SLIPPERY CABBAGE FLEA BEETLE IN THE PACIFIC ISLANDS

The slippery cabbage, *Abelmoschus manihot* Medicus (Malvaceae: Malvales) is a perennial shrub. It is favourite spinach in many Pacific Island countries and territories, particularly in Papua New Guinea (PNG), Solomon Islands, Vanuatu, Fiji and Tonga and, to a lesser extent in other island nations.

Slippery cabbage has a record of a total of 57 insect pests, of which 23 are regarded as important pests and 34 as seasonal pests (Preston 1998). These pests include beetles, grasshoppers, caterpillars that are chewing leaf feeders and stem borers and sucking bugs that are sap feeders.

In Solomon Islands it is locally known as slippery cabbage, in PNG as aibika, in Vanuatu as island cabbage, in Fiji as bele, in Samoa as lau pele, in Tonga as pele, and in Cook Islands as raukau viti (Fa’anunu 2009). There are more varieties in PNG and Solomon Islands than in other Pacific Island countries and territories.

The slippery cabbage flea beetle, *Nisotra basselae* (Bryant) (Chrysomelidae: Coleoptera) is a tiny flea beetle (4 mm long and 2 mm wide), with an orange head and thorax and black elytra. It is the worst pest of *A. manihot*, with adults causing direct damage by chewing on leaves and larvae causing indirect damage by feeding on the roots.
DISTRIBUTION

Slippery cabbage flea beetle is of PNG origin. It was first found in PNG in 1937 but was incorrectly named *Podagrica basselae* Bryant (Bryant 1941). Its distribution in PNG is widespread on the Papuan mainland and on other islands as far as Bougainville in the southeast (Kimoto et al. 1984). The flea beetle was first recorded in Solomon Islands in 1981 (Macfarlane 1986; Henderson & Hancock 1988). To date *N. basselae* is not recorded anywhere other than PNG and Solomon Islands (Bryant 1941; Preston 1998; Macfarlane 1986). In Solomon Islands it is present in all provinces except those of Renbel and Temotu, which are located in the south and southeast of the double chained archipelago.

DAMAGE SYMPTOMS

Adult slippery cabbage beetles feed on leaves creating many small (5 mm diameter) holes. The damage can be very severe if no control measures are applied. In several cases in Solomon Islands and PNG, farmers had to stop growing slippery cabbage because of severe outbreaks of the beetle. The larvae feed on small tender roots, especially the tiny root hairs. Whether or not such root damage affects the growth of the plant is still unknown.

HOST RANGE AND PEST STATUS

Like other species of the same genus, slippery cabbage flea beetle feeds primarily on the plant family Malvaceae (Jarvis 1919; Rawat & Singh 1971; Macfarlane 1986; Preston 1998; Oke & Odebiyi 2008). The beetle seems to prefer slippery cabbage over other Malvaceae when the crops are grown together. The beetle feeds on the same host plant as both adult and larva. However, adults feed on the leaves of the plant while larvae feed on the roots of the same plant.

BIOLOGY AND ECOLOGY

Female beetles usually lay eggs close to the base of plants where roots are easily accessible to the neonate larvae after hatching. The gravid female either drops off from the crown of the plant to the soil surface or walks down the stem of the plant to lay eggs in the soil and debris at a depth of 2–5 cm below the surface of the ground. The eggs are either laid singly or in clusters of up to 13.

An egg usually takes eight days to hatch into a larva; there are three larval instars. The first instar larva has a pair of egg-bursters on the mesonotum and metanotum segments, but these are not present in later instars.

Initially, the colour of the first instar larva is bright yellow, but this coloration is lost after 24 hours when larvae turn pale yellowish brown. Immediately after hatching, the larva usually crawls about swiftly on the soil to look for roots to begin feeding. This rapid movement ceases as soon as the larva encounters rootlets and starts to feed. The first larval instar lasts an average of 4 days, the second lasts 5 days and the third lasts 6 days; this is temperature dependent.

Pre-pupation starts when the larva ceases to feed, burrows into the soil and excavates a pupal chamber before moultiong and developing into an exarate form pupa. The transition from pre-pupa to pupa is subtle and takes place within hours. Newly formed pupae are snowy and creamy white and exhibit a pair of spine projections from the posterior apex of the abdomen. The development of the pupal eyes is quite distinct in that at first they appear as faint black spots on the facial area, but they gradually become pronounced as the pupa ages. The colour of the pupa gradually turns light yellowish brown before the adult emerges. Following adult eclosion, the elytra turns greyish and creamy white, metallic silver bluish and then eventually black. Other parts appear light yellowish and fulvous.
The newly emerged adult usually remains inside the individual pupal chamber in the soil for between one and two days before coming up onto the soil surface. After emerging on the soil surface, the beetle usually spends some time crawling, resting and jumping around before making its first flight. The newly emerged adult gets its first taste of food within an hour of emergence on the soil surface. Virgin female beetles reach sexual maturity three days after emerging, while virgin males mature three days later.

Both adult male and female beetles can live for up to 65 days. Adult females only lay eggs within the first 42 days after emergence from pupae and can lay an average of 266 eggs within that period. A single generation of slippery cabbage flea beetle takes an average of 38 days to complete, which means that eight overlapping generations can occur in a single year.

However, the beetle favours dryer seasons over wetter periods as the juvenile stages in the soil are vulnerable to prolonged water-logging, erosion and flooding during harsh wet seasons.

**CONTROL MEASURES**

**QUARANTINE CONTROL**

The pest is currently only present in PNG and Solomon Islands. Therefore, it is an important quarantine pest for other countries, particularly Pacific Island countries and territories that regard slippery cabbage as an important vegetable crop for domestic consumption or a potential export. In Solomon Islands, it is of internal quarantine importance as two provinces (Renbel & Temotu) are still free of the pest. The potential market for export of slippery cabbage to Australia and New Zealand looks promising, so it is important that this notorious pest is controlled and contained as much as possible in infested islands and countries (Fa’anunu 2009). The beetle is a poor flyer, like its sibling genera (Matthews & Reid 2002). This means that it is dependent on other carrier organisms to spread, particularly human beings, who may inadvertently move it while transporting planting materials or soil that harbours immature stages of the beetle. It is advisable that members of the public do not take planting materials from PNG and Solomon Islands to other Pacific Island countries and territories without proper quarantine compliance.

**BIOLOGICAL CONTROL**

The search for predators and parasites of slippery cabbage has not yet been done properly. However, there is speculation resulting from observations of deaths of eggs, larvae and pupae in soil exposed to a range of soil pathogens, spiders, insects, lizards and birds. The invasive ant *Wasmannia auropunctata*, usually common in slippery cabbage gardens in Solomon Islands, may have some impact as a biological control agent but which may require further investigations.

**CULTURAL CONTROL**

Slippery cabbage plants grow very well in open sunlight but they can also tolerate a certain level of shade. However, plants grown under shade usually have fewer beetles than those grown in open sunlight; thus, it may be advisable to grow slippery cabbage in moderately shady environments to mitigate damage on the crop. It may be advisable to use thick mulches of straw, grass or other organic materials (several centimetres thick), as they prevent female beetles from laying eggs at the base of the stems.
Natural mulches from ground cover plants such as clover (*Trifolium repens L.*) may also help impede oviposition, reducing beetle infestation.

To take advantage of the fact that slippery cabbage flea beetle is a poor flyer, farmers are advised to plant beetle-free planting materials about a kilometre away from infested areas. This has been proven to work in Solomon Islands.

As research has shown that slippery cabbage flea beetle populations favour dry seasons over wetter times of the year, it is recommended that farmers grow more slippery cabbage during the wet season to avoid great infestation. However, occurrences of other pests and the agronomical and market aspects of the crop must also be considered when deciding whether to apply this recommendation.

Research has also shown evidence that beetles, especially females, usually walk along the plant stem before and after oviposition. By putting sticky paste such as tangle-foot around the circumference of the stem, it is possible to trap and kill beetles in great numbers.

Regularly hand picking adult beetles off the leaves is another effective way of reducing population numbers to reduce the damage caused by the pest. However, this method is time intensive. Eggs, larvae and pupae are confined within the root system of each plant; thus, it is expected that farmers could reduce beetle populations by regularly turning over the soil at the base of the plants to expose juvenile beetles to the sun, dry air and natural enemies.

Slippery cabbage flea beetle has proven to prefer certain cultivars over others, so farmers can reduce damage on the crop by growing resistant varieties. This information also means that trap cropping technology could be designed to achieve effective control and efficient use of insecticides on resistant varieties.

**CHEMICAL CONTROL**

Farmers have used a range of insecticides available on the market to try and control slippery cabbage flea beetle. For example, in Solomon Islands, they have used orthene (acephate) and synthetic pyrethroids such as lambda cyhalothrin and permethrin, to name just a few. Anecdotal evidence suggests that a plant variety of *Derris* species, which contains rotenone and is present in PNG and Solomon Islands, has been effectively used as a spray. Although farmers have used these insecticides to control slippery cabbage flea beetle, there have not been any proper insecticide screening trials yet carried out to verify insecticide efficacy tests and recommendations.

The conventional practice when using insecticides is to spray them on foliage, targeting adults, which are tough to kill. In the future, when using chemicals to control slippery cabbage flea beetle, farmers should target the juvenile stages of the beetle, which may be more vulnerable and therefore may controllable with smaller amounts of insecticide.