# INSECT PEST CONTROL.

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Elaboration of methods for the control of insect pests is not merely a question of the haphazard use of insecticides, the action of which can only be more or less guessed, but demands a considerable amount of careful detailed study of the life history and habits of each pest before any question of the method of control to be used can be raised. There are certain broad lines of control that may be applicable to certain groups of insects, but variations in habit and local conditions will often necessitate adaptation of such to special cases.

A thorough knowledge of the life history and habits gives data on the length of the life cycle (deposition of egg to emergence of adult); where the eggs are deposited; where and when the larvae feed—whether they are internal or external feeders; where the adults shelter and where and when they feed; any indigenous parasites, and at what stage of development of the host they are operative, and their economic importance. With this data in hand, the research worker is able to decide whether one stage of development is more vulnerable than another, what line or lines of attack offer the best possibilities of success, and how to set about their application.

In relation to plant life, insects may be divided into three classes;

(i) those which obtain nourishment by chewing (caterpillars, &c.);
(ii) those which, by specially adapted mouth parts, puncture the bark, and suck up the sap (plant bugs, aphids, &c.);
(iii) those which feed on other insects.

The first two form the pest groups (i.e. insects which interfere with agricultural production), while the third comprises insects of great value to man. It is obvious that the two pest groups require the application of very different methods for their control.

The general lines on which control may be considered are:—

(i) *Mechanical measures*; the use of insecticides by dusting, spraying or fumigation.
(ii) *Biological measures.*
(iii) *Variations in agricultural practice.*

## Mechanical Measures.

There are a number of chemicals, and preparations of such, that can be used either as sprays or dusts, and are classed as:—

(*a*) stomach poisons, for chewing insects.
(*b*) contact insecticides, for sucking insects.

Of the *stomach poisons,* mention may be made of Arsenate of Lead, Calcium Arsenate, Barium fluosilicate, Paris green, Derris and Pyrethrum preparations, and of the *contact insecticides,* Lime-sulphur spray fluid, Kerosene emulsion, Miscible-oil sprays, Derris and Pyrethrum preparations. For fumigation, Hydrocyanic acid (Prussic acid) is the gas most in use, although Carbon disulphide and other chemicals have certain uses.

In the case of mechanical measures to be adopted, the type of insecticide is decided on. The next step is the method of application, either spraying, dusting, baiting or fumigation.

Spraying is a measure in which the insecticide is mixed with a fluid as carrier (usually water), and projected over the crop in the form of mist, the fluid running off and leaving the insecticide as a fine film over the plant.

Water used for this purpose must be soft (i.e. lather easily with soap), as hard water (i.e. does not lather easily with soap, but forms a hard precipitate) will cause chemical change when used with some chemicals; therefore if the only water available is hard, it must be treated with soft soap or soda-lye to eliminate the chemicals causing the hardness.

Where the area to be treated is large, water in sufficient quantity may present considerable difficulties, and add considerably to the cost of operations.

*Dusting* (sometimes called dry spraying) consists of the projection of the insecticide into the air as a fine dust-cloud, allowing the natural air currents to carry the powder through the crop, the dust slowly settling as the cloud travels onwards. Much larger areas can be covered in the same time and with less labour by this method, which has largely superseded spraying for most purposes; furthermore the difficulties of sufficient supplies of soft water and costs of cartage are eliminated.

*Baiting* consists in treating some suitable material with poison and setting it out as baits for the insects to feed on, on and around the feeding grounds.

*Fumigation* requires a gas-proof container, into which the plants and materials to be treated are placed and subjected to the poison gas for a given period.

The next step in the investigations is the setting up of a series of comparative trials with the insecticides selected to determine which preparation gives the best results with a minimum of cost consistent with efficiency, and without damaging the crop. These tests are made on a small scale, and, on completion, lay the foundation for field trials.

## Biological Measures.

In biological control, advantage is taken of the assistance of insects which prey on others, either internally or externally. There are two groups of these friendly insects; those which confine themselves to one individual of the host (parasites), and those which wander from one member to another of the host (predators). Of the former, some are parasites of eggs, others of larvae, and still others of the adults of the host. Some are more or less specific in their host relationships, while others are found over a wide range of hosts.

Where indigenous parasites and/or predators are absent, or of little economic value, it may be advisable to consider the introduction of such from foreign countries. In these cases the very greatest care must be taken to prevent the introduction of any insect that may, under the new conditions, become a pest, or even a hyperparasite of some economically useful insect already present in the country, or even of the useful insects it is desired to introduce. Careful detailed study, preferably in the country of origin, is required for these purposes, and the breeding of the parasites through two or more generations may be necessary, should hyperparasites be present, to ensure a pure strain.

Biological control may be slow in its initial stages, while the parasites become acclimatized, but if successful will save a great deal of labour and expenditure of money, for once established it requires no further attention.

## Agricultural Practice.

It has been stated that healthy, vigorous plants are not subject to infestation by pests and diseases. Although many consider this as rather too sweeping a statement, there is no doubt that a vigorous healthy plant will not be affected as badly by pests as one of low vitality.

It has been proved time and again that proper attention to agricultural practice has a very important bearing on pest and disease control.

When a crop is affected by soil frequenting insects, cultivation of other crops on that area for a period will assist in starving out the pests. A system of crop rotation may even be sufficient.

Cultivation and manuring will assist in forcing growth, and minimise damage by some foliage feeding insects, in addition to improving the general vigour of the crop.

Due attention to plantation hygiene can lead to the removal of breeding grounds and sheltering sites of many pests.

## Field Practice.

In actual practice, field trials may prove that control of a pest may be more satisfactorily obtained by a combination of two or more of these lines of attack.

## General Insecticides.

A few notes on general insecticides used against plant pests may act as a guide in treating common pests as they arise.

### Leaf Eating Insects.

*For Spraying,* Arsenate of Lead, Paris Green, Derris and Pyrethrum preparations.

*For Dusting,* Arsenate of Lead, Calcium arsenate, Paris Green, Derris and Pyrethrum preparations.

### Sap-Sucking Insects.

Kerosene emulsion, Derris and Pyrethrum preparations, Lime Sulphur fluid, Miscible Oils, Black-leaf 40 (Nicotine sulphate), and Resin wash are some of the more general sprays, depending on the pest to be treated.

### Arsenate of Lead.

This insecticide is obtainable in two forms, powder and paste. With the former, it is advisable to use some preparation that will assist the poison in spray form to adhere more strongly to the foliage, referred to as a "spreader" or "sticker."

The paste form has the sticker already mixed with the poison.

For spraying, Arsenate of Lead is used at the rate of 1½ lb. of powder or 3 lb. of the paste to 50 gallons of water. When preparing the material, it should be worked up with a little water into a thin paste free from lumps; this is then poured into the full quantity of water, stirring constantly. As the poison is only in a state of suspension, the apparatus used for spraying must be equipped with an efficient agitator to prevent the powder settling out, on to the bottom of the container.

Used as a dust, Arsenate of Lead is usually mixed with hydrated lime or other inert filler in the proportion of one part of poison to three to ten parts of lime.

This insecticide has certain advantages over other arsenicals in that it is comparatively safe to use on foliage; it adheres fairly well to foliage, and when used as a spray it does not settle as rapidly as, e.g., Paris Green.

The usual spreader used with Arsenate of Lead is:—*Calcium Caseinate,* or *Casein-Lime* at the rate of 2½ oz. to 50 gallons of spray mixture.

This preparation can be made by mixing thoroughly 3 oz. of *Powdered Casein* with 7 oz. of *Hydrated Lime.* The ingredients may be added to the spray in the dry form, or first mixed into a paste with a little water, and then added to the spray. When added in the dry form, it should be done slowly while the agitator is in motion.

When the mixture is first made into a paste, the two powders must be thoroughly mixed together dry, and water added in small quantities stirring vigorously until chemical combination takes place. When this is complete, the thin paste can be diluted with water for convenience in handling, and the necessary amount added to the spray.

Calcium caseinate has advantages over other stickers in that it is compatible with all sprays, is convenient to handle and low in cost, and does not cause injury.

### Paris Green.

This poison has a much more rapid action than Arsenate of Lead on insect life, but there are several reasons why it is not used more extensively; used as a spray, it settles much more rapidly, and therefore it is difficult to keep an even strength of spray through the nozzle; it does not adhere as well to the foliage, and thus necessitates more frequent spraying; furthermore it may contain an appreciable amount of water-soluble arsenic, which will burn the foliage: (this can be overcome by the addition of lime, which combines with the soluble arsenic, and reduces the risk of damage to the foliage); the greater cost as compared with other arsenicals.

For spraying the poison should be worked up into a thin paste without lumps by the addition of small quantities of water; the lime should be slacked in a little water and added to the full volume of the spray; finally the Paris Green is added. The regular formula is—

| | |
|---|---|
| Paris Green .. .. .. .. .. | ½ lb. |
| Quick lime .. .. .. .. .. | 1 lb. |
| Water .. .. .. .. .. .. | 50 galls. |

Paris Green may be used as a dust, mixed with hydrated lime in the proportions of 1 part of poison to 6—10 parts of Lime.

This insecticide is used extensively in a bait for "cutworms", which shelter in the soil during the day, and come out to feed at dark. The general formula for this bait is—

| | |
|---|---|
| Bran .. .. .. .. .. | 50 lb. |
| Paris Green .. .. .. .. | 2 lb. |
| Molasses .. .. .. .. .. | 2 quarts. |
| Lemons .. .. .. .. .. | 3 fruit. |
| Water .. .. .. .. .. | 4 galls. (approx.). |

The Paris Green is thoroughly mixed with the dry bran; the fruit is chopped up and added to the water with the molasses. The fluid is then stirred into the poisoned bran to form a damp, slightly crumbly product.

It is more satisfactory to mix the bait during the day, and scatter it on the ground at the base of the infested plants in the late afternoon, so that it is fresh when the caterpillars come out to feed about dusk.

### Calcium Arsenate.

This is a light flocculent powder that offers possibilities in certain cases of dusting.

### Derris.

The roots of certain Derris spp. contain chemical bodies that are very toxic to some forms of insect life, but are much less poisonous to mammals than arsenicals. A great deal of attention has, therefore, been paid to preparations in which Derris extractives are the active principle. Against caterpillars, this insecticide appears to be very satisfactory, and for dusting and spraying of vegetables has largely replaced arsenical preparations.

### Pyrethrum.

Research in recent years has shown that there are greater possibilities in Pyrethrum preparations than had been heretofore realized.

This insecticide is derived from the ground-up flowers of a plant, *Pyrethrum spp.*, belonging to the Chrysanthemum family, and although very toxic to insects, has little or no harmful effect on warm blooded animals.

### Resin Wash.

This spray is specially useful for scale insects on citrus trees. A formula recommended in New South Wales is:—

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|---|---|
| Caustic soda, 98% quality .. .. .. .. | 5 lb. |
| Resin .. .. .. .. .. .. | 16 lb. |
| Soft soap .. .. .. .. .. .. | 6 lb. |
| Water .. .. .. .. .. .. | 100 galls. |

To 10 gallons of boiling water, add the above quantity of caustic soda; slowly add the resin (which must be first finely powdered) a little at a time, stirring constantly; then add the soft soap little by little, still maintaining a constant stirring of the fluid; boil the whole together from two to three hours, or until well dissolved. Add hot water, a little at a time, until there is not less than 20 gallons of hot solution. Keep well stirred. Dilute in the proportions of 4 gallons of hot water to one gallon of *hot* solution, or so as to bring the whole up to 100 gallons. *Never add cold water when cooking.*

If obtainable 3 pints of fresh oil would be preferable to the soft soap.

The concentrated solution can be kept for some time as a stock solution and diluted for use as required.

The solution should be used as hot as the hose can stand without damage, for, if allowed to cool, the spray may interfere with the valves of the pump. As it comes in contact with the air in the form of spray, the mixture will be cooled to such an extent that no harm will be done to the tree.

In spraying, see that the inside of the tree is reached as well as the outside, and the under—as well as the upper—surfaces of the leaves.

This spray will be found most effective when applied to the trees when the young scales are hatching out from the mother-scales. This must be determined by observation.

Should the trees be suffering from the effects of droughty conditions, it is not advisable to apply this wash, as it would destroy the foliage, and thus injure the tree.

### Kerosene Emulsion.

The stock formula for this emulsion is as follows:—

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|---|---|
| Kerosene .. .. .. .. .. .. | 2 galls. |
| Whale oil soap .. .. .. .. .. | ½ lb. |
| Water .. .. .. .. .. .. | 1 gall. |

(One quart of soft soap may be substituted for the whale oil soap). The soap is first finely divided and dissolved in the water while boiling; when dissolved immediately remove from the fire and add to the kerosene. The whole mixture is then violently agitated while hot by being pumped back into itself with a force pump and a direct charge nozzle throwing a strong stream, preferably ⅛th inch diameter. After 3 to 5 minutes pumping, the emulsion should be perfect and the mixture will have increased from one-third to one-half in bulk and assumed the consistency of cream. Well-made emulsion will keep indefinitely, and should be diluted only as wanted for use. The use of whale-oil soap, especially if the emulsion is to be kept for any time, is strongly recommended, not only because the soap possesses considerable insecticidal value itself, but because the emulsion made with it is more permanent, does not lose its creamy consistency, and it is always easily diluted, whereas with most of the other common soaps, the mixture becomes cheesy after a few days and needs reheating to mix with water.

Soft soap answers very well, and one quart of it may be taken in lieu of the hard soaps. In limestone regions, or where the water is very hard, some of the soap will combine with the lime or magnesia in the water, and more or less of the oil will be freed, especially when the emulsion is diluted. Before use, such water should be broken with lye, or rain water employed.

For spraying, thoroughly mix one gallon of the above stock with 7 gallons of water.

Where only small quantities of the spray are required, the following formula may be used.

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|---|---|
| Water (1 kerosene tin full) .. .. .. .. | 4 galls. |
| Sunlight soap .. .. .. .. .. | 2 cakes. |
| Kerosene (good quality) .. .. .. .. | 1 pint. |

Emulsify the kerosene as above and spray with the liquid with just the chill off.

### Miscible Oils.

In these preparations, the oils are so mixed that they are readily miscible with water; they are of two types, one for trees in a dormant condition (i.e. without foliage) and the other for trees in full growth; only the latter type are applicable to this Territory.

Against scales and mealy bugs, certain of these oil sprays have given good results.

### Lime Sulphur Spray Fluid.

This is not only an excellent insecticide, but is also an important fungicide.

This spray fluid can be obtained in a concentrated form that only requires diluting with water, according to the directions supplied by the manufacturers.

The preparation can be made on the plantation, but is an unpleasant and tedious business; the field formula is as follows:—

| | |
|---|---|
| Flowers of Sulphur .. .. .. .. | 100 lb. |
| Good burnt lime .. .. .. .. .. | 50 lb. |
| Water .. .. .. .. .. .. | 50 galls. |

About half the water is brought to the boil, and the lime stirred in while heating; the sulphur is mixed into a paste and added and the liquid stirred until the lime is well slacked and the contents thoroughly mixed. The remainder of the water is then added, and the whole boiled for three-quarters of an hour to one hour, but no longer. The liquid, orange red in colour, is strained to clear out any sediment, and stored in airtight containers.

The dilution of the solution depends on its density, the determination of which is done by means of a Baumé hydrometer, from which the density is read off in degrees Baumé. The appended chart will enable sprays of correct dilution to be prepared from lime-sulphur concentrate of various densities. First determine the density of the lime sulphur to be used; find the corresponding density in the left hand column. The figure in the same horizontal line in the column headed by the dilution required will give the amount of water to be added to one part of the stock solution in order to give the required dilution.

| *Density of Stock solution in 0° Baumé. | Dilutions Required, Based on a 33° Baumé Standard. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-10. | 1-15. | 1-20. | 1-30. | 1-40. | 1-80. | 1-100. | 1-120. |
| 25° .. .. | 7.6 | 11.4 | 15.2 | 22.7 | 30.3 | 60.6 | 75.8 | 90.9 |
| 26° .. .. | 7.9 | 11.8 | 15.8 | 23.6 | 31.5 | 63.0 | 78.8 | 94.5 |
| 27° .. .. | 8.2 | 12.3 | 16.4 | 24.5 | 32.7 | 65.5 | 81.8 | 98.2 |
| 28° .. .. | 8.5 | 12.7 | 17.0 | 25.5 | 33.9 | 67.9 | 84.8 | 101.8 |
| 29° .. .. | 8.8 | 13.2 | 17.6 | 26.4 | 35.2 | 70.3 | 87.9 | 105.5 |
| 30° .. .. | 9.1 | 13.6 | 18.2 | 27.3 | 36.4 | 72.7 | 90.9 | 109.1 |
| 31° .. .. | 9.4 | 14.1 | 18.8 | 28.2 | 37.6 | 75.2 | 93.9 | 112.7 |
| 32° .. .. | 9.7 | 14.5 | 19.4 | 29.1 | 38.8 | 77.6 | 97.0 | 116.4 |
| 33° .. .. | 10.0 | 15.0 | 20.0 | 30.0 | 40.0 | 80.0 | 100.0 | 120.0 |
| 34° .. .. | 10.3 | 15.4 | 20.6 | 30.9 | 41.2 | 82.4 | 103.0 | 123.6 |
| 35° .. .. | 10.6 | 15.9 | 21.2 | 31.8 | 42.4 | 84.8 | 106.1 | 127.3 |

* Diseases and pests of Queensland fruits and vegetables—Veitch and Simmonds.

## Spraying and Dusting Apparatus.

The type of apparatus required for any particular area will depend partly on the nature of the crop, and partly on the area to be treated.

For small garden or nursery areas, hand dusters and sprayers are obtainable at low cost, while a range of machines up to large power plants, sufficient to do any class of work, are quoted by a number of manufacturers.

When spraying with poisons which are only held in suspension in the fluid, such as Arsenate of Lead and Paris Green, an agitator is required to keep the mixture in constant movement and maintain an even strength of spray.

Advice on these matters will be freely given to any one desiring information; when inquiry is by letter, the fullest information should be given on the nature of the crop to be treated—low or high, and if the latter, the range of height—area, &c.