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Pineapple Pests and their Management: A Review

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Abstract: Pineapple Monocotyledonous, self-sterile, perennial plant of the tropical and subtropical area. It grows as a small shrub and the plant is normally propagated from the offset produced at the top of the fruit or from side shoot. The fruit are eaten fresh where available and in canned form worldwide which is the only source of bromelain, an enzyme used in pharmaceuticals and as meat tenderising agent. Pineapples are infested by a variety of insect pests. Some of the major pests that affect pineapple are mealy bugs, scale insects, thrips, fruit borer, bud moths, midgets, fruit flies, white grubs, beetles, weevils, termites and mites. Here we are going to discuss only the major and minor pests of pineapple, other than sucking pests viz. mealy bug, thrips, scale insect and mites.

Keywords: Pineapple, Insect Pests, Management

Introduction:

Pineapple (*Ananas comosus*), is self-sterile, herbaceous, monocotyledonous, perennial plant of the family Bromeliaceae. Pineapple is originated in tropical and subtropical America and has been introduced to all other places. Pineapples cultivated as a small shrub; the separate flowers of the unpollinated plant fuse to form a multiple fruit. The plant is normally propagated from the offset produced at the top of the fruit, or from side shoot and typically mature within a year. Since the 1820s, the crop has been commercially grown in protected structures/green houses and many tropical plantations. The fruit are eaten fresh where available and in canned form worldwide. The fruit has developed a characteristic ingredient in the essence, vegetable, fish and rice dishes of what is roughly termed Pan-Asian cuisine. Pineapple grows to 1.0 to 1.5 m (3.3 to 4.9 ft) tall. The plant has a short, sturdy stem with rough, waxy leaves. When producing its fruit, it typically produces up to 200 flowers, though some large-fruited cultivars can exceed this. Once its flowers, the individual fruits of the flowers join together to create a multiple fruit. After 12 - 20 months, the stem grows into a spike like inflorescence up to 15 cm (6 in) long with over 100 spirally arranged, trimerous flowers, each subtended by a bract.

The ovaries grow into berries, which merge into a large, dense, multiple fruit. The fruit of a pineapple is typically settled in two interlocking spirals, characteristically there are eight in one way and 13 in the other, each being a Fibonacci number. The pineapple is CAM plant, where fixing carbon dioxide at night and storing it as the acid malate, then releasing it during the day aiding photosynthesis. In the wild, pineapples are pollinated

primarily by hummingbirds (Stahl *et.al.*, 2012). Bromelain may be dangerous for some users, such as during pregnancy, allergies or anticoagulation therapy.

The main pineapple cultivating countries in the world are Brazil, Thailand, Philippines, Costa Rica, China and India. The total area under pineapple cultivation in the world is 909.84 thousand ha with production around 19412.91 thousand tons (Anonymous, 2011). In India, total area under pineapple production is 88.7 thousand ha and the production are 1415.4 thousand tons. The major pineapple producing states in India are West Bengal, Assam, Karnataka, Meghalaya, Manipur, Arunachal Pradesh, Kerala and Bihar. Maximum area under pineapple cultivation is in Assam (14 thousand ha), but productivity is of medium scale whereas total production and productivity is higher in West Bengal. Productivity is much low in Karnataka, Kerala and Meghalaya states.

Pineapples are attacked by a diversity of insect pests, some of them commonly affect are mealy bugs, scale insects, thrips, fruit borer, bud moths, midgets, fruit flies, white grubs, beetles, weevils, termites and mites. Pineapples are infested by a variety of insect pests. Some of the major pests that affect pineapple are mealy bugs, scale insects, thrips, fruit borer, bud moths, midgets, fruit flies, white grubs, beetles, weevils, termites and mites. Here we are going to discuss only the major and minor pests of pineapple, other than sucking pests viz. mealy bug, thrips, scale insect and mites.

Important major and minor importance in Pineapple (Other than sucking pests)

Common Name	Scientific Name	Family	Order
Fruit borer	*Strymon megarus* Godart	Lycaenidae	Lepidoptera
Fruit fly	*Melanolomacano pilosum* Hendel, *M. viatrix* Hendel	Richardiidae	Diptera
Sugarcane midget	*Elaphiranucicolora* Guenée	Noctuidae	Lepidoptera
Bud moth	*Opogona sacchari* Bojer	Tineidae	Lepidoptera
White grub	*Phyllophaga* spp.	Scarabaeidae	Coleoptera
Fig beetle	*Cotinis mutabilis* Gory and Percheron	Scarabaeidae	Coleoptera
Pineapple weevil	*Diastethusbromeliarum* Champion	Curculionidae	Coleoptera
Termite	*Mastotermes darwiniensis* Froggatt	Mastotermitidea	Isoptera

1. Pineapple Fruit Borer *Strymonmegarus* Godart (Lepidoptera: Lycaenidae)

The pineapple fruit borer, *S. megarus* is also one of major pest of pineapple. Fruit borer affect the shape and galleries in the pulp. It is present in all pineapple growing regions causing heavy yield losses that vary according to population and climatic conditions. All most all pineapple varieties are affected to this pest. Recent evidence shows that, the insect is able to attack fruits even after the dry petal stage and to affect developing slips as well. The pineapple fruit borer is well thought out as one of the principal pests of pineapple. The pineapple fruit borer is considered as one of the principal pests of pineapple. The larvae bore into the fruit causing holes and uneven fruit development (Satyagopal *et al.*, 2014).

Biology:

Eggs are white in colour, circular and slightly flat. Larvae complete their development within the fruit. Burrowing and feeding activities are visible damage in the form of frass production and a sticky, gummy exudates appearance on plant. Adults are reddish in coloured and caterpillar penetrates the inflorescence and remains in the tissue for 15 days, tunnelling and destroying the tissue. After this phase it moves to the base of the peduncle changing into a pupa 12 mm long and 5 mm wide with a brown colour and a few dark spots and emerges 7 to 10 days later as a butterfly. As the caterpillar destruct the tissues of the inflorescence part results in secretions of a resin coloured liquid gum between the fruitlets, which turns to dark brown. The adult can be found during the day or night, flying in a rapid and haphazard fashion. Eggs are laid on flowers from emergence to the end of flowering.

Damage:

The fruit borer larvae make galleries in the pulp, creating an oozing called "gummosis" on the outer side of the fruit. A larva bore into the fruit producing holes and irregular fruit development. The damage from this pest varies significantly but can attain more than 90%and drier climates seem to favour borer attack. It generally attacks during flowering and fruit formation stage.

Seasonal Incidence: The critical period for pest attack is between weeks 7 and 13 after forcing, so applications and monitoring at this time must be intensified.

Management: Cultural Control: Fruit Borer IPM begins prior to establishing the plantation. Land with forest influence is more prone to this pest. After flowering the fruit should be covered with red or grayish bags impregnated with an adjuvant along the plantation perimeter to trap adults.

***Biological Control*:** Biological control has given excellent results combating borer larvae, namely Bt bacteria (*Bacillus thurigiensis*) *kurstaki*s train. It is important to alternate Diazinon and Carbaryl based chemical products, considering that both act by contact. Other molecules like chlorpyrifos or lambda-cyhalothrin have worked well against this pest. Once again, the use of agrochemicals should be a last resort in pineapple.

C*hemical Control*: Application of Chlorpyriphos (Hilban 20EC, 2.5 ml/lit) at 500lit/ha to manage the borer.

2. Pineapple Fruit Flies *Melanolomacano pilosum, M. viatrix*(Diptera: Richardiidae)

Pineapple fruit flies *Melanolomacano pilosum, M. viatrix* are found mainly in Paraguay and Peru**.** Their main host is pineapple infecting the plant part, fruit (Bello *et al.*, 1997). The eggs are silvery and are pointed at the ends with a length of about 1.2 mm and they seem to be in colonies. The larvae develop are yellowish white, vermiform and devoid of legs with up of 11 segments. The first segment of the thorax has a pair of anterior spiracles with short extensions 12 - 14 digits. At the caudal region pair of posterior spiracles presents. At the external area from them form a series of projections like hairs called inter spiracular processes. The larvae mainly inhabit at the shell and fleshy part of the fruit. The pupae are reddish brown, cylindrical capsule also with 11 segments. The spiracles existing are characteristic in nature and have definite cephalic area. Adult grows up to 5- 6.5 mm long having wingspan of about 1 cm. They are black coloured with abundant micro pubescence. They have wide and short scuttellum and presents with thorny hind femora of equal thickness.

Their wings are clear devoid of any protrusions. It has a dark spot extended to the wing margin and it is devoid of subcosta. The radial vein seems dark and cubitoanal cell is slightly round (Arevalo and Osorio, 1995).

Biology:

The female flies deposit eggs within the fruit and Larvae are plant feeders. Sometimes they behave as sarcophagus invading decayed plant material and they also infest on fruits. They form hollows within the fruit which grow and merge and are called "spot with galleries". All the growth and development of the larvae takes place within the fruit later on. This further helps in fermentation of the fruit (Bello *et al.*,1997). Pupal stage larvae continued to inhabit in fruits until the pupa state. Also, they are ovipositors and lay eggs in fruits.

Nature of Damage:

Pineapple fruit fly as the name defines it mostly attack fruits. The fruit injury starts when the female fruit fly holes the fruit with its long and piercing ovipositor. The fruit skin is broken and bacteria go in and the fruit starts deterioration. The larvae that hatch from the eggs feed on the rotting fruit matter and on the yeasts and bacteria that multiply in it. Also, the larvae groove into the pineapple fruit creating burrows. This causes discoloration, uneven ripening, early maturation and fermentation of fruit and further decay (Martínez *et al.*, 2000).

Management:

Prevention: Pulling off infested fruits is a significant method in controlling of fruit flies. Fermented fruits must be cleared up or it can be exposed to bright sun light for death of larvae and decomposition of fruit. Also, the fruit stands leftover fruits form the multiplying places for these flies.

***Natural Methods*:** Traps having fermented fruit covered with an inverted funnel can be placed near its breeding sites. Also bagging and netting of fruits are advisable. Adults need protein for their reproduction henceforth the beer wastes saturated with insecticides can kill the flies. Also harvesting of fruits without much ripening can limit its attack.

3. Sugar cane midget, *Elaphiranucicolora*(Lepidoptera: Noctuidae)

The sugar cane midget also called as Thecla moth, *Elaphira* moth. Their main hosts are sugar cane and pineapple. It is mainly found in South-Eastern United States, South America, Oahu, Maui and Hawaii regions (Sanches, 1999). The females lay eggs on the inflorescence before anthesis and not a single egg is laid on the fruit. The larvae formed infest the fleshy areas of the fruit and feeds within the developing inflorescence. They dig varying holes in the developing fruit. This cause distorted fruit growth with no appeal (Py*et al.*, 1987).

Distribution:

E. nucicolora is the major pests of pineapples in the tropical regions of the Western Hemisphere, including Mexico, Central and South America. The pest is found more in sub-tropical regions of the Americas, including South Eastern US, Caribbean and tropical South America. It counts as host plants sugarcane, watermelon and wild herbs. *E. nucicolora* is also called the sugarcane midget moth (Patterson, 2014) it is also present in Hawaii (Zimmerman, 1958).

Host plants:

The larvae are polyphagous, having been recorded from several species of host plants of different families. Robinson (2010) reports Cucurbitaceae and Gramineae as main food plants for the pest. The species is frequently captured by the USDA on consignments of imported pineapple fruits (*Ananas comosus*) (Gilligan and Passo, 2014).

Biology:

Life cycle involves eggs, larvae, pupae and adult stages. The females lay single eggs. They hatch in five days. Larval period of about23 days and pupae measures up to 7.6 cm in length and it takes five days to emerge. Adult stage lasts for ten days.

Nature of Damage:

The pest scrapes the fruit rind and exudates gum called as gummosis. The attack of caterpillar causes secretions of gum on the fruit called gummosis which become hard when contact with air. This can easily bring out secondary infections with pathogens like *Fusarium*, *Moniliforme* var. *subglutinans*(Collins, 1960).

Management:

Cultural Control: As with the fruit borer land influenced by forests or mountains favours pest incidence. Strict monitoring required after forcing done. Hence, applications must be intensified by the time. Likewise, adjuvant impregnated red or greyish bags are used to trap adult insects along the plantation boundaries after forcing.

Biological control: Biological control has produced excellent results in combating this pest, namely the *aizawai*s train of ***Bacillus thuringiensis*** without forgetting the importance of preventive applications to ensure intake by larvae during juvenile stages.

Chemical control*:* The chemicals like diazinon, chlorpyrifos or lambda cyhalothrin can be applied with suitable recommendation from the Agronomist (Carrillo, 2011).

4. Banana Bud Moth *Opogona sacchari* (Bojer) (Lepidoptera: Tineidae)

It is native to the humid tropical and subtropical areas of the world infesting banana, pineapple, sugar cane and some other ornamental crops. The levels of the pest invasion may vary with location, age of the plant and propagation material. The larvae bore the plant base making an easy path for the development of fungi and bacteria. Also, it produces carbohydrate-based secretions on the fruits superficial (Vorsino, 2005).

The larvae seem as dirty white and slightly translucent and have a bright reddish-brown head with one lateral ocellus at each side and clearly visible brownish thoracic and abdominal plates. The presence of older larvae can be detected by characteristic masses of bore-meal and excreta at the openings of bore holes. The pupae are brown coloured and are about 10 mm and formed in a cocoon of 15 mm size (Süss, 1974). The adult is nocturnal and having a length of 11 mm with a wing span of 18-25 mm. The forewings may display longitudinal darker brown banding and, in the male, a dark-brown spot near the apex. The hind wings are paler and brighter (Aguilar and Martinez, 1982).

Hosts Plants:

Major hosts plants are pineapple, bamboo, banana, sugarcane, maize. Minor hosts: Alpinia, Begonia, Bromeliaceae, Cactaceae, *Chamaedorea*, *Cordyline*, *Dieffenbachia* (dumbcanes), yam, poinsettia, *Ficus*, *Heliconia*, *Hippeastrum*, arrowroot, snake plant, aubergine.

Distribution: Banana Bud Moth is native to the humid tropical and subtropical regions of the world infesting banana, pineapple, sugar cane and some other ornamental crops.

Biology:

The life span of banana bud moth lasts for about three months. It has four stages like egg, larvae, pupae and adult. The eggs are hatched in 12 days. The eggs develop to larvae within 50-60 days. It has seven instars of growth. Pupal stage lasts only for 20 days. Adult life is only for 6 days (Veenenbos, 1981). The life span totally depends on temperature and it gets shortened at warmer conditions causing only eight generations per year (Giannotti *et al.*, 1977; Heppner *et al.*, 1987). The females lay eggs in crevices of the plant tissue. It lays approximately 200 eggs.

Nature of Damage:

The infestations of banana bud moth are exclusively dependent on optimal conditions of soil moisture, age and type of planting material, temperature, relative humidity, limited insecticide usage etc. Banana bud moth's larvae frequently feed on rotting plant portions and further infesting surrounding healthy tissue. Also, it feeds on leaves and thus destroying the xylem tissues initiating the leaves to wilt. The total growth of the plant retarded and further the whole plant died. When they attack on matured fruit, they bore into the peel of the fruit instigating exudation of secondary metabolites like gum.

Chemical control:

The control of the pests is mainly by the application of suitable chemicals which has been successful in several European countries. The adult moths can be controlled by placing Dichlorvos strips. Thus, the adult moths can be eradicated before they lay eggs. The pest infested poly house must be cleared and the soil must be steamed to remove all the pupae (Billen, 1987).

5. White Grubs, *Phyllophaga* spp. (Scarabaeidae: Coleoptera)

The white grubs of several beetles commonly infest the roots of pineapple plants. White grubs are responsible for a huge part of the injury to the roots of pineapple plants and invasions of larvae leads to adequate to decrease the root system, leading to stunting, wilting and yellowing of the plant (Petty, 1977; 1978: Le Roux, 1992). The adults are fairly heavy bodied insects; most of them with long, spindly legs. They range in colour from light, reddish-brown to shiny black and in size from 12-25 mm in length. The grubs are white with a brown head and legs and with a darker area at the tip of the abdomen. They coil up in a 'C' shape when troubled.

Biology:

The usual duration of one complete generation is 2 to 4 years depending upon latitude. Generations however are staggered so that grubs and beetles are present every year. Grubs are usually most abundant and

damaging the second season subsequent a large beetle flight. The life history of the beetles is completed in 12 months. Eggs are typically 1.5 to 3 mm in diameter and oval in shape (Waite, 1993) and found encased in soil aggregates. Grubs feed upon organic matter within the soil as well. White grubs are easily identified by their white coloured 'C' shaped bodies, which are soft and plump and grubs have three pairs of legs (Waite, 1993). Adult beetles vary significantly in colour markings, shape and size. They are robust, oblong and hard shelled.

Nature of Damage: White grub infestations can finish roots causing the affected area to become spongy. Evidence of grub damage with patches of dead or dying turf are seen during spring (April and May) and late summer and fall (September and October).

Management:

Prevention: Adult northern masked chafers can be monitored by using a black light trap, while Japanese beetle adult flight activity can be observed by using a sex pheromone floral lure trap.

***Biological Control*:** Natural enemies of these pests do exist (insect predators, parasitoids and pathogens, as well as birds, toads, wild pigs and rodents) but the levels of control are not typically adequate (Carter, 1967).

Cultural Control: The cultural practices of viz. late spring and early fall ploughing or disking will provide control. Crop rotation though, is effective cultural control method. Flooding in the areas before sampled is beneficial to prevent the area from drying out and dying.

***Chemical Control*:** Preventive control needs the use of long residual insecticides such as Imidacloprid, Thiamethoxam, Halofenozide, Clothianidin or Chlorantraniliprole. These insecticides give good control of newly hatched grubs. The greatest application period is during the month or so before egg hatch until the time when very young grubs are present. Preventive control requires the use of long residual insecticides. Professional mixture products have a pyrethroid and a neonicotinoid insecticide premixed composed which might be used to try to decrease both adult and larval populations.

6. Fig beetle, *Cotinis mutabilis* (Coleoptera: Scarabaeidae)

Fig beetle, green fig beetle, peach beetles are all members of the scarab beetle family. They host on variety of plant species like pineapple (Camino-Lavín *et al*., 1996), peach, grapes etc. They mainly feed on fruit and the larvae damage roots (Camino-Lavín *et al*., 1996). This beetle is very variable in colour and they lay their eggs in soil. They feed on organic material in soil surfaces (Coviello and Bentley, 2000). The body of larvae is stiff with brown hairs at the back of the thorax and is used for locomotion. They make hollow cells in the soil and pupation takes in soil (Coviello and Bentley, 2000). They are white at early stages and further change to cream coloured as that of larvae stage. At the growing stages they somewhat shift the colour to green. Adults are velvet green in colour and they occupy brownish bands around the edge of the wings and a bright metallic green at the ventral side.

Distribution:

The Fig Beetle is native to Southwestern U.S. and Mexico. The species was likely limited to moister areas of Arizona, New Mexico and northern Mexico in the past. Fig beetles now feed virtually on garden and agricultural fruits.

Biology:

Females lay eggs in August and the eggs develop into larvae after 12 days and are especially attracted to compost and manure piles. The eggs are white in colour and be simply found over the soil (Stone, 1982). Grubs have head and legs and they live on soil surface and have a length of 2 inches. At rest they curl into 'C' shape. Pupal size varies from12-50 mm. They develop by June-July. Its duration extends from 25-27 days. Adults usually emerge by June- November (Stone, 1982).

Nature of Damage:

The plant portion affected mostly includes flower parts like pollen, nectar and petals, fruit and larvae damage roots.

7. Pineapple weevil, *Diastethusbromeliarum* Champion (Coleoptera: Curculionidae)

Weevils are one of the most common insects attacking bromeliad family. It has the life history involving egg, larvae, pupae and adult stages. The female weevils lay eggs inside a hole within the plant part like base of the crown or base of the shoots. It is motile and move up and down damaging the internal tissue of the flower stalk (O'Brien, 1994). This affects the usual development of the fruit causing lack of crown. Adults appear 10.6-18.2 mm long. They are black or brown in colour with no scales over the body. They feed on leaves causing necrotic edges. Many times, the fruits they attack starts to decay (O'Brien, 1994; Salas and O'Brien, 1997).

Distribution:

The pineapple weevils are dispersed in Northern Venezuela (Salas and O'Brien, 1997). It will damage the parts of the plant like crown, flower stalk, fruit, leaf (O'Brien, 1994).

Biology:

The life cycle completed within 3-4 months and more rarely, females lay eggs at the base of the crown and in the basal shoots (O'Brien, 1994). Grubs hatch in eight to ten days and tunnel upward in the rootstock or fruit stalk or in the fruit itself. The larval stage lasts for eight to ten weeks. The pupa is formed at the extremity of the channel lasting 18-24 days. The adults are poor fliers and require a great deal of protection from the direct rays of the sun. It prefers a very humid environment as it shows a preference for the recesses of dense vegetation.

Nature of Damage:

The whole life span of the weevil occurs in the same plant. The caterpillar goes to the stem producing tunnels in the plant. The invasion causes the exudation of a gummy material which is protective for the weevil slits. The damage to the host plant includes adult feeding marks on the leaves, leaves browning, decomposition of base of central leaves (Barbra and Frank, 2010).

Management:

Beetle IPM begins prior to establishing the plantation (prevention) to thus ensure good quality seed stock. Abandoned land put back into use is often not as profitable as land in full development. That is when

beetles enter the production system, spreading through seedlings. Seeds must be cured through immersion in a pineapple approved insecticide.

To confirm the presence of this pest, plantations are monitored using traps with pheromones and attractants (5/ha). Additionally, this technique may become a mass adult trapping method by placing 4 to 6 traps/ ha along the plantation borders. Biological control with the *Beauveria bassiana,* fungus has given excellent results applied in large volumes of water (4000 L/ha) and using a sun protectant (pinolene, vegetable oil). Monitoring is required to verify the effects of the insecticide on the beetle and re-entry periods and intervals between application and harvest must be respected.

Natural Control*:*

1. Pineapple fields must be cleared of weeds.
2. The planting should be done in shade free areas.
3. After two crop cycles replant the suckers
4. Use fresh disease-free samples for planting
5. Incinerate the bio wastes in and around the field.
6. Dipping the fresh plants in Malathion or Diazinon
7. Apply crop rotation with non-host plants
8. Restricting the movement of diseased samples to different areas (Sherwood, 2010)

Biological control: Biological control agents like *Lixadmontiafranki* and *Bacillus thuringiensis* offer the most likely success in management (Cave, 1997; Wood and Cave, 2006) The larvae of the fly feed on the pest's larvae and thus they won't reach the pupae stage (Frank and Cave, 2005).

Bacillus thuringiensis: This been used as a biological management for the weevils. The effect of the bacteria *Bacillus thuringiensis* (Bt) has been successful in pest control (Lacey *et al.*, 2001). The main target pests of *Bacillus* are of Lepidoptera, Coleoptera and Diptera species. The pesticidal effect of the bacteria and its eco-friendly nature are well studied (Lacey and Siegel, 2000).

8. Termites, *Mastotermes darwiniensis* Froggatt (Isoptera: Mastotermitidae)

It is very peculiar insect the most primitive. It is the only alive member of its genus *Mastotermes* and its family Mastotemitidae. *Mastotermes darwiniensis* is typically not very frequent nor are the gatherings large when left to natural conditions. However, when given plentiful water and favourable food and soil conditions, populations can be huge, totalling in the millions, quickly destroying their host.

Biology:

The termites are having three life stages like egg, nymph and adult stages. In the nymph stage of the termites, it goes through a series of moults. Queen lays eggs in lots of about 20 joined composed to form one mass. A nymph after coming out passes through 4-7 moults before becoming a developed worker, soldier or winged

reproductive. Nymphs resemble the adults or mature castes. Nymphal stage lasts approx. 2-3 months dependent on food and climatic conditions. Kings and Queens live longer.

Nature of Damage: The most damaging species inside its range of incidence. It also rings barks and kills living trees and damages crops such as sugarcane, pineapple, etc. The nymphs are the caste that causes the damage.

Management:

Prevention: Choosing low risk sites, use of species appropriate for a region or resistant species, reduction of mechanical damage, maintenance of plant vigour, removal of nests, increasing biodiversity, inter planting can be done as preventive measures.

***Biological Control*:** Biological control of termites has largely focused on the use of fungi (e.g. *Metarhizium*) and nematodes. It is not easily achieved in the field because of the tendency of termite colonies to cut off and avoid infected areas as soon as disease sets in.

Cultural Control: Flooding and clearing the area of that could attract termites before planting. Burn or completely remove affected stumps. In areas of high termite activity, the hole and soil may need treatment with bifenthrin or chlorpyrifos during planting.

***Chemical Control*:** If termite activity or damage is located in the premises, repellent termiticides (e.g. Bifenthrin) will not be made available as an option. This is to avoid the situation where termites can be 'locked in' rather than use their natural habits and biology against them (which is the benefit of non-repellent termiticides). Drenching of Chlorpyriphos (Hilban 20EC 2.5 ml/l) is recommended in grave situations.

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