

CONTROL OF FUNGUS DISEASES*

DIRECT METHODS OF CONTROL

DIRECT methods of controlling fungus diseases consist of the use of certain chemical poison, or rather agencies such as heat, to kill the parasitic fungi or to prevent their spores from infecting healthy plants. Before embarking on a campaign of spraying or dusting with a view to control fungus diseases, some knowledge of the properties, action, and methods of applying the various fungicides available will enable the cultivator to make the best use of the materials at his disposal. All direct methods of combating fungus diseases are somewhat expensive so that the crop must be of a valuable nature to make the expenditure worth while. Hence such measures of control are only widely employed on valuable crops such as vines, fruit trees, potatoes, and other market garden and orchard crops, some of which are liable to be totally destroyed by severe epidemics of fungus diseases.

The poisons (fungicides) by which fungus diseases can be successfully attacked may be divided into three groups:

(a) Those which kill or destroy the fungus immediately on coming into contact with it; the so-called "hitting" spray fluids.

(b) Those which form a poisonous layer on the surface of the foliage and on which the germinating spores of the fungus are killed before they can gain entry into the plant.

(c) Those which are intermediate in their action between (a) and (b); i.e., they kill the fungus on coming into contact with it but to a certain extent they also form a poisonous layer.

Fungicides may be in the form of dusts or powders or in liquid form, composed of solutions or fine particles suspended in a liquid.

A fungicide should fulfil two conditions: (a) it must contain a poison sufficiently strong to kill the fungus or to prevent its spores from germinating, but at the same time it must not be injurious to the plant, and (b) it should be inexpensive and easy to handle.

Of the liquid fungicides of the first group which have a direct action may be mentioned washing soda and soft soap (Formula No. 1) which is useful for controlling powdery mildews in small gardens, the ingredients being common household commodities. In common with "hitting" fluids of this nature, several applications must be given, as only the fungus present is killed; the plant is not protected from future infection. The mixture of soap and soda has a further advantage in possessing the power of breaking down the film which causes water to run in drops. It is thus able to penetrate the tightly woven mass of fungus threads of which the mildew is composed. The property of spray fluids is discussed further below.

A weak solution of carbolic acid and soft soap is another example of a "hitting" fluid useful for combating rose mildew.

Of the protective layer type of fungicides are the well-known copper spray fluids, Bordeaux Mixture (Formula No. 2) and Burgundy Mixture (Formula No. 3). Both these contain copper sulphate as the poisonous principle. Copper sulphate is one of the most efficient fungicides known. A solution of this substance, however, even when greatly diluted, has an

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injurious effect on plant foliage. The interaction of the copper sulphate with lime or washing soda produces a compound which, while retaining much of the fungicidal property of the copper sulphate, does not injure the foliage. Further when the liquid evaporates it leaves a poisonous layer which is washed off by rain only with considerable difficulty. This persistent layer serves to protect the leaves from infection, as spores alighting on it are either killed directly or when they commence to germinate.

Burgundy Mixture, though slightly more expensive to make than Bordeaux Mixture, is to be preferred where lime is of an inferior quality or is difficult to obtain. It has certain other advantages in that it is rather less likely to be washed off by rain and is not so likely to clog the spraying machine. These spray fluids have a wide application against a large number of fungus diseases, especially the Downy Mildew of the Vine and the Early and Late Blight of Potatoes.

An example of a spray fluid which acts both as a "hitting" spray and also forms a protective layer is lime sulphur. It is best bought in the concentrated form and before use merely has to be diluted with the requisite amount of water. It is a valuable fungicide for use on fruit trees which are liable to be injured by certain copper fungicides and is particularly effective against the powdery mildews of apple, peach, and almond.

It is a matter of common observation that rain or water sprayed on the surface of a cabbage leaf immediately forms drops or globules which tend to run off the inclined leaf surface. If the leaf on the other hand, is dipped into a solution of soap, the globules do not form but the water "spreads" over the surfaces as a film of moisture. In the same way pure water sprayed on wool will remain on the surface of the fibres in the form of drops. The soap solution, however, will penetrate between the wool fibres and thoroughly "wet" the wool. This spreading and wetting property of spray fluids is of great importance, for without it the fluid will not spread and make an even film on the leaf surface, nor will it penetrate and wet the tangled mass of fungus threads of which the powdery mildews are composed. Various substances as well as soap can be added to spray fluids to increase their wetting and spreading powers, as much as calcium caseinate, saponin, skim milk, etc. Certain proprietary substances such as "Agrol" are also on the market.

DUSTS

The only fungicidal dust at present in general use in Cyprus is sulphur, which should be in the form of "Flowers of Sulphur" or very finely ground or precipitated sulphur. This kills the fungus by direct action of the sulphur particles in contact with the fungus. Its chief value lies therefore in combating the powdery mildews and is the chief specific in use against the "Oidium" of the vine. The chains of spores where they have come into contact with the particles of sulphur have shrivelled up. As the particles of sulphur are in actual contact with the fungus, it follows that, to obtain the best effect, the sulphur should be in a fine state as the smaller the sulphur particles the greater the amount of mildew with which they can come into contact.

Other dusts, which have not yet had a wide application in Cyprus, are the copper-lime dusts which, on coming into contact with moisture on the surface of the foliage dissolve and form a deposit similar to that left by Bordeaux Mixture. They are not on the whole as efficient as the wet sprays but have useful application in districts where water is not readily obtainable or in hilly districts where water is difficult to carry to the spraying machines.

APPLICATION OF FUNGICIDAL MATERIAL

A spray fluid whose efficacy depends on its penetrating or wetting power such as the soap and the soda mixture may be put on with a fairly coarse nozzle. With the protective layer type of spray fluid the foliage must not be "washed". A fine misty spray is required which will form a film on the surface of the leaf without causing it to drip. Spray fluids can be readily applied by means of the numerous knapsack machines on the market. The pneumatic type of machine which can be pumped up to a considerable pressure is on the whole more efficient than the lever pump type. Knapsack machines can be used for all garden and field crops and for trees not more than ten feet high. With a knapsack machine one man can use about 60 gallons of spray fluid a day. For larger orchards, vine plantations, and potato plots a hand pump mounted on a 15-gallon tank on wheels is a more suitable type of apparatus to use, especially as with this machine a higher pressure can easily be maintained.

Powders can be applied by means of small hand bellows or a knapsack dusting machine. The most efficient of the mechanical dusters are those fitted with a rotary fan in place of the bellows. The chief desideratum is to produce a cloud which will penetrate the thickest foliage and leave a deposit of particles on both surfaces of the leaves. For this reason powder can usually only be applied when there is little wind. It is generally necessary to dust in the morning or evening when the foliage is wet with rain or dew. This is essential with the copper-lime dusts which depend for their efficiency on the solution and interaction of their component particles. For dusting on a very small scale a muslin bag filled with powder and beaten with a stick will give fairly good results.

In deciding which of the various fungicides should be employed to combat a particular disease a knowledge of the life-history and mode of infection is required. Parasitic fungi may be divided for this purpose into two groups: (a) those which spend the greater part of their existence on the surface of the plant merely sending down minute suckers into the plant tissue to obtain nourishment, and (b) those which live inside the plant tissue only appearing on the surface to produce spores or fruit bodies. As an example of the first group may be mentioned the powdery mildews which each year take a heavy toll from vines, cucurbits, cereals and many other plants. All the fungus threads of this group are entirely superficial with the exception of the minute suckers. A fungus of this nature is susceptible to treatment by a fungicide having a direct action such as a "hitting" spray fluid or a powder-like sulphur which kills the fungus on coming into contact with it.

In the second group are a very large number of the fungi such as the Downy Mildew of the vine, the Early and Late Blight of potatoes. Since these fungi live inside the tissue of the plant the external application of fungicides can have no effect on them. The small portion of the fungus which emerges to produce spores can be killed by the direct action of fungicides but the effect is only temporary; a fresh crop of spores being produced after a short time. The most effective way of dealing with this type of fungus is to cover the surface of the plant with a poisonous layer which either prevents the spore from germinating or kills it during the process of germination. It will be at once obvious that with this type of fungicide early application is necessary in order to get the poisonous layer into position before the spores alight on the surface. Once the spores have penetrated the leaf of the protective poisonous layer will be of little avail. The golden rule is to *spray early before the disease appears*. Further additional applications must be made from time to time in order to cover the fresh foliage as it unfolds.

The following formulae for the preparation of liquid fungicides are recommended:—

Formula No. 1.—*Washing Soda and Soft Soap.*

Soft soap	40 drams.
Washing soda	70 grams.
Water	10 okes. (oke=2.75 lb.).

The soap is dissolved in a small quantity of hot water boiling if necessary, and is then added to the solution of soda.

Formula No. 2.—*Bordeaux Mixture.*

Copper sulphate	...	1 oke or 32 drams.
Stone lime	...	1 oke or 32 drams.
Water	...	125 okes or 10 okes.

The copper sulphate should be of 98 per cent purity and the lime must be freshly-made quicklime.

The copper sulphate should be dissolved in about one-tenth of the water in a wooden vessel. The lime should be carefully slaked with as little water as possible in another vessel. In slaking the lime as much heat as possible should be developed. The lime must not be flooded but first slaked to a powder, then to a cream and finally to a milk. It is then diluted to nine-tenths of the final volume and the copper sulphate solution poured slowly into it, the mixture being stirred during the process. The two solutions may be kept separately for a long time but when mixed they should be used as soon as possible.

To be sure that the mixture has been properly made it should be tested by dipping into it a bright knife blade or iron nail. If after one minute the colour of the iron remains unchanged the mixture is safe to use, if it becomes stained more lime must be added and the test repeated.

Formula No. 3.—*Burgandy Mixture.*

Copper sulphate	...	1 oke or 32 drams.
Washing soda	...	1½ okes or 40 drams.
Water	...	125 okes or 10 okes.

The copper sulphate should be dissolved as in Formula No. 2 in one-tenth of the water and the solution then made up to nine-tenths of the final volume. The washing soda should be dissolved in one-tenth of the water and then added slowly to the copper sulphate solution; the whole mixture being well stirred during the process.

The same safety test may be carried out as with Bordeaux mixture, if the iron is stained more soda must be added.