SOME SUGGESTIONS FOR THE CONTROL OF THE CITRUS AND MANGO FRUIT-FLY (DACUS FERRUGINEUS)

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THE females of the citrus and mango fruit-fly usually start laying eggs in fruits, such as oranges, grapefruit, mangoes, &c., just before these begin to ripen. The eggs are laid inside the fruit and hatch within one week into maggots which tunnel about inside the fruit, causing it to decay and sometimes to drop early. The maggots are full-grown in 1 to 2 weeks and come out of the fruit, drop to the ground and form their puparia or cocoons about 2 inches below the surface. Maggots emerging from fallen fruit usually pupate in the soil under or near the fruit. The pupal stage lasts about 1 to 2 weeks, after which the male and female flies come out of the soil in approximately equal numbers. The female flies may remain for at least one month after emergence before laying their eggs, and since they require food before mating and egg-laying, they can frequently be attracted to feed on a sweetened poisoned bait and be killed before they can lay their eggs.

This pest is usually present in considerable numbers in any citrus or mango plantation during the fruiting seasons, but the flies themselves frequently pass unnoticed, and the presence of the pest is not usually detected until much damage has been done and the fruit has begun to fall prematurely or turn rotten on the trees as the result of maggot infestation. By that time it is usually too late to start a control campaign with any real prospect of success and nothing can be done beyond the regular collection and destruction of fallen fruit.

These notes are intended to show that this fruit-fly can be satisfactorily controlled and that most of the crop in a garden or orchard can be saved if the suggested control campaign is started in good time and carried out thoroughly and systematically. It will be noted that (1) citronella oil is a very useful indicator of the seasonal prevalence of this fruit-fly; (2) that a sweetened poisoned bait can be used to the best advantage during the seasons of prevalence; (3) that bagging of half

to two-thirds grown fruits serves to protect them from subsequent attacks of fruit-flies to a great extent, but does nothing towards reducing the numbers of these flies; and (4) that the systematic collection and suitable disposal of all fallen fruits are essential to the success of any other control measures employed.

1. CITRONELLA OIL LURE

(for *males* of the citrus and mango fruit-fly)

Experiments have shown that the ordinary commercial citronella oil is quite attractive to *male* flies of the citrus and mango fruit-fly (*Dacus ferrugineus*) when exposed in glass jam-jars two-thirds full of water with about 10 drops of the oil on the water. The jar can be hung on the branch of a tree by an arrangement of wires and the jar-cover or a cigarette tin cover should be suspended about two inches above the jar to keep out heavy rains. The water and oil should be renewed twice a week during dry weather and once a week during wet weather and the catch of flies counted. The *males* of the citrus fruit-fly are small, dark-brown insects, a little larger than house flies, with black and yellow bands and stripes on the body and a pair of clear wings. Occasionally a few other flies and other smaller or larger insects may be attracted to the citronella jars, but the fruit-flies can soon be distinguished. The type of tin recommended for poisoned bait can also be used for the citronella oil lure without the cloths, but may not be quite so effective as the glass jars.

Since citronella oil does not attract the egg-laying *female* flies, it has no special value as a control measure for this pest. This oil when exposed in jars of water does, however, serve as an indicator that the pest is present in an orchard or garden, since it is known that both *male* and *female* flies of this species may be present at about the same times of the year and in approximately equal numbers.

It may be mentioned that the vanilla essence, ammonia and water lure recommended in Australia has not proved attractive to our fruit-flies.

In order to find out whether the citrus fruit-fly is present in a fruit area it is necessary to expose two or three citronella lure jars on trees as soon as the earlier fruits are about half-grown. When the number of *male* fruit-flies per jar rises to about a dozen or more in two or three successive weeks, then it is usually advisable to start using the poisoned bait according to the instructions given.

There may be two periods during the year when fruit-flies are unusually numerous, that is, a major and a minor season of prevalence, and these usually occur when citrus or mango trees

or both are in fruit. These two periods of prevalence may vary somewhat according to the district, and fruit growers can obtain this information for their own districts by the use of the citronella lure jars during the early part of the fruiting seasons. For instance, at Peradeniya there is a minor season of fruit-fly prevalence during February and March, coinciding more or less with the secondary fruiting season of citrus and with the mango fruiting season. This is followed by a decline in numbers of flies during April and May. Then there is another marked rise in numbers to the major season of prevalence from June to August coinciding approximately with the main fruiting season of citrus.

2. POISONED BAIT

(for both sexes of the fruit fly)

Poisoned bait can be used to the best advantage during the periods when fruit-flies are likely to be most numerous, that is, mainly during the fruiting seasons of citrus and mango. If citronella jars have not been used, then baiting should be started about six weeks before the earlier fruits are expected to ripen and carried on throughout the season. It is generally unnecessary to use it at other times of the year.

The following is the formula for making the bait :—

Either sodium silicofluoride powder *or* lead arsenate powder	2	oz.
Cheap sugar	2	lb.
Water	4	gallons.

The same proportions can be used for larger or smaller quantities. Mix the powder with a little water and stir this into the sweetened water made by dissolving the sugar. Sodium silicofluoride is a non-arsenical powder, but if it is not available the lead arsenate can be used as a substitute, but it is more expensive.

Bait tins.—The liquid poisoned bait can be exposed in cigarette tins specially prepared for the purpose. Six vertical cuts about one inch deep are made at intervals in the top edge of each tin and alternate pieces between the cuts are bent outwards to form three horizontal flaps ; the tin is covered to keep out rain and wires are inserted into the pieces between the flaps so that the tin can be hung on to a branch. Each tin is supplied with about 3 oz. of the bait and small strips of cloth or lamp-wick are placed with one end in the liquid and the other end projecting slightly beyond the edge of each flap. The flies come to feed on the wet clothes and then fly away to die elsewhere so that no dead flies will be found in the tins, as in the case of the citronella lure.

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Only about 24 trees per acre need be baited at one time, using one tin per tree, and it is estimated that about 4 pints of bait will be required per acre for each application, using about 3 oz. of liquid per tin. The bait tins should be renewed periodically when they become too rusty inside and the liquid can be replenished as required. The exposure of the poisoned bait in tins insures that the flies have continuous access to the poison, whereas the liquid dries up fairly soon when sprinkled in large drops and may lose some of its effectiveness or be washed off by rain. If an orchard is known to be heavily infested with fruit-fly, it is advisable to bait one-third of the area with tins and to sprinkle at least another one-third periodically in rotation for the first two or three weeks after starting the treatment; a less intensive programme can be carried on thereafter.

Sprinkling.—The same poisoned bait can be applied to the trees with an ordinary garden syringe and the liquid can be squirted into the air so as to fall on the leaves in large drops, and while applying the liquid the operator can walk round the tree. If a syringe is not available, the bait can be sprinkled on to the leaves with a bunch of twigs or a broom. If sprinkling of the trees is considered undesirable, bunches of twigs or bundles of paddy straw can be hung on the trees and sprinkled with the bait. The bait should be used two or three times a week during the early part of the season and once a week later on, if the flies are being controlled. It should be applied during the late afternoon in fine weather and repeated after heavy rain.

It is usually necessary to sprinkle only about one-third of the trees in rotation in any given area, or about 24 trees in an acre of about 70 trees. For each application by sprinkling, one pint of the liquid bait will treat 3 or 4 trees in full bearing, so that this amount will be sufficient for a small garden of about one dozen trees. About one gallon will be required per acre for each application. As regards costs, it is estimated that, using sodium silicofluoride, one gallon of the bait will cost about 7 cents, while with lead arsenate as the poison the cost per gallon will be about 10 cents. One acre can therefore be treated for about 10 cents per application for cost of materials alone. Lead arsenate costs about Rs. 1·50 per lb. and sodium silicofluoride about 50 cents per lb. at Cargills, Colombo, and the cost of freight will have to be added.

The following poisoned bait programme is suggested for an orange grove of ten acres situated in a dry zone district, assuming that the fruiting season starts at the beginning of December and lasts for about four months until the end of March.

The poisoned bait should be started about six weeks before the first fruits are expected to ripen and should be continued for about five months, that is, the baiting season should extend

from about the middle of October until about the middle of March. During the first three months, which are likely to be wet, it is preferable to expose the bait in the tins, so as to protect it as far as possible from heavy rains, and to employ the sprinkling method of application during the last two months, which are normally dry. Advantage can, however, be taken of any dry periods during the monsoon to sprinkle the bait instead of using the tins or to combine the two methods in a more intensive baiting programme.

Approximate cost of baiting in tins.—It has been explained previously that about 24 tins will be needed per acre, or 240 tins for ten acres ; also that about 4 pints of bait will be required per acre for each application, or about 5 gallons for ten acres per application. During a tin-baiting season of three months, 24 applications will be necessary at two applications per week, so that 120 gallons of bait will be required for the ten acres for three months. As regards labour, two men for half a day at 30 cents each can renew the bait in 240 tins, costing 60 cents per application, or Rs. 14·40 for the 24 applications during the three months. The following will be the approximate cost for ten acres :—

	Rs.	c.
240 tins cut and fitted with wire at 4 cents per tin ..	9	60
One renewal of 240 tins using old wire at 3 cents per tin	7	20
120 gallons of bait at 7 cents per gallon ..	8	40
Labour for 24 applications at 60 cents a time ..	14	40
	39	60

The cost of baiting 240 tins for the three months is therefore Rs. 4·00 per acre.

Approximate cost of sprinkling.—The bait can be applied for two months during dry weather, and 16 applications will be required at two per week, using one gallon per acre or ten gallons for the whole area per application at 7 cents per gallon. If the liquid bait is sprinkled on to bunches of twigs or bundles of straw hung on the trees, no special apparatus will be required, as a bunch of leafy twigs can be used to sprinkle the liquid. Two men for half a day at 30 cents a man can treat the 240 trees, costing 60 cents per application.

	Rs.	c.
16 applications over ten acres at 70 cents per application	11	20
Labour for 16 applications at 60 cents a time ..	9	60
Total ..	20	80

The cost of sprinkling 240 trees for the two months is therefore about Rs. 2·00 per acre. The total cost of using the two baiting treatments for five months over ten acres will be about Rs. 6·00 per acre. The above cost will be increased to nearly Rs. 7·00 per acre, if lead arsenate has to be used instead of sodium silicofluoride.

It may be mentioned that the fruit-fly poisoned bait should also be useful in controlling the large fruit-piercing moths which puncture the fruit in order to suck the juice. Punctured fruits turn rotten and drop, and the damage is sometimes mistaken for that caused by fruit-flies. The puncture made by the moth can be seen as a small round hole from which juice oozes freely when the fruit is squeezed, but the egg-laying puncture made by a fruit-fly soon closes up and is not noticeable until a small decaying patch begins to form.

3. BAGGING OF FRUITS

In *The Tropical Agriculturist*, February, 1936, pp. 100-101, a note appeared on the bagging of grapefruit and it was stated therein that bagging kept the fruit free from fruit-fly attack and from infection by citrus canker. Further trials made on the Experiment Station, Peradeniya, by the Principal, Farm School, Peradeniya, have indicated that bagging of grapefruit has proved to be quite effective in preventing attack by fruit-fly and that unbagged fruit is usually heavily attacked.

It should be emphasized that bagging alone does not in any way help to control fruit-fly, but merely prevents the flies from laying their eggs in the fruit. Any unbagged fruit is liable to serious infestation. Therefore, if bagging of fruit is employed, it is advisable that other measures, such as the use of poisoned bait and destruction of attacked fruit, should be taken to control fruit-fly.

Usually single fruits are bagged with the smaller size greaseproof paper bag (8″ × 10″) costing Rs. 7·50 per 1,000 or ¾ of 1 cent per bag, and approximately two bags are required for each fruit up to the maturity of the same. The cost per bag including twine, labour, &c., is estimated at 2½ cents up to the maturity of the fruit. Sometimes it is necessary to include two or three fruits in a larger bag (12″ × 14″) costing Rs. 10 per 1,000.

4. DESTRUCTION OF ATTACKED AND FALLEN FRUIT

If fruit-fly is to be effectively controlled in citrus and mango areas, it is essential that all attacked and fallen fruit should be collected and destroyed from the time that the first attacked fruit is noticed or the first good-sized fruit has fallen.

This should be done *daily* throughout the fruiting season as a routine measure whether other control measures are employed or not. If regular collection is started early, the daily number to be destroyed should be very small and easily disposed of. All such fruit should be burnt at once or thrown into a kerosene tin of boiling water, so that all maggots still remaining in the fruits are killed. All maggots which escape destruction will pupate in the soil and emerge later as flies to attack any ripening fruit. Large accumulations of attacked and fallen fruit are not only a prolific source of fruit-fly, but cannot be destroyed easily and effectively, and usually the only method available is burial in pits. But burial is not entirely effective, since fruit-flies can emerge through several inches of soil. The systematic and complete destruction of all infested fruit is essential for the success of any other control measures. Therefore all such fruit should be destroyed daily so that it will not accumulate to such an extent as to make its disposal difficult.