Advisory leaflet 11
1979
Revised 1984

SOUTH PACIFIC COMMISSION

RAT DAMAGE TO AGRICULTURAL CROPS

Left: *Freshly rat-damaged coconut aged about six months.*

Right: *A rat bait of Warfarin-impregnated wheat plus wax, tied in the first fork of a cocoa tree.*

Three species of rat live in the Pacific Islands. The Polynesian rat (*Rattus exulans*) is on most, having spread with early human migrations, while the Roof or Ship rat (*Rattus rattus*) and the Norway rat (*Rattus norvegicus*) have travelled from Asia and Europe with shipping. All three species cause agricultural damage, but the more extensive distribution of Polynesian and Roof rats results in these two being responsible for most. Norway rats tend to be confined to port areas or towns, although all three species do live in close association with man.

CROP DAMAGE

Coconuts

Rat damage to coconuts, of varying severity, is widespread in the Pacific. Damage, mainly holes chewed in young nuts, is usually caused by the Roof rat, but Polynesian rats can cause significant damage in their absence and where palms are relatively short. Most of the attack on young nuts occurs between the third and eighth month of development, before much growth of endosperm, but when coconut milk sugar levels are highest.

Fig. 1: *Rat-damaged cocoa pods with all beans removed. If left on the tree these pods can be a reservoir for black pod.*

Attack is very selective; one study indicated that 75 per cent of the damaged nuts came off less than 30 per cent of the palms. Favoured palms were found to have softer husks than others; this and milk sugar levels could be the reason for selective attack. Also there was no direct correlation between rat numbers and the number of nuts attacked. Coconuts are a relatively minor food source for most rats in Fiji plantations, but on atolls this may not always be so since other food is sometimes scarce.

The effect of rat damage on copra production is not simple; each young nut lost (because of rats) cannot be equated directly with one copra nut. Palms respond in several ways to early nut loss. More flowers are produced and there is possibly less early nutfall for other reasons. So palms are able to compensate for some of the rat damage. A realistic level in Fiji is 50 per cent which means that counts of damaged nuts must be halved in order to equal production loss. However, a study in Kiribati (1980–83) has confirmed that rats favour particular palms. It also indicated that palms on atolls may not be able to compensate for rat damage as well as those on the good soils of high islands.

Cocoa

Rat damage to cocoa pods is also widespread and high levels have been recorded in Fiji, Solomon Islands and Vanuatu. Most damage occurs as the pods ripen, although in a few areas young pods are also attacked. Rats seem to want the sweet mucilage around the beans since, although all are removed, few are eaten. After

attack the husk remains on the tree for many months and is often a reservoir for black pod (Fig. 1). Rats also spread the fungus which causes black pod.

The Roof rat is responsible for most damage to cocoa even though Polynesian and Norway rats are found in plantations. Damage usually increases during the course of the harvesting season even though the total number of ripe pods in any given period may decrease. This feature of damage is thought to be the result of rats having to learn that there is an edible mucilage within the cocoa pod. As the season progresses more rats probably seek ripe pods.

Other crops

Many other crops are occasionally attacked by rats. Damage to sweet potatoes, cassava, maize, peanuts, pineapples, melons, beans and pasture legumes occurs in the region. However, sugarcane, Fiji's major crop, is seldom attacked which is in marked contrast to Hawaii where damage is sometimes extensive.

The nature of attack, and effect on the crop, varies from species to species. In staple foods such as sweet potatoes and cassava partial damage of tubers seldom causes total loss, the remainder being available for consumption. But relatively minor attack on fruits such as melon and pineapple will cause the whole to rot.

ASSESSMENT OF DAMAGE

Before attempting to control rats it is essential to determine the loss they cause. Then control can be applied *if* the value or expected value of the crop loss is *greater* than the cost of control.

Coconuts

Extensive surveys of rat damage to coconuts have been carried out in Fiji, Kiribati, Tokelau, Tonga and Tuvalu. Damage, which varies greatly between plantations, years and sites, must be assessed wherever it appears to be serious.

Rat damage can be estimated by counting damaged coconuts under a known number of palms every one to two weeks for as long as possible, or by simply counting the number of rat-damaged nuts that are still green or partly green. Coconuts damaged by rats fall off palms 2–6 days later and then take a further 30–40 days to turn completely brown. Counts of damaged coconuts that still bear some green patches will therefore represent damage that has occurred in the previous 30–40 days.

A series of counts, by either method, can be used to work out an annual loss per hectare or per palm if there are not marked seasonal changes in rat damage or a prominent wet or dry season.

Estimates of damaged coconuts do not always directly represent a production loss because palms (if on good soils) can compensate for about 50 per cent of the loss that occurs at the "drinking nut" stage. Thus to represent production loss accurately, counts of damaged coconuts must be halved. Control may therefore often not be economic unless copra prices are high and all the coconuts produced are used.

Cocoa

Damage assessment in cocoa is much simpler than in coconuts and can usually be combined with weekly harvest. All rat-damaged pods should be counted and removed from trees, with particular attention being paid to the level of damage early in the harvest season. If a need for control is apparent there is then time to protect the bulk of the crop. All cocoa pods damaged are a total loss to production since attack occurs as pods ripen.

Cocoa is a relatively high value crop and a good plantation will yield more

LEAFLETS IN THIS SERIES

Black leaf streak of banana (SPC Advisory Leaflet 1, 1976, revised 1984)

Banana bunchy top virus (SPC Advisory Leaflet 2, 1977, reprinted 1984)

Taro leaf blight (SPC Advisory Leaflet 3, 1977)

Coconut palm rhinoceros beetle (SPC Advisory Leaflet 4, 1977)

Banana burrowing nematode (SPC Advisory Leaflet 5, 1977)

The giant African snail (SPC Advisory Leaflet 6, 1977)

Black pod and canker of cocoa (SPC Advisory Leaflet 7, 1978)

Alomae and bobone diseases of taro (SPC Advisory Leaflet 8, 1978)

Root-knot nematodes (SPC Advisory Leaflet 9, 1979)

Dasheen mosaic virus (SPC Advisory Leaflet 10, 1979)

Rat damage to agricultural crops (SPC Advisory Leaflet 11, 1979, revised 1984)

Yam dieback (SPC Advisory Leaflet 12, 1980, reprinted 1984)

Green vegetable bug (SPC Advisory Leaflet 13, 1981)

Fruit-piercing moth (SPC Advisory Leaflet 14, 1982)

Tomato leaf mould (SPC Advisory Leaflet 15, 1983)

Cottony cushion scale, Seychelles scale, and Egyptian fluted scale (SPC Advisory Leaflet 16, 1983)

Coconut hispine beetle (SPC Advisory Leaflet 17, 1983)

Queensland fruit fly (SPC Advisory Leaflet 18, 1983)

Sweet potato little leaf (SPC Advisory Leaflet 19, 1984)

This leaflet was prepared by J. Morgan Williams, Ministry of Agriculture and Fisheries, Research Division, P.O. Box 31-011, Christchurch, New Zealand. Further information can be obtained from the Plant Protection Officer, South Pacific Commission. A handbook entitled Rat control in the South Pacific *is also available from SPC, Noumea, New Caledonia.*

Published by the South Pacific Commission and printed by Bridge Printery Pty. Ltd., Sydney, N.S.W., Australia. Commission publications may be obtained from the **South Pacific Commission, BP D5, Noumea Cedex, New Caledonia.**

than 1000 pods per hectare per week, during the main harvest season. In a high yielding plantation that covers at least half a hectare and is well managed control is usually economic if damage exceeds 100 pods per week (10 per cent) of ripe pods. This economic threshold should be checked, whenever extensive control is considered necessary, using current rat bait costs and cocoa values.

CONTROL

Coconuts

Rat damage in coconut plantations can be reduced by banding the trunks with an aluminium strip or by poisoning.

Aluminium bands 30 cm wide and 0.15 mm thick fixed to the trunk at least 2.5 m from the ground are satisfactory. But, they are often bridged by long fronds or creepers which reduces effectiveness (Fig. 2). Banding only works well when palm trunks are more than 11 m tall, vertical, and not close to salt spray.

The most widely used poisons for rat control are the anticoagulants, of which Warfarin is the best known. But others, such as zinc phosphide, have also been used in some countries. The success of these poisons mainly depends on the attractiveness of the bait the poison is mixed with and its distribution within the crop.

Several different baits have been used successfully within the region. Copra, or dessicated coconut, plus meat meal is satisfactory, while grains (rice, wheat, maize) can also be used. All mixtures can be water-proofed with paraffin wax. In Fiji and Western Samoa Warfarin-impregnated wheat (0.05 per cent), either loose or embedded in wax, gives good control. Whatever bait materials are used, the final mixture should have a Warfarin concentration of 0.025–0.05 per cent. Warfarin is usually sold as a 0.5 per cent concentrate. Thus one part plus

Fig. 2: *Aluminium bands did not effectively reduce rat damage in this plantation. Note palm height and bridged band.*

19 parts bait equals a concentration of 0.025 per cent Warfarin (i.e., $\frac{0.5}{20}$ = 0.025). Newer anticoagulants such as bromodiolone (Bromotrol) and brodifacoum (Talon) are more toxic and usually only available in a ready-made bait at a concentration of 0.005 per cent. These materials are more expensive, but considerably less bait is needed and they are more effective in areas where Warfarin or other older anticoagulants have been used for several years.

Anticoagulant poisons are the safest to use and the simplest to apply when the bait contains paraffin wax. Warfarin bait blocks of about 80 g (3 oz) should be placed at 25–30 sites per hectare (every sixth tree). If the new anticoagulants are used, the same number of bait sites is desirable, but total bait quantity should be reduced by about

65 per cent. Baits put in the palm crown give the best control and prevent interference by domestic animals or crabs. Baits at palm bases are satisfactory in many areas.

The older anticoagulants, such as Warfarin, rely on several days feeding to kill. Baits need checking and replacing if eaten. However, bromodiolone and brodifacoum will kill following a *single* feed. Therefore, it is important that additional bait is not laid for 10–14 days. Loose baits, grain or coconut, should be put in weather-proof containers (bamboo tubes or open beer cans). Zinc phosphide can be used in areas of high infestation. A 15 g (½ oz) bait at the base of each palm is satisfactory but in contrast to anticoagulant baits, those not eaten must be collected and destroyed. Considerable care should be taken when handling the zinc phosphide since it is very much more poisonous than the anticoagulants. It should only be handled by trained staff.

Cocoa

The anticoagulant baits described are also the most suitable for use in cocoa. Good control is possible with 80 g (3 oz) Warfarin baits at 25–30 sites per hectare. However, note control comments in coconut section. The baits should be placed in the first fork of cocoa trees and the wax block or bait tube kept in place for at least two weeks with regular inspection and replacement where necessary.

Timing of rat control in cocoa depends on the plantation's history. If damage has been serious in the past it is probably advisable to lay poison at the very beginning of the harvest season to get maximum protection. Re-treatments depend on plantation characteristics (size, nature of surrounding country, etc.), but every two or three months may be necessary.

Frequent picking will always help reduce rat damage to cocoa; once a week is best.

Other crops

Rat control in any crop can be done in essentially the same way described for coconuts and cocoa. In high value crops such as export melons, "off season" pineapples, early beans, etc. it is advisable, if there has been damage in the past, to apply control before crops are attacked. In very small areas of high value crops it may be economic to use traps. However, many more traps than bait stations are needed; traps should always be tied to a peg or a strong plant to prevent removal by crabs or mongoose. □