CONTROL OF COCO-NUT TREEHOPPERS (*SEXAVA* SPP.) BY DUSTING.

B. A. O'Connor, B.A., B.Sc.Agr., Assistant Entomologist.

During the year 1937, a number of laboratory experiments were made to test roughly the comparative toxicity of various dusts to the coco-nut treehopper, *Sexava* spp. These dusts included calcium arsenate, lead arsenate and paris green —diluted in each case with hydrated lime—as well as mixtures of derris, and proprietary mixtures which had as lethal constituents lead arsenate, nicotine sulphate, derris and orthodichlorbenzene. The dusts were applied at a rate somewhat greater than would be economical in the field, the object of the experiments being merely to eliminate the obviously inefficient and uneconomical preparations. Those which appeared most effective were to be tried later in field experiments, using a power dusting machine.

The experiments were carried out as follows:—

Cages of copper wire, 3 feet high and 2 feet in diameter, were constructed, and in each of these from 30 to 50 adult treehoppers were placed, together with food consisting of coco-nut palm leaflets strung on a wire passing across the top of the cage. A hand-duster was used to apply the various dusts, and in each experiment one cage was left untreated, to act as a control. After the first day, fresh, undusted leaflets were placed daily in the cage, the original leaflets being removed. The effectiveness of the treatments was measured by the percentage of treehoppers killed within three days after dusting.

These tests showed that the arsenicals, paris green, calcium arsenate and lead arsenate, were by far the most efficient of the dusts. Paris green was easily the best, but its price appeared prohibitive, and this fact, together with the danger of foliage-burning, caused this insecticide to be passed over in the earlier field trials, though later it was tested out.

Calcium arsenate and lead arsenate appeared roughly equal in toxicity, but as the former was the cheaper, it was the first to be tried in field experiments.

A few results, typical of those obtained in the laboratory tests, are appended. The figures given are the percentage of deaths within three days of treatment—

	Per cent.
Control	10
5 per cent. lead arsenate	97
5 per cent. calcium arsenate	97
5 per cent. paris green	100
Control	10
Proprietary mixture of lead arsenate	100
10 per cent. derris	47
Proprietary mixture of derris	77
Control	16
5 per cent. lead arsenate	100
Proprietary mixture of derris	40
Derris 2½ per cent., orthodichlorbenzene 2½ per cent. ..	40

The paris green in each case killed about 90 per cent. of the insects in one day, and invariably during the second day all were dead. An interesting point was that the insects did no feeding in any of the cages where paris green was used, showing that death was caused most probably by their ingesting particles of the dust during the process of cleaning their feet and antennae. The effects of the dust must have been very rapid, as dusting was carried out always at about 4 p.m., and yet the treehoppers had lost the desire for food by 6 p.m., when feeding normally begins.

Lead arsenate and calcium arsenate also cause death when ingested during the process of cleaning. For this reason the cages had to be very thoroughly washed after each experiment, as any particles of dust remaining on the wire would affect subsequent tests. On one occasion, cages which had been used for tests with the three arsenical dusts were washed roughly, and treehoppers were placed in them with fresh food, no dust being applied. After three days, the majority of the hoppers were dead, showing that even the traces of poison left on the wire had been sufficient to provide a lethal dose. Percentage mortality in the various cages was as follows:—

	Per cent.
Control	18
Traces of 5 per cent. lead arsenate	88
Traces of 5 per cent. calcium arsenate	70
Traces of 5 per cent. paris green	80

An experiment was carried out also to assess the burning effect of paris green on coco-nut palm foliage, a brief description of which follows: A six months' old potted palm was dusted very heavily with 10 per cent. paris green in hydrated lime, the leaves being first moistened to assist adhesion of the dust. For twelve days the palm was left in the open, but removed to shelter when rain fell, so that the dust would not be washed off. After the lapse of twelve days, it was left permanently in the open. At the end of three weeks, small, scattered, brown patches were noticed on the leaflets, and after six weeks the burnt areas were fairly extensive. This was, of course, a very severe test, and it is doubtful if burning occurs when paris green is used in the field, as the rate of application is much lower, and the dust is washed off by frequent rains. Calcium arsenate, when similarly tested, caused no burning.

Field Experiments.

During the period May to November, 1938, a power duster was used in the conducting of field experiments, the object being to determine the cheapest and most efficient type of dust and rate of application which would achieve reasonable control of the treehopper. In the earlier experiments calcium arsenate was used, and later, lead arsenate and paris green were given a trial. Paris green can perhaps compete economically with calcium arsenate, but lead arsenate, besides being more expensive than calcium arsenate, proved to be much less effective. It was found that diluents could be dispensed with in the case of calcium arsenate, as good coverage of the foliage could be achieved with the undiluted dust. With paris green, however, a filler is necessary, as the rate of application per acre is so low that the undiluted dust would not give even coverage. Hydrated lime was

generally used, though trials were made of kaolin and proprietary fillers to determine whether they improved the adhesion of the dust to the foliage. It cannot be said that they were successful, so there is no point in using them except as a diluent. This line of inquiry is not closed, however; it is hoped that a good sticker may be found, thus considerably increasing the effectiveness of dusting as a control measure.

The result aimed at in the field tests was that there should be a mortality of 90 per cent. or more of the pests, when dusting was followed by only one night without rain. Hence, particular attention was paid to the results of experiments in which rain fell after the insects had fed for one night only on dusted foliage, and estimated costs of treatment were based on these results. As the treehoppers feed almost exclusively at night, it is obvious that a fall of rain before their first nightly feed would greatly reduce or neutralize the effect of the treatment, as the dust is easily washed off by rain. This proved, in fact, to be the case. On the other hand, where several rainless days and nights follow on dusting, deaths are more numerous, and where such weather can be counted on, the costs tabulated below can be materially reduced by decreasing the rate of application of the dust.

Unfortunately, owing to the smoothness of the leaf-surface of the palm-foliage, dust will not adhere well to the under surface of the leaflets, where it would be sheltered from the rain.

It seems opportune at this juncture to explain why dusting was decided on instead of spraying. The latter method calls for the use of a smaller quantity of poison, and has the great advantage of causing the spray material to adhere to the leaf surface, even during periods of heavy rain, provided that the film of spray material has had time to dry before rain falls. However, conditions on a local coco-nut plantation make the use of sprays quite impracticable, except in some cases on low palms. Because the spray has to be applied to foliage 50 to 60 feet from the ground, and applied thoroughly, in the form of a mist, a powerful and heavy spraying machine would be necessary to treat an affected area in a reasonable time. The difficulties of operating such a machine in a plantation need no stressing. Large quantities of water would be required (about 200 gallons per acre for each spraying) and the mixing and transporting of the spray material from a depot to all parts of the plantation would be a very big task. Moreover, the time taken for treatment would be several times that taken in dusting. Hence it is clear that spraying is not suitable for local coco-nut plantations.

Dusting, on the other hand, is a comparatively simple process, as a light and low-powered machine, which can be carried by natives or drawn on wheels, will treat 10 acres of palms per hour. Further investigation of dusting machine types is required to determine that most satisfactory for plantation conditions in this Territory.

Technique of Experiments.

For each experiment, a block of 64 palms (1 1/7th acres) was selected, having eight palms on each side. Each block of palms was well separated from the others, so that dust could not drift from one to the other during treatment. Then the fronds were cut from a palm in the middle of the plot, normal in height, foliage and extent of attack by *Sexava*, and the treehoppers counted. The plot was then dusted, and after seven or eight days a similar palm was defoliated, and the

remaining *Sexava* counted. Difference in the two counts was taken as the mortality. This figure would naturally be only approximately correct, but satisfactory, as palms in a given locality seem always to have much the same population, and inaccuracies are reduced by comparing the results of a number of experiments. Cutting of fronds and counting of treehoppers thereon, incidentally, is the only really satisfactory way of determining the severity of *Sexava* attack on a plantation. The appearance of the fronds is no guide, as badly chewed palms may have few treehoppers, but show the effects of previous severe attacks, while healthy-looking palms may harbour large numbers of the pests, constituting the vanguard of a heavy infestation. Collecting of adults at night is a good guide to the most severely-affected portions of a plantation.

When the population of a palm is being determined, a native is sent aloft with a bush knife or hacksaw and a long rope. He cuts off the fronds, and lowers them one by one onto a sail spread at the foot of the palm. Here they are examined by several natives, under supervision, and the treehoppers caught and counted. During the day they are almost invariably found on the under-surface of the leaflets, and careful scrutiny is necessary to find them all, particularly the young nymphs. Examination of a palm by this method takes from one to three hours, depending largely on the efficiency of the boy who cuts and lowers the fronds.

To prove that the insects were killed by the dust, and did not merely migrate elsewhere, large sheets of bagging were placed under certain dusted palms, and on these numbers of dead *Sexava* were found during the few days following on dusting, their condition showing that they had been poisoned.

In almost every case, dusting was carried out between 4 p.m. and sundown, because at that time of the day, it was possible to forecast fairly well whether rain would fall overnight or not. As regards wind, a steady air-drift or light breeze is desirable, at it carries the dust steadily in one direction. When the direction of the air current is changing rapidly, dispersal of the dust is unsatisfactory. This is especially so when two or three rows of palms at a time are being dusted. It appears that successful dusting can be carried out even with quite a strong breeze, as results obtained under these conditions have been good, even though most of the dust appears to be swept away underneath the foliage of the palms. At present, it appears that the most satisfactory combination of speed and efficiency can be achieved by treating two rows of palms at a time. This makes possible the dusting of about 10 acres per hour, except in unusually rough country.

In all, over 30 experiments were carried out on small plots, and two 10-acre plots were also treated. On the large plots it was intended to carry out the full programme of two dustings at an interval of about 100 days. Consequently, they had to be reasonably large, so that results would not be unduly affected by immigration of *Sexava* from surrounding untreated areas, during the six or twelve months needed to show the effects of the treatment on yield and health of palms. Two dustings will almost invariably be needed to achieve reasonable control of the treehopper, the first dusting being designed to kill those already on the palms, and the second to deal with those which have hatched out after the first dusting. The interval of 100 days allows time for the most recently laid eggs to hatch, but not for the earliest hatchings to reach the adult stage and lay a further batch of eggs.

It is extremely difficult to present the results of the experiments in a concise form, so that it has been thought better to give those of some typical successful experiments. These will give a good idea of the killing capacity of the dusts used:—

1. 11½ lb. of undiluted calcium arsenate per acre.
   Dusted three rows at a time.
   One night only without rain.
   Population before dusting—98 (36 adults, 62 nymphs).
   Population after dusting—1st row nil, mortality 100 per cent.; 2nd row nil, mortality 100 per cent.; 3rd row 2 adults, mortality 98 per cent.
2. 8 lb. calcium arsenate per acre, diluted with 9 lb. lime.
   Dusted two rows at a time.
   Three nights without rain.
   Population before dusting—75 (18 adults, 57 nymphs).
   Population after dusting—1st row nil, mortality 100 per cent.; 2nd row nil, mortality 100 per cent.
3. 3 lb. paris green per acre, with 21 lb. lime.
   Dusted two rows at a time.
   Five nights without rain.
   Population before dusting—105 (27 adults, 78 nymphs).
   Population after dusting—1st row 4 nymphs, mortality 96 per cent.; 2nd row 4 nymphs, mortality 96 per cent.

Paris green has not been tried as thoroughly as calcium arsenate, but, at present, it appears that the latter gives somewhat better results on a cost basis, and it has the advantage that it does not need the addition of a filler such as hydrated lime to make it of sufficient bulk to give a good cover of the foliage. A filler is necessary with paris green, which is very heavy, and mixing entails extra time and labour. There is also some evidence that calcium arsenate has a delayed action, causing deaths weeks after being eaten by the insects, but this needs further investigation. The cost of material for two dustings with calcium arsenate at a rate of 12 lb. per acre is about 9s., and the same expenditure would allow of two dustings with 3⅓ lb. paris green and 9 lb. lime. All costs, except for hydrated lime, are based on pre-war American quotes, as prices of arsenicals in Australia are prohibitive. Moreover, the calcium arsenate from the United States of America has proved superior to the Australian article. Manufacture of commercial calcium arsenate in the United States of America has reached a high pitch of efficiency, owing to the vast quantities used annually in the control of pests like cotton boll weevil.

It is anticipated that the total costs of dusting an acre of palms twice will not exceed 11s., including cost of material, depreciation on machine, oil and fuel, labour and supervision. On some properties, where treehopper attack is consistently extensive, it would seem economical to treat the whole plantation first, and during the succeeding years promptly treat any local outbreaks, so that the pest never regains a hold. Complete eradication by artificial means is scarcely possible, and an attempt would be extremely costly, so that the object to be aimed at should be reasonable control.

The economics of the subject are, of course, of paramount importance, for, where dusting might show a profit with copra at £10 per ton on the beach, it might

not be profitable at the £5 mark. At the latter price level, only the heaviest losers from *Sexava* attack might find it worth while to conduct a dusting campaign. In this connexion, the following calculations may be of interest.

A plantation known to the writer is 600 acres in area, and has been severely attacked by *Sexava* for a number of years, production at times falling as low as 6 tons of copra per month. When this property was taken over from the Expropriation Board, its average monthly production over a period of years had been 32 tons. For the five years 1933 to 1937 inclusive, the average has been 16 tons. This may not be due solely to the activities of the treehopper, but the many severe attacks by the pest have undoubtedly been the major factor in the decrease.

The cost of two complete dustings of this plantation at 11s. per acre amounts to £330, so a reasonable estimate to cover unforeseen eventualities would be £400. Probably, during the remainder of a five years' dusting campaign, it would be necessary to dust only isolated areas, as signs of renewed infestation appeared. Two dustings of 100 acres in each of the five years would seem a generous estimate, though only experience will show what is actually necessary. These dustings, at 11s. per acre, would cost £275, so one might budget for £350, making the total cost for five years' control of *Sexava* £750.

In assessing the gain due to increased copra production, it must be remembered that the price received for the extra copra is nearly all clear profit, apart from the cost of dusting, because the increased output is achieved without an increase in capital charges. Bags and twine must be allowed for, and possibly some increase in labour strength, the cost of which items, estimated at £1 10s. per ton, must be deducted from the beach price of copra. At the time of writing, the latter is about £6 10s. per ton, so that each extra ton of copra produced as a result of dusting represents a profit of £5. Hence, to pay for the cost of the dusting campaign, plus interest on the £750, about 170 tons of extra production would be needed during the five years, that is, a little less than 3 tons per month. Any increased production over and above this would represent clear profit due to dusting, apart from the long-range effect of protecting the palms from injury. If copra were only £5 per ton during the five years, 4½ tons per month of extra production would be needed to cover the cost of dusting, and, if it were £10 per ton, a little over 1½ tons extra would be required.

In the case of the plantation mentioned, it is obvious that everything points to a large increase in revenue as a result of a dusting campaign. A calculation along these lines should indicate to any planter whether it would be worth while to embark on such a venture. In the case of less severely infested plantations, dusting of the whole area at one time might not be economical or necessary, the main principle in successful control of the pest being to treat localized outbreaks promptly and thoroughly, thus preventing the spread of the pest over a wide area.

Since the completion of this article, the results of dusting experiments carried out by W. R. Carpenter & Co. Ltd. are to hand. Using lead arsenate diluted with kaolin containing a sticker, and checking results by counts of *Sexava* before and after dusting, they claim great success. The experiments were conducted at Agita Plantation in the western islands.