the foliage and fruit may be covered by a protective substance when the disease spores are sprouting and beginning to attack the rapidly growing and consequently tender fruit and foliage.

TIME OF SPRAYING.

There is a right time to spray. The first spraying, which is intended to destroy applescab fungus, canker worms, bud worms and leaf feeders generally, should be applied just after the cluster cups open and just before the flower buds unfold. The second spray, which is intended principally for codling moth and secondarily for curculio and scab and blotch fungi, should be given at the dropping of the blossoms and before the calyx lobes close. This may

begin when the blossoms are one-half to two-thirds down. The third spraying, which is intended for codling moth, curculio, scab, blotch, black and bitter rot, should be given about three weeks after the blossoms fall, because by this time the first brood of codling moth larvæ is hatching and the fungus-killing mixtures have probably been largely washed from the trees. The fourth spraying, when bitter rot is not anticipated, consists of arsenate of lead alone. It is intended primarily for second brood codling moth larvæ and secondarily for general leaf and fruit feeders. It should be applied about ten weeks after the blossoms fall.

SPRAYING MACHINERY.

Spraying machinery is intended to deliver the spray mixtures in such a way as to cover the trees thoroughly in the shortest possible time. This is accomplished by placing the liquid under pressure and delivering it through a small aperture, whereby it is broken up into a fine mist which can be driven upon all parts of the tree. The first consideration, then, is the power, and the second the pump, the hose, extension rods and nozzles.

The power is usually derived from man work, gasoline engine or compressed air. The first is the cheapest and most practical when less than 500 trees are concerned, but when 500 to 2000 trees must be treated a gasoline engine is needed, and when more than 2000 trees are to be sprayed compressed air might be profitably employed.

It is quite possible that some growers, owing to scarcity of labor, will find the gas engine most practical for a smaller number of trees than 500. The objection to the gas engine for more than 2000 trees lies in the fact that more than one outfit must be employed, necessitating the employment of an engineer for each, who, if satisfactory, is usually high priced. It is better when several outfits are needed, to purchase a good gas or steam engine and a compressor, by means of which an abundance of power can be produced for all outfits. In our experience spraying done by means of a gas engine outfit, when the engine runs well, costs, other things being equal, a little more than one-half as much as when done by hand power. The reduction in cost should be almost as great when compressed air is employed.

Whether the source of power is muscle or gasoline, the spray is put under pressure by means of a force pump. A satisfactory pump, regardless of the power to be employed, should have the following points: (1) all parts that come in contact with the spraying fluid should be made of brass, which will not be corroded

by any of them; (2) the air chamber should be so large that the liquid will be delivered in a steady stream, instead of in a succession of spurts; (3) all working parts, especially the valves, should be so made that they can be easily gotten at and cleaned; (4) the parts should be so arranged that they will have the minimum chance of breakage should the pump fall (this applies particularly to the barrel pump, which is always likely to tumble off the wagon or cart—and can best be insured by having a pump the working parts of which are mainly in the barrel); (5) when gas engine is geared to pump, both pump and engine should be immovably fastened upon the same base, preferably of iron or steel.

The hose should be long enough to permit the operator to reach every part of the tree. In our experience twenty-five-foot lengths have proven most generally useful. Ordinary garden hose connections are not satisfactory when much pressure is to be employed, because the part which is thrust into the hose is too short and too smooth; under heavy pressure such connections are likely to slip and make trouble. Hose connections having an especial length and roughness of shaft are desirable. The hose should end in an extension rod of some sort, either bamboo, brass lined, or ordinary gas pipe uncovered. The extension rod should bear one or more nozzles, depending upon the amount of pressure to be used. Two types of spray are used, the strong dashing type and the mist type. The first type is produced by the Bordeaux nozzle and the second by the Vermorel or "Friend" nozzles. In our experience the "Friend" type of nozzle has proven a little the more satisfactory, because it never catches in the branches of the tree. All joints from pump to nozzle-opening should be made so tight that no liquid can escape.

SPRAYING MATERIALS.

We spray the apple orchard to destroy insects and fungi that would, if unchecked, reduce or completely destroy the crop. The insects that do most of the damage to foliage and fruit bite off and consume pieces of fruit and foliage. They can be destroyed by placing a stomach poison at the proper time on the food which they use. Arsenic combined with lead (arsenate of lead) has been found best for this purpose, because it adheres for a long time to fruit and foliage and has so little free arsenious acid in it that we have never known it to burn appreciably.

The methods by which the several important destructive fungi gain entrance to the tissues of fruit and foliage are much alike. A small spore is blown upon the surface of the fruit or leaf. Under the influence of moisture the spore bursts and the growing sprout

emerges. It finds its way through the skin of the fruit, grows inside the tissue and produces spores which, escaping from the dead tissue, spread the disease to other and healthy tissue. If, while the spore is sprouting, it be brought into contact with a substance deadly to it, it will perish. Of course, this deadly substance must be just strong enough to kill the young fungus plant and not strong enough to injure the foliage and fruit of the apple. Copper sulphate or blue vitriol when combined with milk of lime, forming Bordeaux mixture, has been found, beyond doubt, to kill the injurious fungi and not very seriously injure the apple. Of recent years, however, accumulated experience has shown that even the weakest Bordeaux will, if its application be closely followed by rain, badly burn both the foliage and fruit of certain susceptible varieties. This fact has led to a search for a substitute. Of those tried, lime-sulphur has proven the most promising. For all the common apple diseases except apple blotch, lime-sulphur properly used has proven a satisfactory substitute for Bordeaux,

Our experience would lead us to recommend the use of Bordeaux plus arsenate of lead on varieties of apples especially susceptible to blotch, or upon those not subject to Bordeaux injury, and lime-sulphur plus arsenate of lead on varieties not likely to be badly injured by blotch. We would further recommend the 3-4-5 formula for Bordeaux plus two pounds of arsenate of lead, or 1½ gallons commercial lime-sulphur (testing 30° to 33° Beaume) to 60 gallons of water plus two pounds of arsenate of lead.

Although we have not tried it, it seems likely that a combination of lime-sulphur and Bordeaux mixture might protect even the varieties subject to blotch and at the same time avoid much of the burning; say, make the first two applications with the lime-sulphur combination and the third with the Bordeaux combination. This can be taken only as a suggestion.

METHOD OF APPLICATION.

The method of application should be made to vary with the object to be gained. All sprays except the one given at the dropping of the petals are intended to coat as completely as possible both foliage and fruit with the mixtures. They are therefore delivered as a fine mist from both ground and tower in such a manner as best to effect this object. The spray at the dropping of the petals is intended to fill the open calyx end of the apple with poison, because eighty per cent of the first brood and a large percentage of the second brood of apple worms enter the fruit through this door, and because soon the calyx lobes will roll together, en-

closing the poison and holding it there for all comers. When this spray is delivered the young apple stands with the calyx opening upward and the filling can best be accomplished by shooting the spray into it from above downward under great pressure. There is a difference of opinion among experimenters as to whether the second spray delivered as a dash is more effective than if delivered as a mist.

With the ordinary spraying machinery efficient spraying cannot be done with pressure of less than eighty pounds, and the work can be much more satisfactorily and rapidly done with a pressure of 200. Good types of barrel pumps will give pressures ranging from 60 to 120 pounds, with an average of about eighty. Gasoline and compressed air sprayers will give pressure from 120 to 225 pounds.

SCHEDULE OF APPLICATION.

Varieties Not Likely to be Seriously Injured by Apple Blotch.

First Application—Between the opening of the buds and the opening of the blossoms, thoroughly spray the trees with one and one-half gallons lime-sulphur plus two pounds of arsenate of lead to fifty gallons of water. Apply through fine-holed nozzles as a fine mist, and make every effort to see that all parts of the unfolding foliage are given a complete and even coat of the mixture.

Second Application—Beginning when the petals are one-half down and finishing within five or six days of the complete dropping of the blossoms, spray the trees thoroughly with the same mixture, making an especial effort to fill the up-turned blossom ends of the apples with the mixture. The best results in this spray can be obtained by shooting it from a tower down into the blossom ends under the greatest possible pressure, 200 pounds being much better than eighty pounds, and eighty pounds being the least pressure with which satisfactory work can be done.

Third Application—Three weeks after the blossoms fall spray the trees thoroughly with the same mixture, making every effort to give the fruit and foliage an even and complete coat of the liquid.

Fourth Application—About ten weeks after the blossoms fall spray the trees thoroughly with arsenate of lead alone, using two pounds to fifty gallons of water, delivering the mixture as a fine mist, and making every effort to see that all parts of the fruit and foliage are given an even and complete coat.

If bitter rot is anticipated, this application should be made with the same material as the preceding three.

Varieties Likely to be Seriously Injured by Apple Blotch.

Use exactly the same treatments as those suggested under the previous heading, except that for lime-sulphur 3-4-50 Bordeaux mixture should be used.

PREPARATION OF THE LIME-SULPHUR COMBINATION.

The commercial lime-sulphur solutions made use of during the past summer tested from 30° to 33° Beume. One and one-half gallons of the solution proved sufficiently strong to control in a satisfactory manner all diseases except apple blotch, and injured only six per cent of all the apples treated with it. In using this solution the spray tank should be filled with water, the right amount of the lime-sulphur solution measured out and emptied into the tank full of water. After thorough agitation the mixture is ready to apply. If a poison is needed, two pounds of arsenate of lead to fifty gallons will prove satisfactory. Mix the lead first with a small amount of water until it will pour readily, then empty it into the mixture, agitate it vigorously, and the combination is ready for use.

PREPARATION OF THE BORDEAUX COMBINATION

To make Bordeaux mixture properly and speedily, four tanks are required. Two should be for stock solutions of lime and copper sulphate, and two should be for dilutions. Each dilution tank should have one-half the capacity of the spray tank. In preparation of stock solution of copper sulphate, fill the tank with water, place twice as many pounds of copper sulphate in a burlap bag, or other loosely woven sack, as there are gallons in the tank, and suspend this copper sulphate filled bag in the water by tying it to a pole which extends from one side of the tank to the other. The copper sulphate should be put to soak the night before it is to be used and by morning it will have been dissolved. In preparation of the lime water take twice as many pounds of good stone lime (all of which will slake completely and leave no lumps), place it in the lime stock solution tank and put enough water on it to slake it, After slaking is complete, fill the tank with water. Thus the stock solutions are made at the rate of two pounds to the gallon, When ready to make fifty gallons of Bordeaux mixture, first stir the stock solutions thoroughly, then put 1½ gallons of the copper sulphate water into the copper sulphate dilution tank, put two gallons of the limewater into the lime dilution tank, and fill both tanks with water. After stirring the diluted mixtures, allow them to run together through a burlap or other strainer into the spray tank, and the very best type of (3-4-50) Bordeaux mixture will be

the result. Bordeaux mixture should be alkaline. If, on dropping a few drops of potassium ferrocyanide solution, which can be obtained from any druggist, into the Bordeaux, no change occurs, the solution is alkaline and satisfactory. If, on the other hand, the potassium ferrocyanide drops turn brown on striking the liquid, the Bordeaux is acid and enough limewater should be added to make it alkaline. Mix the arsenate of lead with Bordeaux as with the lime-sulphur, and the combination is ready to apply.

Unless the orchardist has a very large amount of spraying to do it will hardly pay him to make his own lime sulphur, but there is nothing better than home-made Bordeaux.

APPENDIX.

Dealers in Insecticides, Fungicides, and Spraying Apparatus; Insecticides and Fungicides; Arsenate of Lead—Grasseli Chemical Company, St. Louis, Mo.; Merrimac Chemical Company, Boston, Mass.; Agents McPike Drug Company, Kansas City, Mo.

Lime-Sulphur Concentrate—Grasseli Chemical Company, St. Louis, Mo.; Rex Company, Omaha, Neb.; Sherwin-Williams Company, Kansas City, Mo.

NOTE.—There are many excellent brands of lead arsenate and lime-sulphur in the market, but to avoid confusion we are naming only those which we have found satisfactory.

Copper Sulphate and Lime—Copper sulphate can be furnished by any reputable supply house. Satisfactory lime can be had from any reputable dealer.

Dealers in Spraying Apparatus—T. Lee Adams Seed Company, Kansas City, Mo.; Cushman Power Sprayer Company, Lincoln, Neb.; John Deere Plow Company, Kansas City, Mo.; The Demming Company, Salem, Ohio; Field Force Company, Elmira, N. Y.; Goulds Mfg. Company, Seneca Falls, N. Y.; Hardy Mfg. Company, Hudson, Mich.; H. L. Hurst Mfg. Company, Canton, Ohio; Morrill & Morley, Benton Harbor, Mich.; T. E. Myers & Bro., Ashland, Ohio; Niagara Sprayer Company, Middleport, N. Y.; Underwood & Viles, Hutchinson, Kan.; Wyandotte Seed Company, Kansas City, Kan.