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OREGON STATE AGRICULTURAL COLLEGE

Bulletin No. 75.

NOV 6 1931
March, 1903.

DUPLICATE



Department of Entomology and Plant Diseases.

Oregon Agricultural Experiment Station.

CORVALLIS, OREGON.

INSECTICIDES AND FUNGICIDES.

BRIEF DIRECTIONS FOR THEIR PREPARATION AND USE,
INCLUDING SPRAYING, DUSTING, FUMIGATING, ETC.....

By A. B. CORDLEY.

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AGRICULTURAL COLLEGE PRINTING OFFICE.
GEO. B. KEADY, PRINTER.
1908.

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INSECTICIDES AND FUNGICIDES.

Brief directions for their preparation and use, including spraying, dusting, fumigating, etc.

INTRODUCTION.

None of the crops of orchard, garden or field; none of our domestic animals; practically none of our food products, household effects or wearing apparel but are subject to the ravages of insects or fungi, or both. Even man, himself, is subject to great personal annoyance and even disease by these ever present agencies.

The financial losses caused by such ravages are enormous. Some years ago, Dr. C. V. Riley, at that time the greatest authority on economic entomology, estimated the average annual loss in the United States from the ravages of insects alone at not less than ten per cent of the total value of all crops grown—a tax upon agriculture much greater than the combined levies for the support of schools and the maintenance of our municipal, county, state and national governments. The estimate is none too high. I have observed that a tax levied by insects or fungi which does not greatly exceed ten per cent of the value of the crop rarely attracts attention. A loss of twenty-five, fifty or seventy-five per cent is necessary to awaken us to a realization of the fact that something is wrong.

Much of this loss can be prevented—the tax levy can be reduced—some of it by proper agricultural practices, some by the selection of resistant varieties of the crops to be grown, some by the intelligent use of insecticides and fungicides.

It is the purpose of this bulletin to give brief directions for the preparation of the most important insecticides and fungicides that have been tested by experiment station workers and found useful, prefacing these directions by such references to the nature of insects and fungi as may be necessary to an understanding of the general principles which underlie the successful use of the various compounds mentioned.

INSECTS AND INSECTICIDES.

To understand the general principle which underlies the selection of the proper remedy to be used for any particular insect, one has only to know that practically all insects may be divided into two great groups.

GROUP I.—This includes all insects that have biting mouth parts—mandibulate insects—and which actually chew and swallow the tissues of the plant or other substance upon which they feed. Grasshoppers, caterpillars, flea-beetles, striped cucumber-beetles, codling moth larvæ, etc., are good examples of this group.

GROUP II.—This includes all insects with beak-like sucking mouth parts—haustellate insects—which pierce the plant or animal upon which they feed and suck up its juices or blood but neither chew nor swallow any of the structural tissues. The apple-tingis, woolly-aphis, hop-lice, green apple-aphis, black cherry-aphis, San Jose Scale, etc., are good examples of this group.

In general, insects which belong to group I may be poisoned by sprinkling or dusting the surface of the plant upon which they feed with some poisonous substance; but insects which belong to group II cannot be so poisoned since they secure their food from beneath the surface and cannot be made to eat the poison. They must be destroyed by gases, washes, or other substances which act externally upon their bodies.

All insecticide substances may therefore be arranged into two general groups.

GROUP I—FOOD POISONS.—This group includes, principally, the various arsenicals, such as Paris green, London purple, Scheele's green, arsenite of soda, arsenate of lead, etc. These poisons are all valuable against insects which belong to group I and feed exposed upon the surface of plants but are practically valueless against those of group II.

GROUP II—CONTACT INSECTICIDES.—This group includes a great variety of substances which act externally upon the bodies of insects either as mechanical irritants or caustics, or to smother them by closing their breathing pores, or to fill the air about them with poisonous gases, or simply as repellants. Soap, sulphur, tobacco, insect powder, hellebore, kerosene, kerosene emulsions, crude petroleum, the lime-sulphur-salt wash, resin washes, hydrocyanic acid gas, and carbon bisulphide are some of the most valuable insecti-

cides of this group. These are used successfully not only against sucking insects but many of them are also used against biting insects when for any reason it is undesirable to use poisons; or when it is impossible to apply poisons directly to the food supply, as in the case of insects which work beneath the surface of the soil, or as borers or miners in wood, leaf or fruit, or in stored products, or as animal parasites, or household pests.

FUNGI AND FUNGICIDES.

A fungus is a plant as truly as is the apple tree, the prune tree, the wheat plant or any other plant upon which it may be growing. It differs from the common plants essentially in being much more simple in structure and in being devoid of chlorophyll—the green coloring matter of plants. Its seeds, which are called spores, are more simple and very much smaller than the smallest seeds of our common plants and are produced in almost inconceivably great numbers. The vegetative portion of the fungus, the part which, in a sense, corresponds to the roots, stems and leaves of ordinary plants, the part which absorbs the food materials and eventually produces the spores, consists of a mass of more or less branched, white or colorless, and very minute threads and is called the mycelium.

Being so small and light, the spores are readily carried long distances by the wind, are washed about by the rains, and are also carried by birds and insects and probably by other agencies. These agencies are thus largely responsible for the spread of fungus diseases from leaf to leaf, plant to plant, or orchard to orchard. Over greater distances the spores may be carried on shipments of infested nursery stock, fresh fruits, vegetables, seeds, etc.

Should a spore fall upon suitable soil, such as the surface of leaf or fruit, and the conditions of heat and moisture be favorable, it will germinate—push out a delicate, slender germ-tube. In the case of most parasitic fungi this germ-tube soon penetrates the epidermis of the leaf or fruit and the mycelium develops in the underlying tissues entirely beyond the reach of fungicides. In some cases, however, the mycelium spreads over the surface of the plant. In other words, fungi, like insects, may be divided into two groups, as follows:

GROUP I—INTERNAL FUNGI.—This includes those fungi in which the germ-tube penetrates the skin of leaf, fruit, branch or root and

the mycelium develops entirely within the tissues of the host plant. Apple-tree anthracnose, brown-rot, the grain-smuts and rusts, the downy-mildews, for all practical purposes apple-scab, and many others may be included in this group. The philosophy of spraying for this group of fungus diseases is based upon the fact that they cannot be cured, but can be prevented. The germ-tube must be destroyed before it penetrates the epidermis and to do this the surface of the host must be thoroughly protected by the fungicide during the entire time the spores are germinating.

GROUP II—EXTERNAL FUNGI.—This includes those fungi in which the mycelium spreads over the surface of the host. This group includes but comparatively few serious pests. Perhaps the one that has attracted most attention in this state is the powdery-mildew of gooseberries. The powdery-mildews of the grape and of the rose also belong to this group. These diseases may be prevented by proper fungicidal treatment the same as diseases of group I and in addition they may also be cured by such treatment. The mycelium being exposed upon the surface of the host may be reached and killed by the proper fungicides.

INSECTICIDES.

GROUP I—FOOD POISONS.

1. PARIS GREEN.

This is used more extensively than any other poison. It has largely supplanted London purple but is, in turn, being supplanted by various other compounds of arsenic. Pure, it is among the most reliable of insecticides but has the disadvantage that it is a rather coarse crystalline substance which settles rapidly to the bottom of the spray-tank unless the contents are kept thoroughly stirred. For codling moth, bud moth, tent caterpillars and many other insects of group I it is generally used as a spray in the following proportions:

| | |
|------------------|-----------------|
| Paris green..... | 1 pound |
| Quick lime..... | 2 pounds |
| Water..... | 160-200 gallons |

Slake the lime, stir the poison into a thin paste with a little water, then strain the mixture through a sieve into a tank containing the required amount of water. If it is desired to spray for both fungi and insects, Bordeaux mixture (22 or 23) may be used in place of the water in the above formula. For peach or other tender foliage 300 gallons of water or Bordeaux should be used. *It is necessary to keep this mixture well stirred while spraying.*

Owing to the excessive cost of Paris green and the difficulty of keeping it in suspension in the liquid, various other compounds of white arsenic—arsenious acid—are now extensively used in its place. In solution, arsenic is extremely injurious to foliage. It is, therefore, necessary that it be combined with other substances which will prevent the injury. Of these combinations, I have had the best results with the lime-arsenic-soda or Kedzie mixture which was first recommended by Dr. R. C. Kedzie of the Michigan experiment station. It is prepared as follows:

2. ARSENITE OF SODA.

| | |
|--------------------|---------------|
| White arsenic..... | 1 pound |
| Sal. soda..... | 4 to 5 pounds |
| Water..... | 2 gallons |

Boil together 15 minutes, or until a clear solution is formed. This stock solution may be placed in jars, *labeled poison*, and kept indefinitely. Use from 1 to 1½ quarts of this stock solution and 4 to 6 pounds of freshly slaked lime to each 50 gallons of water. Bordeaux mixture (22 or 23) may be used to advantage in place of the water whenever it is desired to use a combined insecticide and fungicide.

Another method of using white arsenic is as follows:

3. ARSENITE OF LIME.

| | |
|--------------------|-----------|
| White arsenic..... | 1 pound |
| Quick lime..... | 2 pounds |
| Water..... | 2 gallons |

Slake the lime and then boil the ingredients together for an hour. For use, dilute with 300-400 gallons of Bordeaux mixture (22 or 23). I have used this formula successfully but find that in this climate injury to the foliage is very likely to occur unless great care be exercised in its preparation.

4. ARSENATE OF LEAD.

| | |
|-----------------------|-------------------|
| Arsenate of soda..... | 4 ounces |
| Acetate of lead..... | 11 ounces |
| Water..... | 25 to 150 gallons |

Dissolve the arsenate of soda in two quarts and the acetate of lead in four quarts, of warm water. When dissolved add them to the 150 gallons of water. This formula is especially valuable for spraying very delicate foliage or for use against insects which are killed only by large amounts of poison, since it can be used upon plants in much stronger solutions than the other food poisons without injury to the foliage.

DUSTING OR DUST SPRAYING.

It is often convenient to apply poisons by dusting. Dry Paris green may be so applied either pure or adulterated with various substances. If used pure it should be dusted from a cloth sack of suitable texture and only the faintest trace of the poison should appear upon the plants treated. 1 or 2 pounds should be sufficient to treat an acre of any low-growing crop.

To avoid using excessive and dangerous amounts of the poison it is usual to adulterate it as follows:

5. PARIS GREEN. (FOR DUSTING.)

Paris green.....1 pound
 Wheat flour or finely slaked quick lime....25-50 pounds.

Mix the ingredients thoroughly and dust until the plants show a faint trace of white. For dusting only a few plants use a perforated tin can or other sifter. To cover a large acreage use one of the "dust sprayers" which are on the market.

The so-called "dust spray" for orchard trees is prepared as follows:

6. PARIS GREEN (FOR DUST SPRAYING.)

Paris green.....1 pound
 Quick lime.....10 pounds
 Water.....3 quarts

Use the water to slake the lime into a very fine dry powder. Add the poison and mix thoroughly. This dust is blown into the air in a cloud by the use of "dust sprayers" and settles upon foliage and fruit. Dust spraying is much cheaper than spraying with liquids, but results so far obtained indicate that it is less effective for most purposes. All dusting should be done early in the morning while the foliage is yet wet with dew.

POISONED BAITS.

Grasshoppers, cut-worms and a few other pests may be destroyed by poisoned baits. These are prepared in various ways. Small bundles of green, succulent vegetation, dipped in a strong solution of any of the above poisons and scattered about the infested field or garden will prove exceedingly tempting to cut-worms, particularly if the field was plowed in early spring and is free from vegetation. Such baits are most effective if used in spring just before the crop to be protected comes up. Poisoned slices of potato or some similar vegetable are used to poison sow-bugs and wire-worms. Cultivated trees and vines may be successfully protected against the ravages of grasshoppers by use of the so-called bran-arsenic-mash, which is made as follows:

7. BRAN-ARSENIC-MASH.

White arsenic.....1 pound
 Brown sugar.....1 to 2 pounds
 Bran.....6 pounds

Mix the ingredients thoroughly, then add enough water to make a wet wash. A spoonful should be placed at the base of each tree

or vine. For cut-worms a still better bait may be prepared by mixing thoroughly Paris green, bran and middlings as follows:

8. PARIS GREEN (DRY BAIT.)

| | |
|------------------|-----------|
| Paris green..... | 1 pound |
| Middlings..... | 15 pounds |
| Bran..... | 15 pounds |

This may be sown broadcast upon the vegetation about the borders of cultivated fields or gardens; or by use of a seed drill it may be sown along the rows of plants to be protected. So used it has been found especially valuable for destroying cut-worms in onion fields.

9. GREEN ARSENOID.

Green arsenoid is very similar to Paris green, both in appearance and in insecticide properties. It has the valuable properties of Paris green and is cheaper and more finely divided. It is, therefore, more easily prevented from settling to the bottom of the spray-tank and is more easily distributed as a dust spray. It can be substituted for Paris green in any of the above formulas in which the latter is used.

GROUP II--CONTACT INSECTICIDES.

10. LIME, SULPHUR AND SALT

The lime, sulphur and salt wash is one of the most satisfactory sprays for San Jose scale and is also of value as a fungicide. It is primarily a winter spray but when much reduced in strength has been used to advantage as a summer spray for San Jose scale. Several methods of preparing it are recommended but the following, known as the Oregon formula, is probably the most satisfactory in this climate:

| | |
|-----------------|-------------|
| Quick lime..... | 50 pounds |
| Sulphur..... | 50 pounds |
| Salt..... | 50 pounds |
| Water..... | 150 gallons |

Slake the lime thoroughly, add the sulphur, cover with water, and boil briskly for at least an hour. Then add the salt and boil 15 or 20 minutes longer. Add water to make 150 gallons. Apply with considerable force through a coarse nozzle while still warm. The results of a number of experiments indicate that the salt adds nothing to the efficiency of this spray.

11. LIME, SULPHUR AND COPPER SULPHATE.

Copper sulphate is sometimes used in place of the salt in the formula, which is then as follows:

| | |
|----------------------|----------------|
| Lime..... | 50 pounds |
| Sulphur..... | 50 pounds |
| Copper sulphate..... | 8 to 10 pounds |
| Water..... | 150 gallons |

This is prepared in the same manner as No. 10, is equally effective as a remedy for San Jose scale and may be slightly more efficient as a fungicide. Further experiments are necessary to determine whether the salt or the copper sulphate add anything to the efficiency of these sprays.

12. WHALE-OIL SOAP AND QUASSIA.

Strong soap suds made from any good soap are useful for destroying soft-bodied insects like plant-lice. It is usual, however, to employ for this purpose special soaps made with fish-oils and sold as whale-oil soaps. These vary considerably in composition, some being made with soda, others with potash lye. The latter are much superior and buyers should insist on having potash soaps.

For scale-insects, whale-oil soap is sometimes used in as concentrated a solution as two pounds of soap to one gallon of water, but only upon dormant plants. As a remedy for the various plant-lice one pound of soap to 8 or 10 gallons of water is usually sufficient. Hop growers are inclined to believe that better results are obtained, when spraying for hop-lice, by adding some quassia decoction to the soap solution, as follows:

| | |
|---------------------|-------------|
| Whale-oil soap..... | 10 pounds |
| Quassia..... | 5 pounds |
| Water..... | 100 gallons |

Place the quassia chips in a sack, cover with 8 or 10 gallons of water and soak 12 to 24 hours. Then bring to a boil, remove the chips, add the soap and boil until it is dissolved. Add water to make 100 gallons. If preferred the grower may prepare his own whale-oil soap after the following formula:

| | |
|-----------------|-----------|
| Potash lye..... | 1 pound |
| Fish-oil..... | 3 pints |
| Water..... | 2 gallons |

Dissolve the lye in the water. When boiling hot add the oil and boil about two hours. Add water to make two gallons. Each pound of the soap thus made should be dissolved in 8 or 10 gallons

of water. It will be found a satisfactory remedy for hop-lice and other soft-bodied insects.

13. KEROSENE EMULSION.

Kerosene oil, or coal oil, is a powerful insecticide. The undiluted oil is, however, liable to seriously injure plants to which it is applied. This difficulty is overcome by using one of the special spray pumps which have been devised for the purpose of mixing the oil with water in any desired proportion; or by forming an emulsion with some substance that may be readily diluted with water. Soap is most commonly used for this purpose, as follows:

| | |
|---------------------------------------|---------------------|
| Kerosene oil..... | 2 gallons |
| Hard soap (preferably whale-oil)..... | $\frac{1}{2}$ pound |
| Water..... | 1 gallon |

Dissolve the soap in the water by boiling. Add the suds, boiling hot, to the oil. Churn the mixture violently with a spray pump until it becomes a thick creamy mass. If perfectly emulsified, the oil will not rise to the surface even after standing an indefinite time. Such an emulsion may be used immediately or may be kept as a stock mixture. Before using, dilute one part of the stock emulsion with 8 or 10 parts of water.

This will be found to be an efficient remedy for green-aphis, woolly-aphis, red-spider, mealy-bugs, and certain scale-insects.

14. RESIN WASH.

This is a favorite spray in California for several of the scales infesting citrus fruits. In this state its chief value is as a spray for the various kinds of plant-lice. For this purpose, it may be used as a substitute for kerosene emulsion or whale-oil soap with good results, particularly in the dry summer months. It can also be used as a summer spray for San Jose scale, but we do not advise such use since summer sprays for this pest are less efficient than the winter spray of lime, sulphur and salt. The resin wash may be made as follows:

| | |
|-----------------------|-----------------------|
| Resin..... | 20 pounds |
| Concentrated lye..... | 4 pounds |
| Fish-oil..... | 2 $\frac{1}{2}$ pints |
| Water..... | 100 gallons |

Place the resin, lye and oil in a kettle with sufficient water to cover them to a depth of three or four inches. Boil about two hours, making occasional additions of water, or until the compound

resembles very strong black coffee. Dilute to one-third the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture which must be diluted to the full amount of 100 gallons when ready for use.

One gallon of resin wash to each three gallons of Paris green spray No. 1, or Bordeaux mixture No. 22, may be used advantageously to cause the latter to adhere better to smooth leaves.

15. CARBOLIC ACID EMULSION.

Carbolic acid emulsion is used to destroy the eggs and the young maggots which infest radishes, onions and similar garden crops; and occasionally for other insects:

| | |
|---------------------------|----------|
| Crude carbolic acid | 1 pint |
| Hard soap | 1 pound |
| Water | 1 gallon |

Dissolve the soap in boiling water; add the acid and churn as for kerosene emulsion. Use 1 part of emulsion to 30 parts of water.

16. TOBACCO.

The tobacco waste from cigar factories is of considerable value as an insecticide. In greenhouses, it may be used to destroy plant-lice by simply spreading the waste two or three inches deep over the pipes under the benches, or by burning about $\frac{1}{2}$ pound of moist waste to each 500 square feet of glass. Worked into the soil about young apple trees in the orchard or nursery, it is one of the best remedies for the root form of woolly-aphis. A strong decoction, made by a prolonged steeping of a quantity of stems in enough water to cover them and diluting the liquid to the color of strong tea, is often used as a spray for plant-lice. A still better method is as follows:

| | |
|--|-----------------|
| Hard soap (preferably whale-oil) | 1 pound |
| Water | 8 to 10 gallons |
| Strong tobacco decoction | 1 gallon |

Dissolve the soap in boiling water, add the tobacco decoction and dilute to 8 to 10 gallons.

17. HELLEBORE.

Powdered hellebore, if fresh, is of value for poisoning insects which are injuring small fruits or vegetables which are nearly ready for market and on which it is undesirable to use the arsenical poisons. It may be dusted over the plants when they are moist with dew, or may be used as a spray in the following proportions:

| | |
|----------------|-----------|
| Hellebore..... | 1 ounce |
| Water..... | 2 gallons |

18. PYRETHRUM OR INSECT POWDER.

Fresh pyrethrum powder is a valuable remedy for flies, mosquitoes, roaches, ants, fleas and other household pests. It is destructive to insects but not poisonous to the higher animals or to man. It should be kept in an air tight receptacle. The dry powder may be dusted over the floors, or in the hair of dogs infested with fleas, or about their sleeping quarters; or in other places where noxious insects congregate. It may also be used as a spray in conservatories or on a few plants in the garden, in the following proportion:

| | |
|----------------|-----------|
| Pyrethrum..... | 1 ounce |
| Water..... | 2 gallons |

It is also stated that the flies and mosquitoes in a room may be destroyed by burning a little pyrethrum powder upon some live coals.

19. BISULPHIDE OF CARBON.

Bisulphide of carbon is a colorless liquid with a very disagreeable odor. It is very volatile and its fumes are poisonous to animal and plant life. When mixed with air in the proper proportion they are also very explosive. As an insecticide, it is valuable mainly as a remedy for subterranean insects, borers, or insects infesting stored grains, seeds, etc., and for fumigating buildings which are infested with noxious insects. It is also used extensively for destroying various burrowing animals whose burrows incline downward into the earth. For this purpose pour 2 or 3 ounces of the liquid upon a ball of rags, or other absorbant, place this well down into the burrow and close the opening. Thus used it is an effective remedy for "digger squirrels" and "prairie dogs," but is not effective against moles and pocket gophers which construct long horizontal burrows. Troublesome ants nests may be destroyed by making a hole in the centre of each nest and pouring into it 2 or 3 ounces of the liquid, after which the hole should be tightly closed. For destroying the root form of woolly-aphis of the apple, it is common to make several holes each 6 to 12 inches deep about the tree and pour 1 or 2 ounces of the liquid into each hole, which should be immediately closed.

Borers in the roots of peach or prune trees may be destroyed by simply pouring from 1 to 3 ounces of the liquid, according to the

size of the tree, about the base of the tree. If the soil is wet or compact, it is best, first, to excavate a shallow trough about the tree and fill this with loose soil before applying the chemical.

For fumigating grains, seeds, storehouses and other buildings, including houses, for the destruction of insects, one pint of the liquid is used for each ton of grain or 1000 cubic feet of space. The building, bin or other receptacle should be tightly closed and kept closed 24 to 36 hours. *During this time no person should attempt to enter the building, nor should any light be allowed inside, until it has been thoroughly ventilated, since the fumes are both poisonous and explosive.*

20. HYDROCYANIC ACID GAS.

This is an extremely poisonous gas which is used in this state principally to fumigate nursery stock. In California it is used to fumigate citrus trees which are infested with scale insects. It has also been used in the east to fumigate scale-infested deciduous fruit trees. Although very efficient the process is so much more expensive than spraying that I do not recommend its use in this state.

Many nurseries now have specially prepared houses, or fumigatoriums, in which to fumigate infested stock. For dormant stock the chemicals are used in the following proportions, for each 100 cubic feet of space inclosed:

| | |
|--|----------|
| Cyanide of potassium (98 per cent) | 1 ounce |
| Sulphuric acid | 1 ounce |
| Water | 2 ounces |

Place the water in an earthenware or wooden receptacle, add the acid and when all is ready drop in the cyanide of potassium, close the door and keep it closed for at least 40 minutes. Do not attempt to re-enter the house until it has been thoroughly ventilated.

Greenhouses may be fumigated to destroy plant-lice, mealy-bugs, slugs, millipedes, etc., by using the above formula for each 350 cubic feet of space, and keeping the house tightly closed for 15 or 20 minutes. Previous arrangements should be made for opening the ventilators from the outside.

FUNGICIDES.

21. BORDEAUX MIXTURE FOR DORMANT PLANTS.

Bordeaux mixture is perhaps the most generally useful of all spraying compounds. It is the principal remedy for fungus diseases, is of some value as an insecticide, has a beneficial effect upon plants independent of its effect upon their insect and fungus parasites and may be used for most purposes in place of water in the preparation of the arsenical sprays Nos. 1 to 4.

Bordeaux for winter use may be made as follows:

| | |
|----------------------|------------|
| Copper sulphate..... | 6 pounds |
| Quick lime..... | 6 pounds |
| Water..... | 50 gallons |

This is known as the 6-6-50 formula. It should be used only upon dormant trees.

22. BORDEAUX MIXTURE FOR PLANTS IN FOLIAGE.

When the trees are in leaf the following 4-6-50 formula is used:

| | |
|----------------------|------------|
| Copper sulphate..... | 4 pounds |
| Quick lime..... | 6 pounds |
| Water..... | 50 gallons |

23. BORDEAUX MIXTURE FOR PEACH AND OTHER TENDER PLANTS.

For spraying peach foliage it is best to use the still weaker 3-6-50 formula:

| | |
|----------------------|------------|
| Copper sulphate..... | 3 pounds |
| Quick lime..... | 6 pounds |
| Water..... | 50 gallons |

To prepare Bordeaux mixture dissolve the copper sulphate in hot or cold water in a wooden or earthen vessel. Slake the lime, using only sufficient water to insure slaking. The lime should not be allowed to become dry while slaking nor should it be submerged in water. After the lime is slaked add water and stir until the "milk of lime" is of the consistency of cream. The best results are obtained by diluting the milk of lime and the copper sulphate solution each to 25 gallons and then pouring these two dilute solutions together. The lime solution should always be strained through a sieve to exclude particles that might clog the nozzles. A brass

wire sieve, 20 mesh, large enough to fit the head of a barrel or the opening into the spray-tank will prove a great convenience.

When large quantities of Bordeaux are required, it is most convenient to make stock solutions of lime and of copper sulphate of known strength. A convenient stock solution of copper sulphate is made by dissolving 100 pounds in 50 gallons of water; one of lime, by slaking 100 pounds and diluting with water to 50 gallons. Each gallon of the stock solution will then contain 2 pounds of lime or of copper sulphate and the amount to be used in preparing any quantity of Bordeaux according to the above formulas can be readily computed.

If sufficient lime has not been used, or if that used was of an inferior quality the Bordeaux may injure the foliage or may cause a "russetting" of the fruit. It is, therefore, always best to determine whether enough lime has been used by testing the mixture.

TESTING BORDEAUX.

There are three simple tests which may be used. First, hold a clean bright knife blade in the Bordeaux, for at least one minute. If it becomes copper-plated more lime should be used. Second, pour some of the Bordeaux into a shallow dish and holding it up to the light blow gently across its surface. If properly made a thin pellicle will form on the surface of the liquid. If this does not form more lime should be added. Third, dissolve one ounce of ferrocyanide of potassium in 5 or 6 ounces of water. Pour some of the Bordeaux into a white dish and add to it a few drops of the ferrocyanide solution. If sufficient lime has been used no change will be noticed. If a brownish-red discoloration takes place more lime should be added.

One gallon of Resin wash No. 14 to three gallons of Bordeaux is said to make the mixture more adhesive.

24. COPPER SULPHATE SOLUTION.

A simple solution of copper sulphate is used as a remedy for grain smuts and sometimes as a spray in place of Bordeaux. For dormant trees use

| | |
|-----------------------|------------|
| Copper sulphate | 1 pound |
| Water | 25 gallons |

For trees in foliage use

| | |
|-----------------------|-------------|
| Copper sulphate | 1 pound |
| Water | 250 gallons |

For smut of wheat or oats, soak the seed for 10 to 12 hours in a solution of one pound of blue vitriol to 25 gallons of water, then put the seed for 5 or 10 minutes into lime water made by slaking one pound of lime and diluting it with 10 gallons of water.

The treatment with lime water tends to prevent the copper sulphate solution from injuring the seed, but many farmers omit that part of the treatment.

Bordeaux mixture has the disadvantage that it produces an unsightly deposit upon foliage, blossoms and fruit and hence can not well be used upon florists' plants or upon fruits nearly ready for market. For use under such conditions the ammoniacal copper carbonate, the simple copper carbonate mixture or the copper acetate solution is recommended.

25. AMMONIACAL COPPER CARBONATE.

| | |
|------------------------|------------|
| Copper carbonate | 5 ounces |
| Strong ammonia..... | 3 pints |
| Water | 50 gallons |

Mix the copper carbonate into a paste with a little water, add the ammonia and when the copper carbonate is completely dissolved pour the resulting deep blue liquid into the water.

26. COPPER CARBONATE MIXTURE.

| | |
|------------------------|------------|
| Copper carbonate | 1 pound |
| Water..... | 50 gallons |

Mix the copper carbonate into a paste with a little water before attempting to add it to the 50 gallons.

27. COPPER ACETATE SOLUTION.

| | |
|--------------------------------|------------|
| Dibasic acetate of copper..... | 6 ounces |
| Water..... | 50 gallons |

Use finely powdered acetate of copper, mix it into a paste with a little water, then dilute with the full amount of water.

28. POTASSIUM SULPHIDE SOLUTION.

| | |
|--------------------------|----------------|
| Potassium sulphide | 1 ounce |
| Water..... | 2 to 3 gallons |

Dissolve the potassium sulphide in the water.

Valuable as a spray for mildews.

29. CORROSIVE SUBLIMATE.

| | |
|--------------------------|----------------|
| Corrosive sublimate..... | 1 ounce |
| Water..... | 7 to 8 gallons |

This is valuable as a preventive of potato scab. In a wooden vessel, dissolve the poison in one gallon of water, then dilute to the full amount. Place the scabby seed potatoes in a sack, immerse them in the solution and allow them to soak 1 to 2 hours. The solution and the treated potatoes are extremely poisonous.

30. FORMALIN.

Formalin, a 40 per cent solution of formaldehyde gas in water, is being used extensively as a preventive of potato-scab and of the grain-smuts, and gives most excellent results. It is cheap, efficient and non-poisonous. For potato-scab, soak the seed 2 hours in the following solution:

| | |
|----------------|--------------------|
| Formalin | $\frac{1}{2}$ pint |
| Water | 15 gallons |

For grain-smuts soak the seed for 1 to 2 hours in the following:

| | |
|----------------|------------|
| Formalin | 1 pint |
| Water | 50 gallons |



METHODS OF TREATMENT FOR INSECT PESTS AND PLANT DISEASES.

APPLE.—For apple-scab, spray with 22; first, when fruit buds are swelling; second, when blossoms are unfolding; third, after petals fall; and thereafter every 10 days or two weeks as long as wet weather persists. For codling moth, add Paris green or one of the arsenic sprays to the Bordeaux for the third and subsequent applications; then begin late in June and spray every two weeks with 1 or 2 until three weeks before the fruit is to be picked. If trees are infested with San Jose scale spray with 10 or 11 when trees are dormant. For green-aphis, use 13, as soon as leaf buds start and repeat whenever the aphis becomes abundant on the foliage. For woolly-aphis, branch-form, use 13; for root-form, use 16 or 19. For tingis, spray with 13 when eggs are hatching and practice *clean* culture. For apple-tree anthracnose, spray as soon as possible after crop is gathered with 21 and repeat in two weeks; write for bulletin No. 60.

BARLEY.—To prevent smut, use 30.

BEAN.—For anthracnose, soak seed in 30; when plants are two or three inches high spray with 22 and repeat two or three times at intervals of 10 or 12 days. For weevil, fumigate seed with 19.

BEET.—See under Sugar Beet.

BLACKBERRY.—For anthracnose, leaf spot and rust spray with 21, before leaves start; when leaves are half grown use 22; repeat in two weeks.

CABBAGE AND CAULIFLOWER.—For club-root, rotate crops; destroy all stumps and other waste in fall; apply lime at rate of 80 to 100 bushels per acre and work into soil. For worms, use 1 or 5 when first observed. After plants head, 17 or 18 may be used if preferred. For aphis, use 12 or 13.

CARNATIONS.—For rust and other fungus diseases, spray with 22, when disease first appears and repeat at intervals of two weeks. For red spider or aphis use 12 or 13.

CELERY.—For leaf-spot or leaf-blight use 22 upon young seedlings and repeat two or three times at intervals of two weeks.

CHERRY.—For brown-rot and leaf-spot, spray with 22 when blossoms are opening and again when petals fall; after fruit begins to

color use 25, 26 or 27. For slugs, use 1 when slugs first appear, or if fruit is ripening dust with air-slaked lime or fine dry dust. For aphid, use 12 or 13. For gummosis, cut out gum pockets, slit outer bark from branches to ground and wash or spray with 21. For San Jose scale use 10 or 11 when trees are dormant.

CHRYSANTHEMUM.—For leaf-spot spray with 22 and repeat once or twice at intervals of two weeks if necessary.

CUCUMBER.—For striped cucumber-beetle, dust the plants with 5, or spray with 22. Plant some early squash as trap plants and when the beetles are feeding on them dust them with pure Paris green. For fungus diseases, spray with 22 when vines begin to form and repeat three or four times at intervals of 2 weeks.

CURRENT.—For mildew, spray with 28, when buds begin to open and repeat at intervals of 10 to 15 days until fruit is nearly ripe. For worms on leaves, use 1 or 17. For fruit worms, destroy infested fruit; allow the poultry the run of the bushes when infested fruit is falling.

GOOSEBERRY.—Same as currant.

GRAPE.—For mildews, rot and anthracnose, spray with 22 when buds are swelling, when leaves are half grown, just before blossoming, when fruit has set, and repeat once or twice at intervals of two weeks. If later applications are required use 25.

HOP.—For hop-lice, spray with 12 *when lice first appear* and repeat as necessary.

HOUSEHOLD PESTS.—For fleas, flies, mosquitoes, roaches, etc., use 18. Garments infested with clothes moths may be inclosed in tight box and fumigated with 19. If house is badly infested with any insect pest fumigate with 19.

MUSKMELON.—For striped cucumber-beetle, see under cucumber. For anthracnose, mildew and leaf-blight, use 22 when vines begin to form and repeat 2 or 3 times at intervals of 2 weeks.

NURSERY STOCK.—For various fungus diseases, spray with 22 when leaves first appear and repeat at intervals of 10 to 15 days until rainy season closes. Fumigate with 20.

OATS.—For loose smut, soak seed in 30 or 24.

ONIONS.—For smut, practice rotation of crops; transplanting seedlings; use 100 pounds of sulphur and 50 pounds of air-slaked lime per acre in the drills with the seed. For powdery-mildew, try 22 when disease first appears and repeat if necessary. For cut worms use 8.

PEA.—For mildew, spray with 22 or 28 when mildew appears and repeat once or twice, if necessary, at intervals of 10 days.

PEACH.—For leaf-curl, spray before buds swell with 10, 11 or 21; as buds are opening use 23; repeat when calyx drops. For pustular spot, brown-rot, or scab make one or two additional applications at intervals of two weeks. If brown-rot is severe follow with one or two applications of 27 while fruit is coloring. For San Jose scale, apply 10 or 11 while trees are dormant. For twig-borer use 10 just before buds swell. For root-borers, as a preventive wrap base of trunks with paper or cloth or paint them with poisoned whitewash; to kill borers dig them out in fall and spring, or use 19.

PEAR.—For scab, codling moth and San Jose scale see under apple. For slug, see under cherry. For pear blight cut out and burn all diseased branches. Make cut several inches below where disease extends and sterilize tools frequently by dipping in 29. Paint cut surfaces with 21, strong.

PLUM AND PRUNE.—For twig-borer and root-borer see under peach. For leaf-curl give good drainage, good cultivation and grow leguminous cover crops in winter. For brown-rot see under cherry.

POTATO.—For scab, soak seed potatoes in 30 or 29. For potato dry-rot, or blight, spray with 22 when plants are 6 inches high and repeat two or three times at intervals of two weeks. For flea-beetles, spray with one of the food poisons, 1, 2 or 3 in 22, whenever they appear. For wet-rot, plant only sound seed, practice rotation of crops, destroy blighted plants as fast as they appear and spray to prevent flea-beetle punctures.

QUINCE.—For leaf and fruit-spot, spray with 22 when blossom buds begin to open; again when fruit has set and repeat at intervals of two weeks until rainy season is over.

RASPBERRY.—See under blackberry.

ROSE.—For mildew spray with 28 whenever it appears. For leaf-spot spray with 22 or 25 when spots first appear and repeat as necessary. For aphid use 12 or 13, or wash them off with a stream of water from the garden hose. For rust, burn fallen leaves in fall; spray with 21 before buds start in spring; repeat the applications, using 25 or 26, at intervals of 10 to 15 days.

STRAWBERRY.—For crown-miner and root-borer destroy infested plants before May 1. For leaf-roller burn tops as soon as possible after crop is gathered. For leaf-blight spray with 22 when new

leaves start and repeat every 10 to 15 days until blooms appear. Mow and burn tops as for leaf-roller.

SUGAR BEET.—For leaf-spot or flea-beetles spray with 22 when spots or beetles first appear and repeat two or three times at intervals of two weeks. For cut-worms, if bad, use 8. For aphid use 12 or 13, or an abundance of very fine dust.

TOMATO.—For rot or blight use 22 when disease first appears. Repeat once or twice, if necessary, at intervals of 10 to 15 days. For flea-beetles spray with 22 when they appear or hang papers from a string stretched just over the plants.

VIOLET.—For blight, use 22 or 25 when it first appears. Repeat once or twice at intervals of 10 to 15 days, if necessary.

WATERMELON.—See muskmelon.

WHEAT.—For smut soak seed in 30 or 24. For Hessian fly practice late seeding. For insects in stored grain use 19.

A. B. CORDLEY.

LIST OF BULLETINS

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