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Injurious insects and plant diseases

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INJURIOUS INSECTS

AND

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METHODS OF DEALING

With Injurious Insects and Plant Diseases.

A. D. HOPKINS, *Entomologist.*
C. F. MILLSPAUGH, *Botanist.*

The object of this Bulletin is to place in the hands of those in West Virginia who have to contend with injurious insects and plant diseases, a compilation of general methods recommended by the best authorities in this country—official entomolgists, botanists, successful farmers, and gardners.

We have drawn freely from Experiment Station Bulletins, Government and State Reports, and special works and papers treatiug upon these subjects; selecting those methods and formulae which have been submitted to successive tests and practical application and found to be reliable, and such others which, our judgement and experience lead us to belive, are worthy of adoption.

The fact that the conditions under which farmers conduct their business are so varied (each necessarily adopting methods peculiarly suited to his locality or circumstances) make it difficult if not impossible for us to recommend a single remedy or method of application that would yield satisfactory results to all. A method requiring expensive apparatus might yield great profit to a large grower who has hundreds of acres to operate upon, while the same method would be utterly out of the question for the small grower who would find the apparatus alone to cost more than the value of the resulting crop. On the other hand a simple inexpensive method which would double the small growers' profits, would not be practicable for the large grower, on account of the extra time and labor necessary in applying the measure. We deem it best therefore to give in this connection a general outline of methods, formulae, and instructions, from which each may select for adoption those suited to his individual needs.

In this age of close competition and low prices the farmers who are making money are those who are quick to adopt methods which their better judgment tells them will yield a profit or at least prevent loss. That there is profit in a properly conducted warfare against injurious insects and plant diseases, when the conditions justify the means, there is no longer a doubt. A loss of hundreds

of thousands of dollars is sustained each year by the producers of this State from these causes alone, much of which could be prevented to those who study to adopt methods best suited to the peculiar requirements in each case.

In dealing with the enemies mentioned, as in all other profitable enterprises or methods, there are certain principles relating to the subject that the operator must become familiar with before he can reasonably expect to gain the highest results from the practice. It is therefore just as necessary for those who adopt the less expensive and complete apparatus to have this rudimentary knowledge, as it is for those who are compelled to utilize every known method on a large and expensive scale.

In this bulletin we shall give the fundamental principles underlying the practice of applying methods to the prevention and killing off of these pests, trusting that those who may desire particular information, before we publish more advanced proceedures, will freely correspond with us as their interests may demand.

We are engaged in this Station to devote our entire time to investigations and research for the benefit of the farmers of the State, and the advencement of economic agriculture. We are testing methods, machinery, formulae, etc., in order to determine and adapt the best to our own State needs, and ask you as farmers and readers of this and other of our publications to criticise, question, and suggest, as well as to try carefully any methods we may publish that suit your crops and necessities, and report your success or failures giving your reasons for such in as far as you deem them contributive to the results gained, this will aid us in future work and publications of all of which you will receive the primary benefits.

INJURIOUS INSECTS.

Among the elementary requirements necessary to the intelligent application of the methods mentioned under this head, we will only discuss a few of the most important.

Insects and Some of Their Peculiar Habits.

The word insect is derived from two Latin words, meaning cut in two, or divided into sections. The class of creatures to which this name is applied is very different from all other kinds of animal life.

The life of all insects begins with an embryo contained in an egg; resembling in this respect some other kinds of animals, yet they differ from all others in the first active form emerging from the egg, and the subsequent changes which take place before their lives are complete. The first form is usually entirely different both in appearance and habits from the parent which deposited the egg, and it is in this first active stage of their lives that they do their growing and principal feeding. At this stage they are familiarly known as caterpillars, grubs and maggots, properly as larva, (plural larvæ). After a time, varying from a few days to 17 years, according to the species, they change into another form different from the first. In this second stage, certain kinds remain inactive without food until the perfect form developes within the shell, from which they emerge in due time to deposit eggs for another generation. This inactive form is called pupa, (plural pupæ).

Caterpillars develop into moths, ("millers") and butterflies; grubs into beetles; maggots into bees, flies, etc.; all of which go through what is termed a complete transformation.

Those going through an incomplete transformation, are grasshoppers, squash bugs, plant lice, etc., which are active in all their forms, from the time they leave the egg until they have attained wings. The larvæ and pupæ of this class of insects bear a general resemblance to the parent form; but they never have wings, while the perfect forms nearly always do.

How Insects Feed.

Injurious insects are divided into two broad divisions, or classes according to their manner of feeding.

1st. Biting or chewing insects include all of those in the perfect or imperfect forms, which bite and consume the substance upon which they feed.

2nd. Sucking or piercing insects, include all of those perfect or imperfect forms which pierce their food substance with a beak, and suck out the sap, juice, or blood from beneath the surface.

Therefore, if a strange insect makes its appearance threatening the destruction of some plant or crop, before selecting a method to repel or destroy it, it is first necessary to ascertain how it feeds. If it belongs to the first division, and like the potato beetle, eat the leaves, it may be easily destroyed by Paris green applied to its food substance, either in a powder or liquid, as the poison will be eaten by them with their food.

On the other hand, if, like squash bugs, plant lice, and other insects belonging to the second division, they suck the sap from the plant causing it to wither and die; poison will have no effect on them, because we can not apply it to the inside of the plant where they get their food. Most of this class of insects may, however, be easily destroyed with remedies like insect powder, kerosene, emulsion etc., which kills by contact when it is applied to the insects themselves.

Preventive Measures.

By preventives is meant any method which will repel or prevent the attack of insects. "An ounce of 'Preventive' is even better than a pound of cure" in dealing with insects, for we find that often we may not only prevent injury by them, but we may gain large benefits to the crops and our farms, as will be seen from some of the following methods:

High Culture and Fertilization is probably one of the best preventives of insect attack, for it is a well known fact that most insects have a preference for weak or unhealthy plants on which to feed and deposit their eggs; while this is not the universal rule (as insects are known to attack perfectly healthy plants and trees), yet this fact is evident. Perfectly healthy plants, if they do not entirely resist attack, may at least recover from it, while weakened and sickly ones invite attack, and are most sure to succumb.

Fertilizers. My experience has been that coarse stable manure, at the rate of fifteen or twenty loads to the acre applied to sod in winter, and plowed under for corn in early Spring, will prevent the attack of White Grubs and Wire Worms, even in badly infested fields.

Wood Ashes, leached or unleached, have been successful with me in preventing the attack of Peach and Apple Tree borers, if applied in a conical heap about the base of the trees in May of each year.

Soap placed in the forks of trees, or suds applied to the trunks is recommended to repel borers of various kinds from depositing eggs. (Formula 10.)

Commercial Fertilizers. Kainit, and brands containing a large per cent. of Potash, are recommended as remedies or preventives against insect attack.

Nitrogen in the form of Nitrate of Soda is also recommended for the same purpose.

Tobacco, a valuable fertilizer, is used against the cucumber beetle, cabbage maggot, etc., to prevent their feeding and depositing eggs. The stems and wastes are used for this purpose.

That it is profitable to apply most of the fertilizers mentioned for their fertilizing qualities alone is evident, and when we consider the added benefit in protection against destructive insects, it seems that every one should realize the importance of such methods, and we hope that farmers generally will try some one or all of them, and report to us their success or failure, especially with stable manure and commercial fertilizers.

Rotation of Crops. If a crop is grown for a number of successive years in the same field, the insects injurious to it are liable to increase to the greater detriment of the crop each year; a system of rotation will avoid this to a great extent. We would mention the following rotation as a suggestion, as each must judge to a certain extent for himself.

Meadow 2 years; corn, with fertilizer, 1 year; potatoes, with fertilizer, 1 year; wheat and fertilizer the next, then back to meadow. This would require 5 years to elapse between the time any one crop would occupy the same field.

General Farm Management with a view of preventing insect depredations and attack, such as time of plowing and sowing; selection of plants less liable to attack; clean farming, burning or converting into manure all trash and rubbish; cutting and burning all dead branches and infested trees and plants; using the ashes to prevent further attack; feeding fallen fruit to hogs, sheep and poultry, or roting them in the compost heap.

Many other methods will suggest themselves to the thoughtful and observing farmer, that will help him to make his business profitable in more ways than that of preventing insect attack alone.

Preventing Egg Deposits. Dr. Lintner, State Entomologist of New York, advances the theory that insects are attracted to plants "not by the sense of sight, but by that of smell, and that substances giving off a strong odor like lamp oil, coal tar, carbolic acid, gas lime, and the remedies applied to or near the plants to be protected, prevent egg deposit by giving out an odor overpowering that of the plant or animal itself, thereby preventing its recognition by the insect." If this theory is correct, the importance of the measure is evident, for as Dr. Lintner argues, "if no eggs are deposited, we have no artificially concealed eggs to seek for; no larvæ whose rapacity and destructiveness we must arrest; no pupæ whose retreat is to be discovered and no perfect forms to be captured or entrapped."

Fencing Out includes any method which will keep insects away by placing a barrier between them and any plant or fruit to be protected. Among these: are covering plants or small shrubs with thin muslin or mosquito bar; bagging choice fruit in paper bags; paper and metal bands to protect young plants from cut worms; and tar paper bands for peach and apple tree borers.

With all the preventive measures mentioned, it would seem that we should have no use for remedies. Perhaps we would not if every one were thoroughly acquainted with all insects, their habits, and methods of dealing with each; and would be persistent in the thorough and prompt application of such knowledge. It is safe to say, however, that such a condition will never exist; and that after all, certain kinds of insects will appear, which will destroy certain crops, if they are not killed by the prompt application of poisons and other substances, which we will mention under the head of remedies.

Beneficial Animals.

Many of the domestic and wild animals of the farm are efficient aids in the destruction of injurious insects, and may be made even more useful than they are, by a little knowledge and careful management on the part of the farmer.

Sheep are useful in orchards to feed on fallen fruit and destroy the insects contained in them.

Hogs are valuable to root for and destroy grubs in meadows just prior to plowing for some cultivated crop. They may also be utilized, either in the orchard or the pen, in consuming fallen fruit.

Poultry. Turkeys subsist principally on grasshoppers when they can get them, and may be bread to a good advantage where this insect is plenty, not only as a destroyer of the insects, but as a profitable product of the farm.

Chickens confined in a plum orchard are said to be very beneficial in feeding on the Plum Curculio, thus protecting the fruit. Coops of small chickens in gardens to feed on flea beetles, etc., is also recommended.

Ducks are recommended to free gardens of certain kinds of insects, especially potato beetles.

Birds. The protection of certain kinds, and the destruction of the English Sparrow is especially recommended by many writers.

The *skunk* is undoubtedly the friend of the farmer in feeding on grubs and mice, and should be protected.

Toads consume immense quantities of insects and their domestication has been recommended for gardens.

Remedies.

Remedies proper differ from preventives (which are sometimes called remedies) in the fact that preventive measures are used to avert an attack, and remedies are used after the attack is made.

The six best remedies in general use are: Paris Green, London Purple, Kerosene Emulsion, Pyrethrum (insect powder), White Hellebore, and tobacco in various forms.

Killing with Poisons.

Paris Green is a combination of arsenic and copper. It came into general use as a destroyer of the Colorado Potato Beetle directly after that insect made its appearance. It is probably one of the most widely known insecticides and more generally used than any other. It will kill most of the biting insects provided it is pure, and is applied in the proper proportion and at the right time. There are some insects like the Rose beetle, on which it seems to have no effect in the strength safe to apply to the foliage of plants.

Injury to Foliage. If used too strong it will burn or kill the leaves, certain kinds being affected more than others, and strange to say, it may be used stronger on young foliage than on that older or matured.

Diluents. It may be diluted either with dry or liquid substances, and should be usually diluted just enough to not injure the foliage.

Dry Mixtures. In its dry state it may be used all the way from pure, or mixed with one hundred parts of a diluting substance, depending on the plants on which it is to be used. It may be diluted with a cheap quality of wheat flour, which is probably the best substance for this purpose on account of its adhering to the plants and being more readily eaten than other substances. Plaster, finely sifted ashes, air-slacked lime, road dust, etc., may also be used as diluents. Much care in all cases should be taken to thoroughly mix the poison with the diluent that it may be evenly distributed.

Application of the Powder. The simplest and best method of application to small plants and shrubs is to tie a muslin bag containing the powder to the end of a stick or pole and dust it over the plants.

It is usually claimed that powder substances should be applied in the morning when the plants are wet with dew; while this may have its advantages, it is not always necessary, as it may in most cases be applied at any time in the day, but never when the wind is blowing hard; a very gentle breeze is claimed to be a help in distributing the powder to the under side of the leaves. In all cases the operator should keep on the windward side to avoid breathing the powder.

Wet Mixtures. In most cases the liquid application has advantages over the dry, especially when used on a large scale, and to fruit trees. Dilute with water at the rate of one pound of the powder to 40 or even 350 gallons of water, according to the kind of plants on which it is to be applied. On a small scale, a teaspoon to a tablespoonful is sufficient for four or five gallons of water. Flour paste added to the water is claimed to be a decided benefit.

Application of the Liquid. The simplest method is a broom or brush by which the liquid is sprinkled or thrown on the plant, this

method is well adapted to application on a small scale. The ordinary watering pot provided with a finely perforated rose is often sufficient for kitchen and flower gardens. For large shrubs, fruit trees and field crops, pumps and spraying apparatus must be secured for doing thorough and efficient work. (See Spraying machinery.) It is not the strength of the mixture but the force and thoroughness with which it is applied that secures success, hence pumps and nozzles should be selected, which are best suited to these requirements.

London Purple is a refuse material obtained in the manufacture of analine dyes, and its principal constituents are arsenic acid, and lime. It is cheaper and better in most cases than Paris Green, except that it is more liable to injure the foliage. However, when diluted with hard water, or the addition of lime, it is said to prevent this injury; hence it is admirably suited to mix with the bordeaux mixture, (see formula 19), as a combined remedy for insects and plant diseases, otherwise the remarks on diluting, applying, etc., of the former remedy will apply as well to this.

Caution in Using Paris Green and London Purple.

There is no danger in properly using these poisonous substances if the following rules are observed:

The poison should be kept in a safe place, and plainly labeled POISON.

Do not distribute the poison with the hands.

Always keep to the windward side of plants or trees when applying the powder or liquid.

Do not use them upon leaves or fruits which are soon to be eaten. There is seldom, if ever, any danger in eating vegetables and fruit after they have been exposed to the sun and rain for a few weeks, as several pounds or bushels of treated fruits or vegetables would have to be consumed at one time by one individual to get a sufficient dose of the poison to produce serious results.

Test the strength of the diluted mixture on a few plants first to ascertain if it will injure the leaves.

Never apply it to fruit trees while in bloom, as the poison will kill the bees so necessary to the formation of perfect fruit.

Killing by Contact.

Kerosene Emulsion. A mixture of lamp oil, soap and water, (see formula 3), is probably the best known remedy for plant lice, lice and ticks on animals, the Horn Fly, and many other sucking insects.

Application. It may be applied on a small scale to house plants, etc., with perfume atomizers; to garden vegetables with garden syringe; and to large trees and field crops with the more expensive machinery.

Insect Powder, (Pyrethrum), is manufactured from a plant which is grown largely in California for the purpose. It is very extensively

used to kill house flies, mosquitoes, cabbage worms and many other insects. It kills by stopping up the breathing pores, and is only hurtful to insects. It may be applied as a powder or diluted with water. As a powder, it may be diluted with flour and applied on a small scale with a small tin bellows, or on a larger scale with Woodason's bellows or Leggett's Powder Gun.

White Hellebore is a vegetable substance which will kill certain insects both by poisoning and by contact, and is used successfully against Currant Worms, Rose and Cherry Slugs. Its principal value, however, is that of destroying Currant Worms. This, like insect Powder, may be used dry or in water. This should be labeled Poison.

Tobacco Dust is manufactured from tobacco stems and other refuse, large quantities of which may be found at cigar factories, packing houses, etc., which may usually be had for the asking. This material may be used without grinding into powder, and is vuluable both as an insecticide and as a fertilizer, if liberally used around plants and trees. A strong tea made from it will kill plant lice and other insects. It is also used to destroy lice on cattle, ticks on sheep, and to drive away cucumber beetles, etc.

Miscellaneous Remedies.

Hand-Picking must often be resorted to as a remedy for certain kinds of insects, such as tobacco, tomato and other large "worms," and the eggs, cocoons and perfect forms of certain kinds which it is not practicable to destroy otherwise.

Jarring Method, by which insects are jarred or shaken from the plants and caught in sheets, then burned or crushed, is sometimes the best means of dealing with certain insects which will fall from the plants when disturbed.

Beating the insects from low plants into a pan of water, soapsuds or oil, is sometimes the most practical method for dealing with the potato bug, rose bug, etc.

Cutting Out grubs from the apple and peach, after they have once entered the bark, is probably the surest way of ridding the trees from such pests. They may also be killed by probing for them with a small wire.

Ditching. To collect marching caterpillars, etc., like the army worm and chinch bug.

Hot Water is often used to kill insects, such as ants, cabbage worms, rose bugs, etc.

Road Dust or clay dust is recommended as an efficient remedy for slugs, especially cherry slugs, as it adheres to their slimy bodies, causing them to die.

Vapors. Grain, pea and bean weevels may be easily destroyed by the vapors of bisulphide of carbon, if the grain or seeds are placed in a tight bin. and a small quantity of the liquid poured on, then covered with blankets, the vapors being heavier than air will settle through the mass and kill the weevels contained therein. This

is a dangerous poison to man and very imflammable. Use excessive care in handling.

Coal Tar is used largely in the West for the destruction of grasshoppers. It is placed in a long shallow tin or sheet iron pan and pulled over the ground, the grasshoppers jump in and are destroyed.

For the successful application of the remedies and methods mentioned the following rules should be observed:

1st. Observe and study the habits of insects, that you may attack them at their weak points.

2nd. Ascertain how insects feed before applying a remedy.

3rd. Endeavor to prevent attack by high farming and fertilization.

4th. If a remedy must be resorted to, do not delay, but apply it while the insects are young, or when they first make their appearance.

5th. Select that remedy which will yield the best results at the least expense, but do not hesitate to use expensive methods if they will pay in the end.

6th. Apply all liquid and powder remedies as thorough as possible. If a poison, the under as well as the upper surface of every leaf should be reached. If a contact remedy, every insect should be saturated or covered with it.

7th. If further information is desired on any subject relating to insects, questions in writing should be sent to the Experiment Station, and they will be answered either by letter, in county papers, or in future bulletins.

8th. Always send specimens with letter of inquiry if possible. Send live insects in tin or wooden boxes with some of their food substance, (air holes are not necessary in such packages). Send dead insects in quills, small envelopes, homœpathic vials, etc, packed in cotton, or tin boxes. Such packages sent by mail will cost 1 cent per ounce.

Sections of infested trees or plants, and large packages should be sent by express.

9th. Any information sent to the Station regarding the appearance and destructiveness of injurious insects in any locality of the State, and reports of success or failure with remedies for insects will be thankfully received. Prompt attention will be given to inquiries, and due credit for information if published.

DISEASES OF PLANTS.

The first principle to impress upon the minds of those who desire to give some attention to the diseases of plants and the best method of combating them, is the fact that these diseases are of themselves plants, which, instead of living in the soil, find their proper place of growth mostly to be upon plants of higher organization than themselves. They reproduce by seed much as any plant does, but have the power of producing a far greater abundance than their more fully developed hosts.

Among these plants are the great numbers of rusts, smuts, moulds, rots, mildews, knots, spots, bunts, blights, ergots, scabs, cracks, yellows, etc., that are becoming such deplorable reducers of profit in agriculture and horticulture.

These peculiar forms of life are all thrown together, by their general similarity, in one large class called Fungi, which includes every like plant from the Toadstool down to the microscopical germs found present in putrefying animal and vegetable matter; the aftermath of death.

Fungi (plural of Fungus) are of very simple organization and differ from other plants in many ways, principally, however, first: In the absence of green coloring matter (chlorophyll) so noticeable in the higher order of plants, a principle which they are compelled to draw from those already possessing it; second: the absence of flowers, they producing their seed (spores) directly from their stems or branches; third: having no chlorophyll they do not need the influence of the sun so materially in their growth. Fungi are therefore plants of darkness, dampness, destruction, and disease, all of which are necessary to their subsistence; it is for this reason that crops are affected in proportion to the murkiness of the season, and

all such other conditions as tend to vitiate their strength. Fungi that thrive upon living plants are called *parasitic*, and are always detrimental to man; those which live upon dead plants *saprophytic*, many of which are beneficial, and some even edible and nutritious.

Why is it that for fifty years or more our crops and plants in general have become more and more infested by these diseases, may probably be explained by the fact that a greater profusion of spores are annually produced by natural increase; and that lands are becoming in too many instances too poor to produce vigorous crops from a lack of careful and proper fertilization on the part of the farmer.

The spores of parasitic fungi are so exceedingly minute that they are able to penetrate directly through the microscopic pores of the plants upon which they fall, making their way into the internal tissues of the leaf or stem from which they sap the vital juices. On this account the leaf or stem once attacked can not be saved, nor can the fungus so secluded be dislodged or killed by poisoned applications. Treatment, therefore, of plant diseases must be divided into three heads: Exclusive, Hygienic, and Tropical.

Exclusive Treatment.

During winter, the spores of parasitic fungi weather much as the seeds of higher plants do, life remaining dormant within their coatings. They catch in crevices of bark, on dead leaves, seeds or withered fruits, or rest upon the ground beneath or about the plants upon which they fructified the previous season, ready to spring into life as soon as a warm and moist spring or summer day incites them.

This being the fact then, we must first attempt each season to exclude these living germs from new crops of their special hosts; this we may do by exerting the following precautions:

1. Never plant grain upon a field that showed rusts, bunts, or ergot the previous season, until the land has rested in sod or has been cropped for several seasons with widely different plants from those previously grown thereon.

2 Never sow seed grain procured from a locality where bunts, smuts, or ergot are suspected to have existed, without first treating the seed as directed under Formula 11. This treatment is always recommended to be used as a safeguard even when no doubt has crept in concerning the cleanliness of the seed.

3. Carefully cut out all Barberry and Blackberry briers from the neighborhood of your wheat fields.

4. Cut out and burn all old Plum and Cherry trees dead with the Black Knot. Prune off all formed and young knots and burn them. Clear off all Wild Cherry and Plum trees from about your home and orchard.

5. Rake off and compost with plaster, or burn, all dead leaves from your vineyards and orchards, replacing them with good clean manure or well rotted compost.

6. Carefully reject all tubers (potatoes, etc.,) when cutting for seed that show the least sign of disease of any kind.

7. In procuring young trees or sions for planting, look to it that they come from a region not known to be infested by diseases.

8. Barnyard manure especially that containg much stable bedding, is often a fertile method of spreading disease, therefore, carefully compost such manure with a liberal supply of plaster and see to yet that it is well-rotted before spreading. If the straw used as bedding is known to be rusty, then keep such separate from the general heap and use it only on root crops or orchards.

The above points intelligently and carefully followed will tend to substantially decrease plant diseases upon your farm.

Hygienic Treatment.

It is a well known truism in medical science that contagious diseases seldom if ever attach a healthy, cleanly, strong and well-nourished person; and *per contra*, that a person illy-nourished, poorly fed and clad, uncleanly in habit, overworked either mentally or physically, or who has not followed the general rules of physical hygiene; is particularly open to "catch" almost any infections disease that at the time may be going about. If this is true of animal life, why should it not also be of vegetable? We feel confident in stating that it is; therefore, to avoid diseases of crops as fully as possible the farmer or horticulturist should see that his plants are properly fed (fertilized); well clad (drained or dressed); well ventilated (cultivated and cleared of weeds); strong (pruned and suckered); and otherwise treated in a proper plant-hygienic manner.

This with proper exclusive treatment as detailed above, should reduce diseases of crops to a minimum.

Topical Treatment.

Should however the two above treatments be omitted, or be considered insufficient for any reason, then we must resort to the applicetion of some substance that will prevent the spores of disease from germinating upon the plants. I have appended a list of the more prominent diseases which should be treated with the formulæ mentioned under them. These formulæ will be found at the end of this Bulletin, and the proper apparatus used for their application will also be found under the head of Spraying Apparatus. All the apparatus there described are excellent, their principal difference lies in the amount of work each will do at one loading. You will of course select that one that will best suit your purse and purpose, according to the amount of territory you need to cover, and the time you have to devote to such operations.

The proper time to spray for each disease is given below in connection with it. The general method is one that tends to completeness; that is to say, the use of a hose and nozzle that will throw a very fine spray and will be so controllable that this spray may

be directed in all directions and thus reach all surfaces of the plant to be sprayed. Should a rain fall occur shortly after spraying the benefits of that application will be lost, and should be repeated as soon as possible.

Checking. Should you desire to prove to yourself, what you gain by the use of any application or operation, leave a certain row or patch untreated as a check upon the method, that by comparing in the field or orchard, the crop of the treated with that of the untreated, you may be able to say positively whether the time and outlay have paid or not when harvest comes.

Plant Diseases and Treatment.

Grape Mildew, and Black-rot: The fruit once infected by the disease cannot be saved. Spray the vines with formula 12 before the leaf buds have opened ; again with formula 16 just before the flowers open ; again with formula 17 when the berries are about the size of peas ; and about two weeks before harvesting the fruit.

Grape Bitter-rot: The same treatment will suffice to prevent this disease unless very prevalent, when formula 13 should be used for the first treatment.

In these diseases of the vine, if you should desire to use a powder, having a bellows, instead of a liquid, having no spraying apparatus; then formula 18 may be used with as good results. Should the vines be troubled with any insects that are eating the leaves then add one-fourth pound Paris green to the formula before using.

Black Knot of the Plum and Cherry. Prune out, after the leaves have fallen, all branches affected with old knots and burn them. Cut out young knots thoroughly, and apply lamp-black and linseed oil to the wounds so made. Spray thoroughly before the leaves appear in spring with formula 12; and after the flowers have fallen with formula 19, this will prevent the leaf rust also, as well as protect the fruits from the curculio.

Apple Scab. Spray first just after the flowers have fallen (before the fruit pip turns downward,) with formula 19, which will also defend the fruit against the codling moth. Subsequent sprayings (at least three or more) may be made with formula 15 or 17, but no Paris green nor London purple whatever should be mixed with these.

Pear and Quince Leaf Blight. Spray with formula 17, as directed for grape mildew.

Pear Fire-Blight and Peach Yellows. So far as known these diseases are very contagious and incurable. Should any trees become affected by these diseases dig them up and burn them as soon as possible to save the balance of your orchard from infection.

Potato Blight and Rot and Tomato Rot. Spray seed potatoes in the hills before covering, with formula 14 or 15. Then spray tops with formula 19 every two weeks, making from three to five applications in all. In case you desire to use a powder instead, then formula 18 should be used. If bugs are eating the vines add one-fourth pound of Paris green to the formula before applying.

Should you desire particular advice for any special disease, we would be glad to answer your request for the same by mail at any time, especially if you will send a specimen of the disease in or with your letter of inquiry.

FORMULAS.

For Insects.

No. 1. Paris green or London purple, (liquid).
a. Poison powder, 1 pound.
Hard water, 200 gallons.
Cost about 1 cent for 10 gallons.
b. Poison powder, 1 pound.
Flour paste, 5 pounds, or liquid glue, 1 pint.
Hard water, 150 to 300 gallons.
Cost from 1 to 2 cents per 10 gallons.
c. Poison powder, 1 to 3 teaspoonfuls.
Hard water, 4 gallons.
Cost about one-half cent.
Directions. Moisten the powder and work into a paste with a paddle, then add it to the whole amount of water and stir frequently when in use.
For codling moth and curculios on apple, plum and cherry, use formula *a* and apply as soon as the blossoms fall from the trees and again in ten or fifteen days.
For peach trees the weakest solution must be used.

No. 2. Paris green or London purple (dry powder).
a. Poison powder, 1 pound.
Wheat flour, 10 pounds.
Road dust, plaster or coal ashes, 20 pounds.
Cost about 1½ cents per pound.
b. Poison powder, one teaspoonful.
Flour, lime or coal ashes, 40 to 100 teaspoonfuls.
Cost about 1 cent.
Directions: Sift the lime or coal ashes, add the flour and poison and mix very thoroughly. Apply with bag, bellows, or powder gun.

No 3. Kerosene Emulsion, (A. J. Cook.)
Soft soap, 1 quart.
Water, 2 quarts.
Lamp oil, 1 pint.
When diluted, cost about 1½ cents per gallon.
Directions: Boil the soap in the water, remove from the fire, and

when boiling hot add the oil, then violently stir or churn until the mixture forms a thick cream.

For plant lice, cattle lice and young caterpillars, dilute six pints of the emulsion with seven pints of water and apply thoroughly with brush, atomizer or sprayer.

Kerosene Emulsion (C. V. Riley.)

Hard soap, ½ pound.

Water, 1 gallon.

Lamp oil, 2 gallons.

When diluted costs about 1½ cents per gallon.

Directions: Boil the soap in the water until all is dissolved, remove from the fire and add the oil, then churn for ten minutes or spray it back into the vessel until it is thoroughly mixed and will form a substance like butter when cold. Dilute with 9 parts of water 1 of the emulsion, and apply as in the Cook formula.

No. 4. Potash Soap.

Concentrated lye, 1 pound.

Cotton seed oil, 3 pints.

Soft water, 3 gallons.

Costs when diluted, 15 cents per 100 gallons.

Boil the lye in water until dissolved, then add the oil and boil for two hours, replacing evaporated water with hot water from time to time. Use 1 pound of this soap to 8 or 10 gallons of water on lice-infested plants and trees, and wash the trunks and branches with a stiff brush. This remedy has been highly recommended for this purpose.

No. 5. Fish Oil Soap.

Concentrated lye, 1 pound.

Fish oil, 3 pints.

Soft water, 3 quarts.

When diluted, costs about 35 cents per 100 gallons.

Directions: Same as No. 4. This is a valuable remedy for plant lice, etc.

No. 6. Pyrethrum Powder.

a. Pure powder, 1 part.

Flour 10 to 20 parts.

Directions. Mix thoroughly, place in a tight vessel and allow to stand for a few hours, then apply with a bellows. This is recommended for Cabbage Worms.

Pyrethrum liquid:

b. Powder, 1 tablespoonful.

Water, 2 gallons.

Directions. Stir the powder into boiling water and use as soon as cool enough.

No. 7. White Helebore. (Liquid).

Powder, 1 tablespoonful.

Water, 1 gallon.

Directions. Dissolve in the water and apply with sprayer or brush. The dry powder is used without diluting. The liquid or powder is the best known remedy for the currant and gooseberry worms, rose slugs, etc.

No. 8. Tobacco Decoction.

Tobacco stems or dust, 1 pound.

Water, 3 gallons.

Directions. Boil until the strength is extracted from the tobacco, then strain and boil the liquid down to one pint. For use, dilute one part of the liquid with eight parts of water. This is a remedy highly recommended for plant lice, flea beetles and many other insects.

Tobacco dust, if finely ground, will kill most smooth bodied caterpillars, plant lice, etc., if thoroughly applied to them with the bellows or powder gun. It is also excellent to drive away the Horn Fly if thoroughly rubbed in among the hair on cows and other cattle.

No. 9. Kerosene Ointment.

Lard, 1 pound.

Sulphur powder, 1 ounce.

Lamp oil, ¼ pint

Directions. Mix the lard and sulphur, then add the oil. This is valuable for killing lice on poultry and domestic animals, also used on the horns of cattle to drive away the Horn Fly.

No. 10. Carbolic Acid Soap.

{ Soft soap, 1 quart.
{ Or hard soap, 1 pound.

Water, 2 gallons.

Carbolic acid, 1 pint.

Directions. Add the soap to the water and boil until it is dissolved, then add the acid. This is used as a wash for trees to prevent insect attack, and for lice on animals. Apply with a scrub brush.

For Plant Diseases.

No. 11. Hot water.

Water heated to 135 to 140 Fahrenheit.

Directions. Place seed grain suspected of being smutty, in a coarse sack and plunge the whole in a barrel of this hot water. Be sure that the water is no hotter than 140, and no cooler than 135; or in the first instance you would kill the seed, and in the second you would not destroy the disease spores. Swash about the loose grain in the plunged sack for eight or ten minutes, then remove, spread, and dry quickly; Then sow as soon as possible, in ground that you know is not smutted.

No. 12. Simple solution of copper sulphate.
Copper sulphate (blue-stone, blue-vitriol,) 1 pound.
Soft water, 22 gallons.
Cost three-sixteenths of a cent per gallon.
Directions. Dissolve the copper sulphate in the water. This solution will keep any length of time.

No. 13. Simple solution of iron sulphate.
Iron sulphate (copperas) 5 pounds.
Soft water (hot) 22 gallons.
Cost one-half cent per gallon.
Directions. Dissolve the iron sulphate in the hot water, and use as soon as possible thereafter.

No. 14. Bordeaux mixture.
Copper sulphate (blue-stone, blue-vitriol), 4 pounds.
Unslaked lime, 4 pounds.
Water, 22 gallons.
Cost ⅓ cent per gallon.
Directions. In a wooden, glass, or eathen vessel, dissolve the copper sulphate in sixteen gallons of the water. In another vessel slake the lime in six gallons of the water. Strain the lime through a sieve and stir it into the copper sulphate solution. It is now ready for use. Never make this mixtute in any other way than this.

No. 15. Eau Celeste, modified.
Copper sulphate (blue-stone, blue-vitriol) 2 pounds.
Soda carbonate, (washing soda) 2½ pounds.
Ammonia (22 Baume), 1½ pounds.
Water, 22 gallons.
Costs 1⅓ cents per gal.
Directions: Dissolve the sulphate of copper in the vessel described as under Formula 14, in two gallons of boiling water. In another vessel dissolve the soda in two gallons of water. Add the soda solution to the copper solution, and when settled add the ammonia. Now add enough water to make 22 gallons of the mixture, and use as soon as possible.

No. 16. Burgundy Mixture, Modified.
Copper sulphate (Bluestone, Blue-vitriol.) 2½ pounds.
Soda carbonate (Washing soda) 3¼ pounds.
Hard soap (shaved), ½ pound.
Water, 22 gallons.
Cost 1½ cents per gallon.
Directions: In a vessel as mentioned under formula 14, dissolve the copper sulphate in twelve gallons of water. In another vessel dissolve the soda in ten gallons of water. Strain the soda solution through a seive, and stir it into the copper solution. Dissolve the soap shavings in one-half gallon of boiling water, and stir it into the mixture. Use as soon as possible.

No. 17. Ammoniacal Carbonate of Copper.
Copper carbonate, 3 ounces.
Ammonia carbonate, 1 pound.
Water, 50 gallons.
Cost 1⅓ cents per gallon.
Directions: Dissolve the two carbonates in a half gallon of hot water. Dilute this solution to fifty gallons.

No. 18. Copper and Sulphur Powder.
Sulphate of copper (very dry and finely powdered), 1 pound.
Flowers of sulphur, 10 pounds.
Air-slaked lime, 1 pound.
Cost 4⅓ cents per pound.
Directions: Mix thoroughly, and use in a bellows or powder gun.

No. 19. Bordeaux Mixture, with Paris Green, or London Purple.
Copper sulphate (Bluestone, blue-vitriol), 2 pounds.
Unslacked lime, 4 pounds.
Water, 22 gallons.
Paris green or London purple, 2 ounces.
Cost, ½ cent per gallon.
Directions. Mix as stated under formula 14, then add the Paris green and stir in well.

SPRAYING APPARATUS.

The implements illustrated here are all good ones, but not all that are upon the market. We would suggest that those intending to use insecticides and fungicides write to any reliable dealer for catalogus of such aparatus; and choose that which will best suit the amount of work to be done. The points to be insisted upon are: That all working parts coming in contact with the liquid should be made of brass, and have an arrangement for keeping the liquid agitated in its receptacle while the spraying is going on; and that the spray shall be as fine and constant as possible.

We place the illustrations in the order of the quantity each will handle, and the price, without special regard to their merits.

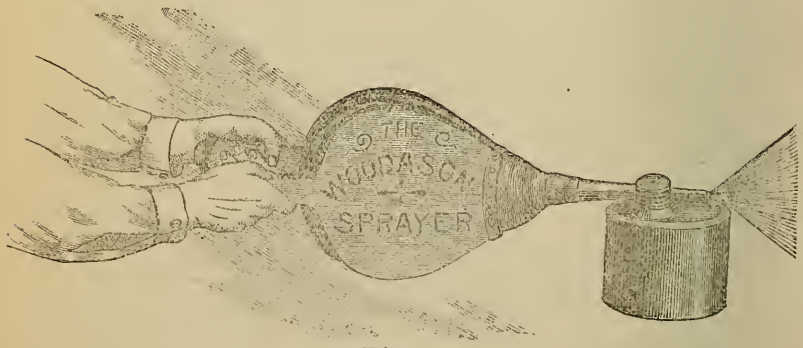
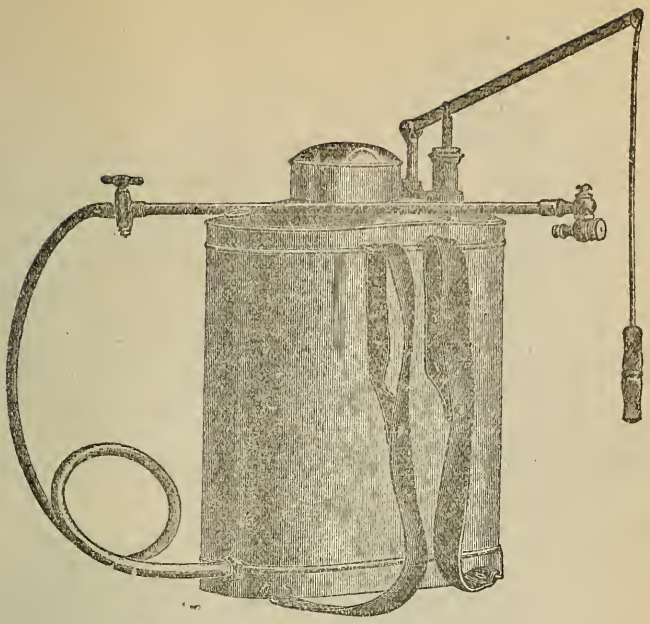


Fig. 1.

Woodason Atomizer.

Fig. 1 represents the "Woodason Atomizer," which is recommended as a very useful implement, especially for indoor and small plats, where but little area is to be covered at any one operation.



THE EXCELSIOR KNAPSACK SPRAYER. FIG. 2.

Fig. 2 represents one of the forms of Knapsack Sprayers, all of which are meritorious and cost in the neighborhood of $14. They carry about 8 gallons at a charge, and are capable of covering considerable territory.

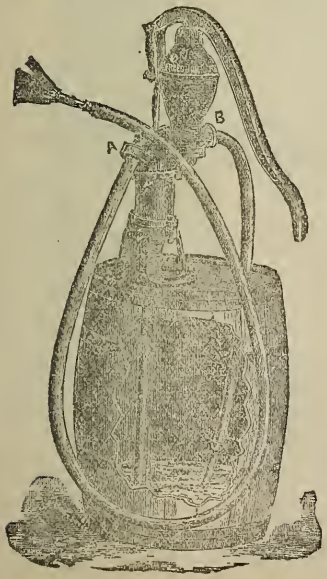


FIG. 3.

Fig. 3 calls attention to one of the larger machines. This "Perfection Spraying Outfit" is an excellent type of its class, costing without barrel, $10 in iron, or about $12 in brass, which should be selected.

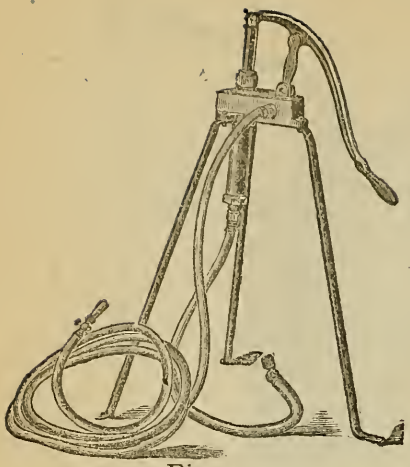


Fig. 4.

NEW STYLE CLIMAX TRIPOD PUMP.

Fig. 4. Represents the "New Style Climax Tripod Pump," which will cost (including the nozzles represented in Fig. 5.), from $15 to $20 according to size. When mounted with a barrel upon a wagon or sled, this outfit will prove very efficient for covering large areas of crops, or orchards of considerable acreage,

These cuts illustrate the nozzles. No. 3 shows the outer end covered by a wire screen, which cuts the water into spray. No. 2 shows nipple end of same. No. 1 shows the nozzle entire.

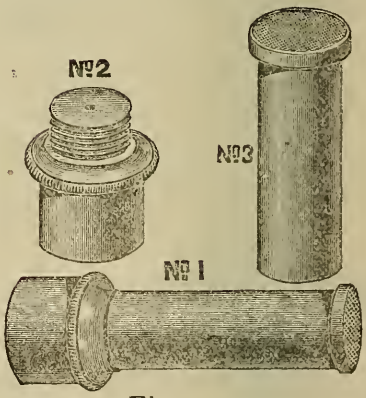


Fig. 5.

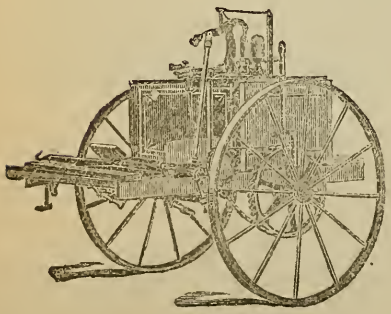


Fig. 6. Shows an improved Field and Orchard machine for extended operations. This machine costs, with gearing, $85.

POWDER APPARATUS.

FIG. 7.—WOODASON DOUBLE CONE BELLOWS.

Figure 7 is a cheap form of bellows, well adapted to the application of powder on a small scale. Price, $3.

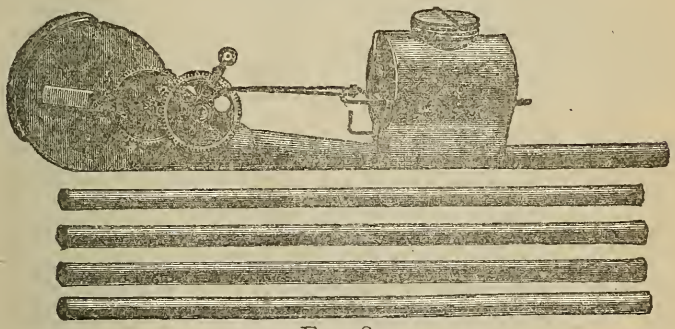


FIG. 8.

Figures 8 (and 9 upon another page) represent the cheapest form of "Leggett's Powder Gun," an implement admirably adapted to the application of dry powders to field crops and fruit trees. There is also a larger form manufactured by this company, called "Leggett's Paris Green and London Purple Gun," at $12.

Manufacturers.

Implements figures 1 and 7, are manufactured by Thomas Woodason, 451 E. Cambria St., Philadelphia.

The Knapsack figure 2, is made by William Stahl, of Quincy, Illinois.

The Perfection Spraying Outfit figure 3, and several others of this type, are from the works of the Field Force Pump Co., Lockport, N. Y.

Implements 4, 5 and 6, are manufactured by The Nixon Nozzle & Machine Co., Dayton, Ohio.

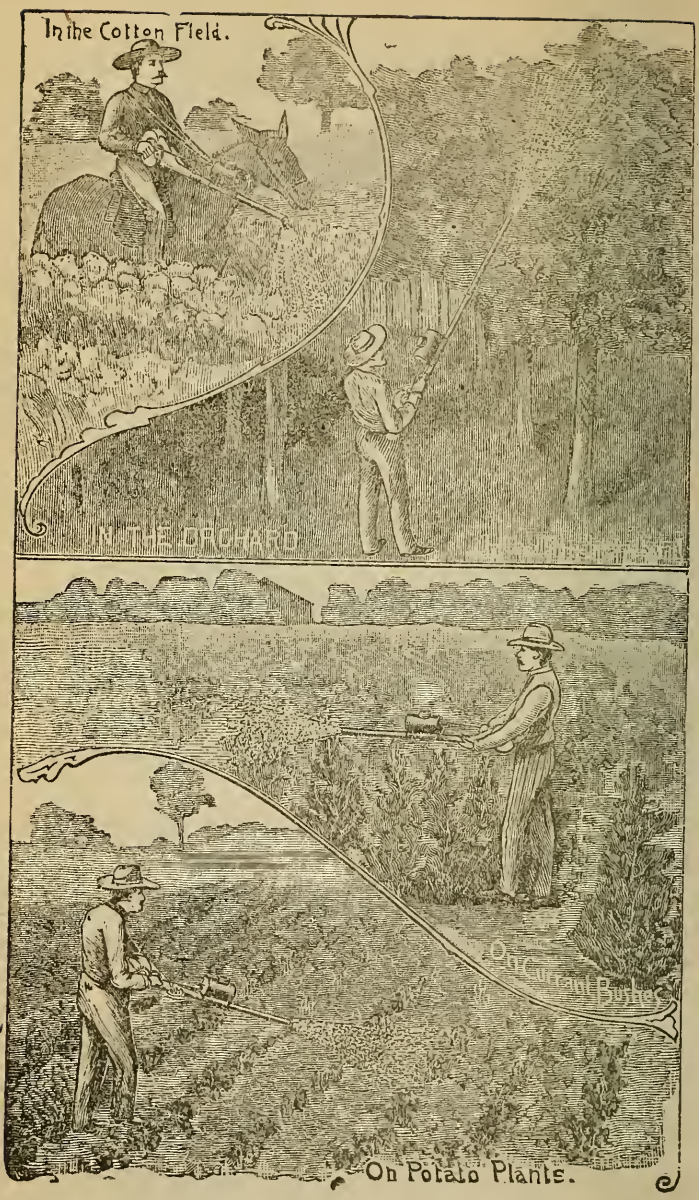


Fig. 9.
Leggett's Dry Powder Gun.

The Dry Powder Gun, Figs. 8 and 9, is manufactured by Leggett & Bros., 301 Pearl St., New York.

All of these firms manufacture many different kinds of apparatus which are fully described in their free catalogues.

There are several other reliable firms advertising in the leading agricultural papers who will send out full descriptions of the implements they have for sale, upon application. Most of the leading seedsmen also either manufacture or act as agents for spraying apparatus, and keep for sale insecticides and fungicides as well.

We would caution all to use good judgment in the purchase of the chemicals, and to look with considerable doubt upon all insecticides advertised as "cure-alls;" these, like many patent medicines, are often more profitable to the manufacturer than to the user.

A spraying outfit, which will cost from $3 to $15, and the small bellows and powder gun, costing from $2 to $5, together with the cheap formulæ mentioned in this bulletin, will usually prove amply sufficient for the West Virginia farmer and fruit grower; and if used intelligently will pay a large per cent. on the investment.