New York Agricultural Experiment Station.

Geneva, N. Y.

Spray Pumps and Spraying.

Wendell Paddock.

Published by the Station.
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*Connected with Fertilizer Control.
†Connected with Second Judicial Department Branch Station.
BULLETIN NO. 121, APPENDIX.

SPRAY PUMPS AND SPRAYING.

INTRODUCTION.

Bulletin No. 121 (April, 1897) gave a description of the best forms of spraying apparatus and spraying mixtures in use at that time. Since its publication, however, appliances have been modified and new formulas tested with good success; so it seems advisable to present brief descriptions of these new aids to horticulture.

PUMPS.

_The Kerowater._—The demand for a cheap and easily made insecticide that can be used in place of kerosene emulsion has led to the invention of pumps that have the power of making a mechanical mixture of kerosene oil and water. One of the recent inventions in this line is the Kerowater manufactured by the Gould Mfg. Co., Seneca Falls, N. Y., illustrated Fig. 1. The oil tank within the barrel in shown in the figure. Each tank is provided with a pump and the two liquids do not come together until they reach the discharge pipe outside of the barrel. Thus a constant proportion between the two liquids is maintained whether the tanks are full or nearly
empty. The sprayer can be set to throw different percentages of oil by changing the length of stroke of the oil pump as is indicated by figures cast in the lever. Both pumps can be very easily taken from the barrel, when the two may be separated, and by replacing the larger pump we have an outfit similar to the Pomona that may be used in spraying Bordeaux mixture.

The Kerowater outfit complete is listed at $18.50.

Removable barrel top.—*No doubt not a few fruit growers have found when they come to overhaul their spraying apparatus in the spring that the heads of the barrels to which the pumps are attached were loose or much warped. Such was our experience, but our man-of-all work has found a way to overcome this source of annoyance. As Fig. 2 shows, he has made a removable head to which the pump is permanently attached. The head is secured by three bolts that are fastened to the inside of the barrel. This arrangement also has great advantages when it becomes necessary to repair the pump. With the old way, the pump can only be got at through the small hole in the top of the barrel, and everyone knows how disagreeable that is; or else the pump must be taken from the barrel at the expense of much time and patience in removing rusty screws and bolts. With the removable head it is but a minute’s work to remove the pump, and it is easily replaced when the repairs have been made.

*Paddock, W. Rural New Yorker, 57: 299.
SPRAYING MIXTURES.

*Copper sulphate solution.*—A solution of copper sulphate has been recommended as a substitute for Bordeaux mixture to be used under certain conditions. This fungicide is, however, of doubtful value since it is liable to be washed off of the trees by the first rain and when used during the growing season even a very weak solution will injure the foliage of some kinds of trees. A solution for use on dormant trees may be made of the following strength:

Copper sulphate........................1 pound.
Water...................................15 to 25 gallons.

No definite instructions can as yet be given for the use of the solution on the different kinds of trees after growth has started in the spring.

*Paris green dissolved in ammonia.*—Some fruit growers make a practice of dissolving all the Paris green that they use thinking that the poison will be more effectual in a liquid state. This might work very well if it were not for the fact that lime must be added to the Paris green solution in order that injury to the foliage may be prevented.

When lime sufficient to neutralize the corrosive action of the poison has been added the Paris green is at once precipitated so that it is in a form similar to what it was before it was dissolved. Thus it will be seen that nothing is gained by the operation, but on the other hand a considerable expense has been incurred since it takes about a pint of strong ammonia to dissolve a pound of Paris green.

*London purple.*—This poison is a by-product that is obtained in the manufacture of certain dyestuffs, the poisonous principle being arsenite of lime. From the fact that London purple is a by-product the amount of poison that it contains is variable therefore it cannot always be depended on to produce desired results. This is the only reason that it is not generally recommended. It should be applied somewhat stronger than Paris green, using a pound to from 100 to 150 gallons of water.

*Green arsenite.*—One serious drawback to the use of Paris green is that it settles very rapidly when mixed with water and

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unless the pump is provided with the best of agitators it is difficult to maintain a spray in which the amount of the poison is constant. Green arsenite is superior to Paris green in this respect as it is in the form of a very fine powder which stays in suspension much longer than Paris green. On comparing mixtures of the same strength it was found that while Paris green settled to the bottom of the vessel in about five minutes, the green arsenite remained in suspension over two hours. It is used in the same proportions as Paris green, one pound to from 150 to 200 gallons of water, using lime to prevent injury to foliage or combined with the same amount of Bordeaux mixture. Green arsenite costs about fifteen cents per pound and may be obtained from the Adler Color and Chemical Co., New York, and probably from other dealers.

*Arsenite of lime.—The demand for a cheaper poison than Paris green has led to the use of white arsenic as a substitute. Arsenic must be used in combination with other substances which will render it insoluble, since it is very injurious to foliage when in a soluble form. It will be seen then that white arsenic and water or white arsenic dissolved in sal-soda and water without lime are unsafe combinations to use. Arsenite of lime is a safe form in which to use arsenic since it will not dissolve in water. There are two methods of preparing arsenite of lime as follows:

| White arsenic | 1 pound |
| Fresh slaked lime | 2 pounds |
| Water | 2 gallons |

Boil for twenty minutes then dilute with 400 gallons of water. This formula is not considered as reliable as the one given below since it is difficult to tell when all of the arsenic is dissolved and combined with the lime and if prepared in large quantities the arsenite of lime will gradually settle into a compact mass that will not readily mix with water. The following formula is much more reliable:

| White arsenic | 2 pounds |
| Sal-soda | 8 pounds |
| Water | 2 gallons |

Boil until the arsenic is all dissolved which will take about fifteen minutes. Replace the water that has been lost in boiling as otherwise some of the material will crystallize upon cooling;

then place in an earthen vessel where it can be kept as a stock solution. One pint of this stock is equivalent to four ounces of Paris green and is used in the same way; that is one pint of the stock, two pounds of fresh slaked lime and 45 gallons of water, or one pint of the stock to 45 gallons of Bordeaux mixture.

It is very important that the vessels that are used in making or storing these poisons be plainly labeled and never used for any other purpose.

*A poison carrier.—Anyone who has tried to combat cabbage worms is familiar with the difficulty that is experienced in getting the liquid to adhere to the foliage. The surface of cabbage leaves and similar plants is such that is impossible to make enough poison stick to the leaves to do any good when applied as directed in any of the formulas that have been mentioned. Mr. Sirrine has recently devised a method whereby poison may be evenly distributed over the surface of such leaves and in a form that is not easily washed off by rains. This is known as a resin lime mixture and is prepared as follows:

<table>
<thead>
<tr>
<th>Pulverized resin</th>
<th>Concentrated lye</th>
<th>Fish oil, or any cheap animal oil except tallow</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>..............................</td>
<td>..............................</td>
<td>..............................</td>
<td>..............................</td>
</tr>
<tr>
<td>5 lbs.</td>
<td>1 lb.</td>
<td>1 pt.</td>
<td>5 gals.</td>
</tr>
</tbody>
</table>

Place oil, resin and a gallon of water in an iron kettle and heat until resin is softened; add lye solution made as for hard soap; stir thoroughly; add remainder of water and boil about two hours, or until the mixture will unite with cold water making a clear, amber-colored liquid. If the mixture has boiled away too much, add sufficient boiling water to make 5 gallons.

For use, 1 gallon of this stock solution is diluted with 16 gallons of water and afterward 3 gallons of milk-of-lime or whitewash added. The resin mixture is in reality a liquid soap and the addition of the lime turns it to a hard soap which remains suspended in the water in minute particles. The poison, \( \frac{1}{4} \) pound of Paris green or other arsenite, is then added, and the particles of poison adhere to the finely divided soap particles and are thus distributed throughout the mixture in minute and uniform quantities. The soap solution is very adhesive and thus

a thin film of poison is made to stick to every part of the leaf which is touched by the spray. The application must be made by a hand power machine, either a strongly-made knapsack or a barrel sprayer, as no horsepower machine will do the work thoroughly enough or carefully enough upon cabbage and cauliflower. 

This material can no doubt be used to advantage in combination with Bordeaux mixture for use on plants that have leaves that are not easily wetted.

*Kerosene and water mechanical mixture.*—The increase of scale insects in recent years has created a demand for a remedy that is cheaper and easier made than kerosene emulsion. An attempt has been made to meet this demand by the invention of pumps that have the power of making a mechanical mixture of kerosene oil and water (Fig 1).

While this mixture has been used successfully in some cases other instances are reported when serious injury has been done to trees by the its use at a strength that was too weak to kill the insects for which it was applied. Therefore this manner of using kerosene oil as an insecticide must still be regarded as being in an experimental stage.
TO THE BULLETIN READER:

The mailing list of the New York Agricultural Experiment Station now includes 25000 names of the residents of New York, chiefly farmers! It has been the custom to send to this entire list our complete bulletins which give in a somewhat extended and comprehensive form the data and discussions of the investigations that have been conducted. Such bulletins have contained tables of figures, elaborate reasoning in some cases, and more or less of the concise language of science, and have been valuable to the workers in other stations and to a limited number of readers who are engaged in Agriculture as a business. I have become convinced, however, by my contact with the rank and file of New York farmers that, for a time at least, bulletins written in a simpler and more popular style with less of confusing data would be greatly more useful, and consequently it has been decided to make a somewhat radical change in the literature of the Station which is designed for general distribution. The accompanying popular edition of Bulletin No. 114 written by the Station editor, Mr. Hall, is the beginning of the new departure, and I trust that this, together with all future efforts in this direction, will meet with the approval of these in whose interests we are working.

The popular bulletins only will be sent to the regular mailing list, but if any farmer desires to receive a copy of any one of the complete bulletins, it will be mailed promptly upon request.

W. H. JORDAN,

Director.

N. Y. Agr'l Exp't Station,

Geneva, N. Y., April 15, 1897.
New York Agricultural Experiment Station.

POPULAR EDITION
OF
BULLETIN No. 121.

SPRAYING MIXTURES AND THEIR APPLICATION.

APRIL, 1897.

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Elementary instruction concerning the materials, Spraying not appliances and methods used in spraying still understood. seems to be demanded. Experiment stations and periodicals have done much to scatter broadcast the principles governing the use of fungicides and insecticides in spray form, and prominent growers of fruits and of garden crops have made practical application of these principles to their own financial gain; yet many still inquire: How shall we spray? Some of the more important features involved in this method of treatment are here reviewed.

It is not wise to spray just because spraying is a Intelligence good thing or because by it a neighbor has saved a necessity. the crops of his garden or orchard. The pests which troubled him may have passed away and an entirely different sort may have taken their place. The crop must be carefully examined and if injury is detected its character and cause must be determined before it can be effectively treated. Judgment and care must be exercised for no set of rules or spray calendar is a sufficient guide. It is essential to know why to spray, what to use and how to apply the remedy. It would be useless to spray with kerosene emulsion to repress mildew, to combat currant worms with Bordeaux mixture or to apply Paris green for an attack of plant lice.

*This is a brief review of Bulletin No. 121 of this Station on Spray Pumps and Spraying, by Wendell Paddock. Anyone specially interested in the detailed investigations will be furnished, on application, with a copy of the complete Bulletin.
Bordeaux mixture is a fungicide and is used to prevent plant disease; Paris green and kerosene emulsion are both insecticides; but they are useful against very different classes of insects. The former poisons the beetles and worms that eat the foliage while the latter kills, by contact, the lice and scales and other insects that pierce the plants and suck their juices. Descriptions and treatment of the most important pests of these three classes are given in Bulletin No. 86 of the Station, and a little careful study will soon enable one to recognize the plant foes he is most liable to meet. Then it becomes necessary to know how to make the appropriate remedy and how best to apply it.

The Bordeaux mixture which the Station uses, and which has proven highly satisfactory, consists of 4 pounds of copper sulphate, 3 pounds of fresh lime and 45 gallons of water. The sulphate dissolves readily in a few gallons of hot water or by suspending it for a longer time in a coarse bag in cold water. The solution is then diluted to about 30 gallons and to it is added a thin whitewash made from the freshly slaked lime, stirring thoroughly and straining the whitewash if it contains large particles. When diluted to 45 gallons, the mixture is ready for use. Stock solution of copper sulphate may be made up in large quantity by using twice as many pounds of the sulphate as gallons of water, so that each gallon of the solution will contain 2 pounds of the salt. The solution must be protected from evaporation to prevent change of strength. A saturated solution in which the water contains all it will take up of the salt will hold 3 pounds (49 ounces at 59°F.) of sulphate per gallon of water. Two gallons of the stock solution, then, or 1 1/2 gallons of the saturated will be sufficient for 45 gallons of water. The lime also may be slaked in quantity and the proper amount to be added be determined by a simple color test. When sufficient lime is not present drops of a solution of potassium ferrocyanide added to the Bordeaux mixture will immediately change to a dark, reddish brown, but if the lime is in excess no change will occur. Be sure the lime is in excess by adding it even after no color change takes place; for too much lime will do no harm but too little of it allows the sulphate to "burn" the foliage.
Kerosene emulsion is made by dissolving one-half pound of common soap or whale oil soap in one gallon of water, heating to the boiling point and adding 2 gallons of kerosene. Pump the ingredients vigorously and repeatedly through a small force pump until they form a thick, creamy mass which does not separate on cooling. For use, heat cautiously, as it is very inflammable, and dilute with 10 to 15 parts of water for spraying foliage, or with 4 or 5 parts if for winter spraying of bare trunks and branches.

Paris green may be applied with Bordeaux mixture, 1 pound to 150 or 200 gallons on foliage of apples, pears, etc.; 1 pound to 250 or 300 gallons for stone fruits. When applied with water the same amount is used but 2 pounds of lime must be added for each pound of Paris green to prevent injuring the foliage. Adulteration of Paris green will be indicated if small white spots appear when the lumps are crushed between the fingers or between pieces of glass; or if the Paris green does not dissolve quickly in ammonia forming a solution of deep blue color and without sediment.

The appropriate spraying mixture should be applied very thoroughly to the affected plants and this requires the assistance of a good pump and good nozzles. The exact style of pump to be used is a matter for the purchaser to decide as no one style can be said to be better than all others for all purposes. The good pump should work easily, maintain a steady spray from several nozzles, be simple in construction, have non-corrosive working parts, be durable and able to stand hard use, be easily taken to pieces for repair, have pipes properly arranged to prevent clogging, and be provided with an agitator which keeps the solution in vigorous motion and the sulphate and lime thoroughly distributed. Judging by cheapness alone often proves poor economy.

For a very finely divided spray the Vermorel nozzle seems the best of any tested at the Station, and that form should be chosen which is provided with a joint between nozzle chamber and elbow to allow easy access in case of clogging. For spraying at some distance the McGowen nozzle is useful, and the double Vermorel is adapted for thorough, rapid work. A light bamboo pole, enclosing a brass
tube and fitted with proper connections, seems the lightest and simplest means for raising the nozzles and, with a light framework erected in the wagon or cart upon which the operator may stand, will usually afford sufficient elevation for even tall trees.

The hand power pumps consist essentially of force pumps fastened upon or in barrels or other tanks which should be made round to avoid corners for collection of sediment. Many types have been tested at the Station and some of their good and bad points, their prices and the names of their manufacturers are given below: The Eclipse, made by Morrill & Morley, Benton Harbor, Mich., and the Pomona, manufactured by the Gould Pump Company, Seneca Falls, N. Y., are listed at $20.00 each and are quite similar in appearance and action. Each pump is placed upright in the barrel, from which it is easily removable; the cylinder of each is at the bottom, is of brass with brass plunger, and the air chamber surrounds the discharge pipe. The cylinder of the Eclipse is subject to heavy wear at the middle and when worn cannot be sufficiently packed to give good results. A new cylinder, however, costs but seventy-five cents and can be easily put in place. The agitators of both machines are quite satisfactory.

The Caswell, made by the Caswell Pump Company, Sandusky, O., is also a $20.00 pump. It has a horizontally acting handle allowing full weight of body to be put upon both strokes. Its parts are very easy of access for repair, but the agitator is not first class and the pump cannot be attached to the barrel but must be bolted to a specially made frame upon which the barrel rests horizontally, or to the frame of the wagon.

The Advance, an $18.00 pump, is made by the Deming Pump Company, Salem, O., and has the air chamber above the upright barrel like the old style pumps, but unlike them, its working parts are quite accessible. It is well made and powerful, and though not thoroughly tested at the Station, seems satisfactory.

The Empire Queen, Field Force Pump Company, Lockport, N. Y., is a $9.00, old style pump, whose parts are hard to get at when repairs are necessary and whose agitator is not sufficiently vigorous in its action. For small orchards where work is not heavy and repairs not frequent it may be preferable to higher priced pumps.
The Defender, P. C. Lewis Manufacturing Company, Catskill, N. Y., is a $10.00 pump of small size which attaches to the top of the horizontal barrel. All its parts in contact with the liquid are of brass and its leather valves are easily replaced when worn. Its hose couplings are of unusual size preventing interchange with hose fitting other pumps. Its form and size make it convenient and its low price recommends it to those whose work is not heavy.

Of a distinct type is the Geiger, manufactured by the Geiger Pump Company, Rochester, N. Y. It is a semi-rotary pump, provided with separate agitator and is listed at $20.00. Pumps of this style are very satisfactory while the parts fit closely as there are no valves to get out of order or packing to replace, but one season of hard use frequently wears the cylinder so that a new one is necessary.

Bucket pumps of small size to be fastened to pails are made in great variety. They cost but little, can be obtained from most dealers, and are very useful where but a small amount of spraying is required.

Knapsack sprayers, because of the hard, dirty work involved in their use, are not to be recommended, unless the barrel and bucket pumps can not be used to advantage.

**Powder guns and bellows.**

Small machines for applying powdered materials are often very convenient for use in green houses and on small plantations. Two types are represented by the Leggett Powder Gun and the Lightning Potato Bug Killer. The former is made mostly of tin and consists of a reservoir and an enclosed hand-revolved fan which blows the powder out through a tube. The latter distributes the powder by bellows action through a funnel shaped spout.

**Steam sprayers.**

The application of steam to spraying has of late received much attention but wholly satisfactory machines have not yet been developed. The Rochester Machine Tool Company manufactures a steam sprayer which is listed at $250.00 and may be used in an ordinary wagon. The outfit consists of a kerosene heated boiler, a pump and tank, and an agitator and one horse power engine to run it. This seems an expensive method of agitation and the
attachment of the suction pipe to the bottom of the barrel is liable to cause clogging.

**Horse power sprayer.** Bulletin No. 74 of the Station describes quite thoroughly the different styles of horse power sprayers, and recommends those distributing the liquid by force pumps and not by gravity. A new machine which is specially designed for spraying potatoes possesses some desirable features. This is the Hudson Sprayer, manufactured by the Riverhead Agricultural Works, Riverhead, N. Y., and listed at $75.00. By this apparatus four rows of potatoes may be treated at once, each with two nozzles. It agitates the mixture thoroughly, the barrel may be easily filled, the machine is well balanced, and the rotary pump is easily controlled and powerful. The manufacturers of other horse power sprayers are the Caswell Pump Company, Sandusky, O., Thomas Peppler, Heightstown, N. J., and the Field Force Pump Company, Lockport, N. Y.