Macadamia problem solver & bug identifier

Reprint – information current in 2003

REPRINT INFORMATION – PLEASE READ!

For updated information please call 13 25 23 or visit the website www.deedi.qld.gov.au

This publication has been reprinted as a digital book without any changes to the content published in 2003. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest www.infopest.qld.gov.au
- Financial information—costs and returns listed in this publication are out of date. Please contact an adviser or industry body to assist with identifying more current figures.
- Varieties—new varieties are likely to be available and some older varieties may no longer be recommended. Check with an agronomist, call the Business Information Centre on 13 25 23, visit our website www.deedi.qld.gov.au or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

Even with these limitations we believe this information kit provides important and valuable information for intending and existing growers.

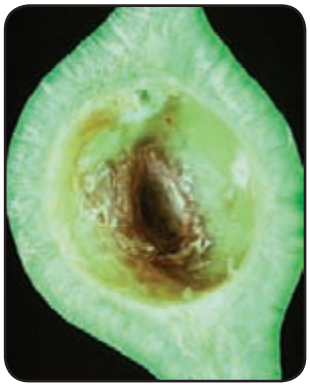
This publication was last revised in 2003. The information is not current and the accuracy of the information cannot be guaranteed by the State of Queensland.

This information has been made available to assist users to identify issues involved in macadamia production. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

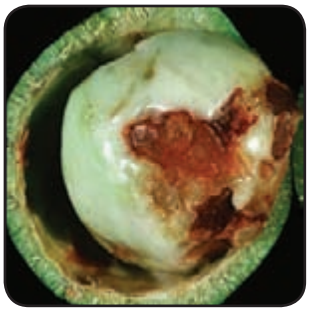
While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in this publication.

Queensland Government

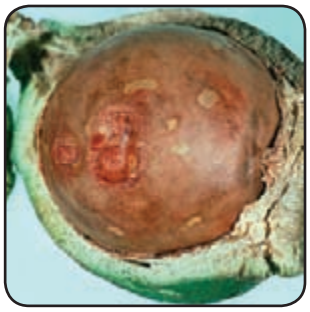
Spots on a young green nut



Sectioned nut showing lesion on inside of husk (nut removed)



Sectioned nut showing damage to soft shell and developing kernel



Early damage to hardening shell

Appearance of damage as nut matures

Damage to kernel

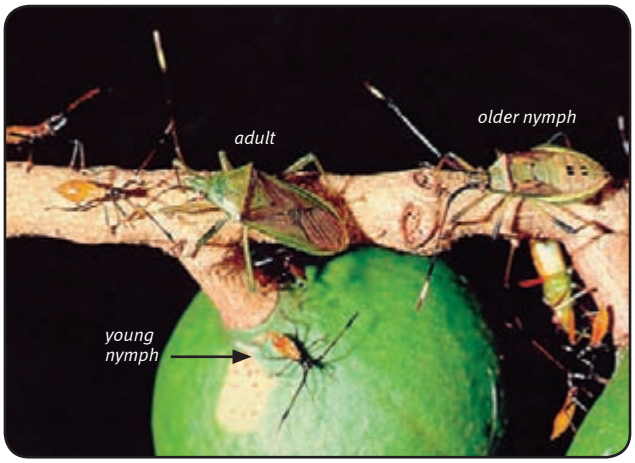
Fruitspotting and bananaspotting bug damage - 1

Cause: The fruitspotting bug *Amblypelta nitida* and the bananaspotting bug *Amblypelta lutescens lutescens.*

Identification: Often, the first indication of damage is a heavy fall of young green nuts. On some varieties, dark sunken spots may be present on the surface of the husk, but in many cases, there are no external symptoms. Nuts need to be sectioned to confirm the presence of damage. Here, brown lesions will be obvious on the inside of the husk and on the developing soft shell and kernel. When shells start to harden, damage shows as small light brown pin-point marks, craters or crinkled spots on the shell. These become darker and sunken as the nuts develop. Kernel damage appears as brown watersoaked spots. Damage is generally worse in orchards adjacent to rainforest. Bananaspotting bug occurs in Queensland only. It also attacks shoots – see symptoms on page 46. See next page for bug identification details.

Treatment: Spray with an appropriate registered insecticide if 4% or more of sampled green fallen nuts are affected in any one week or 2.5% or more in consecutive weeks.

Prevention: Regularly monitor nuts so that the problem can be treated as soon as the action level is reached. Monitor first in areas adjacent to rainforest or known 'hot spots', as this is where damage is generally first seen. In some cases, spraying may be necessary only in these parts of the orchard.



Fruitspotting bug nymphs and adult – actual size of adult about 12 to 15 cm long (excluding antennae)

Banana spotting bug nymph – actual size about 10 mm long (excluding antennae)

Bananaspotting bug adult – actual size about 12 to 15 mm long (excluding antennae)

Fruitspotting and bananaspotting bug damage - 2

Cause: The fruitspotting bug *Amblypelta nitida* and the bananaspotting bug *Amblypelta lutescens lutescens.*

Identification: See previous pages for symptoms of damage. The nymphs and adults of the bugs tend to hide when approached so may be difficult to see. Nymphs may be green or orange-red to brown in colour, with a pair of large black spots on the abdomen. Bananaspotting bug has distinctive light-red stippling surrounding the large black spots. Adult bugs are somewhat rectangular in shape, slender in build, winged, and light green to yellow-brown in colour. Adults are about 12 to 15 mm long (body only – not including antennae). Nymphs increase in size from 2 mm to 10 mm as they develop through the five nymphal stages. Damage is generally worse in orchards adjacent to rainforest. Bananaspotting bug occurs in Queensland only.

Treatment: Spray with an appropriate registered insecticide if 4% or more of sampled green fallen nuts are affected in any one week or 2.5% or more in consecutive weeks.

Prevention: Regularly monitor nuts so that the problem can be treated as soon as the action level is reached. Monitor first in areas adjacent to rainforest or known 'hot spots', as this is where damage is generally first seen. In some cases, spraying may be necessary only in these parts of the orchard.

Infested nut showing larval faeces protruding from the entry hole

Internal damage to a nut

Damage to mature nuts showing the holes made by the larvae

Kernel damage. Mould often enters through the entry hole of the larva

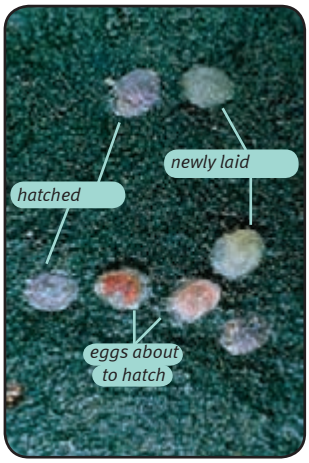
Macadamia nutborer damage -1

Cause: Larvae of the macadamia nutborer *Cryptophlebia ombrodelta*.

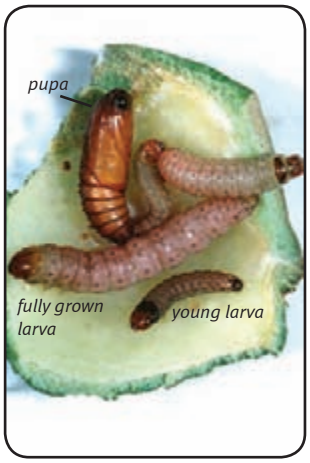
Identification: Eggs are laid on the surface of the green husk. On hatching, larvae burrow into the husk and while the shell is still soft, are able to tunnel through and feed on the kernel. The entry hole in the husk often has larval faeces protruding from it. Damage often leaves shallow dimple-like marks on the shell. Once the shell has hardened, tunnelling is usually confined to the husk. On occasions, larvae may penetrate the shell of some mature nuts, particularly thin-shelled varieties, and nuts with shells weakened by other insects such as fruitspotting bug. Infested nuts generally fall prematurely, reducing yield and nut quality. Moulds may enter through entry holes, further reducing quality.

Treatment: Spray with an appropriate registered insecticide if green, fallen nuts are damaged and live unparasitised eggs are found on nuts on the tree. Larvae must be killed before they enter the nut otherwise it is difficult to contact them with the spray. This requires regular monitoring of fallen nuts and nuts on the tree, and prompt spraying.

Prevention: To prevent carry-over from one season to the next, remove old nuts from the tree and orchard floor at the end of the harvest, discourage out of season nut set and avoid varieties with a sticktight problem. Regularly monitor nuts so that treatment is applied as soon as the action level is reached. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.



Eggs on the surface of a husk (actual size 1 mm across)



Close-up of larvae and pupa removed from nuts (actual size of fully-grown larva 22 mm long)

Adult moths – female (left) and male (right) – actual size up to 20 mm long

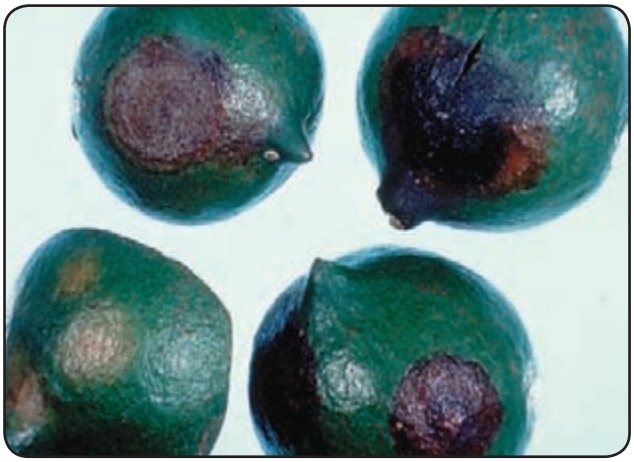
Macadamia nutborer damage -2

Cause: Larvae of the macadamia nutborer *Cryptophlebia ombrodelta*.

Identification: Eggs are scale-like, oval-shaped, about 1 mm across, and vary in colour from ivory-white when first laid, to red prior to hatching. Fully-grown larvae are up to 22 mm long and pinkish in colour, with discrete dark green spots. Larvae pupate in the damaged nuts or husks. Pupae are brown. Adult female moths have a wingspan of up to 25 mm. They are reddish brown in colour with a distinctive black triangular mark on the hind margin of each forewing. This forms a dark spot when the wings are folded. Male moths are smaller and lighter in colour.

Treatment: Spray with an appropriate registered insecticide if green, fallen nuts are damaged and live unparasitised eggs are found on nuts on the tree. Larvae must be killed before they enter the nut otherwise it is difficult to contact them with the spray. This requires regular monitoring of fallen nuts and nuts on the tree, and prompt spraying.

Prevention: To prevent carry-over from one season to the next, remove old nuts from the tree and orchard floor at the end of the harvest, discourage out of season nut set and avoid varieties with a sticktight problem. Regularly monitor nuts so that treatment is applied as soon as the action level is reached. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.



Husk spot symptoms showing a range of spot development (early stage bottom left)

Internal symptoms. Note that the shell is not affected

Husk spot disease

Cause: The fungus *Pseudocercospora macadamiae*.

Identification: Earliest symptoms are pale yellow flecks with a diffuse halo on husks. Note that these flecks can easily be confused with similar spots caused by nuts touching within a bunch. With husk spot, these expand to become darker yellow to tan-brown, circular spots, 5 to 10 mm in diameter. Spots occur on three-quarter to full-size nuts only. Under moist conditions, spots produce a grey velvety carpet of fungal spores. Dried husk spots are woody and harder to cut through with a knife than the surrounding husk tissue. On the internal surface of the husk, spots are circular and tan coloured until the nut reaches maturity when the husk turns dark brown. The shell and kernel are not affected. Infected nuts drop up to six weeks prematurely.

Treatment: Spray with an appropriate registered fungicide. However, once lesions are evident on husks, the disease is difficult to control with conventional sprays.

Prevention: Harvest nuts as soon as possible after nut maturity is reached. This ensures that carry-over of the fungus from one crop to the next is minimised. In areas with a history of the problem, start preventative sprays in September to early October. Canopy pruning to improve air circulation may help to reduce disease severity.

Rat-damaged nuts under tree

Close-up of damage

Rat damage

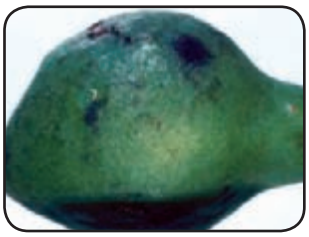
Cause: The black rat *Rattus rattus*.

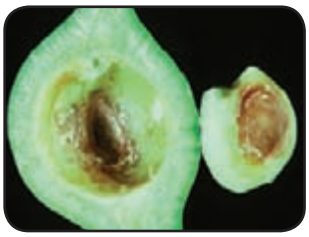
Identification: Holes about 1 cm in diameter are gnawed through the shell to allow the rats to eat the kernel.

Treatment: Bait with appropriate registered rodenticides in and around farm buildings as well as the orchard. Prevent all access to the baits by children, domestic animals and non-target wildlife by using bait stations.

Prevention: Remove all food sources for rats such as old nuts, nut waste and wild tobacco. Remove rat harbourage within and close to the orchard. This includes bana grass, long grass, weeds, fallen trees and scrub. Destroy rat nests in trees. Flood in-ground nests and net or use fox terriers to catch rats. Avoid dumping nut waste from grading and sorting operations in and around the orchard. Before and during harvesting, keep grass within the orchard and on headlands mown short. Where possible, maintain a clear mown area up to 20 m wide around the perimeter of the orchard. This deters rats from entering the orchard as they tend to avoid open areas. It also helps predators such as owls and hawks to hunt the rats. Owls can be encouraged by providing nesting boxes.

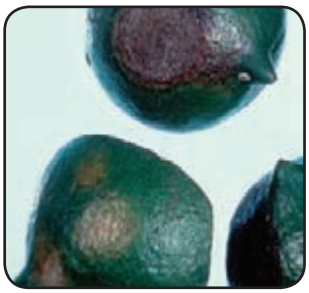
Premature nut drop





Look for these symptoms in green fallen nuts: fruitspotting bug damage – left, external; right, internal (sectioned with nut removed). Note that in some varieties, there are no external symptoms. Nuts must be sectioned to properly identify damage

Macadamia nutborer damage



Husk spot

Premature nut drop

Cause: Natural thinning, fruitspotting bug damage, nutborer damage, husk spot, heat stress, storm damage or tree decline.

Identification: Large numbers of green nuts drop. There are two periods of natural nut drop: 3 to 8 weeks and 10 to 30 weeks after flowering. Nut drop from fruitspotting bug occurs early during nut development and coincides with the first period of natural nut drop. Husk spot and nutborer cause premature drop in later stages of nut development, coinciding with the second period of natural nut drop.

Fallen green nuts need to be closely examined and sectioned to identify the cause.

Treatment: Treatment is only required if the nut drop is caused by fruitspotting bug, nutborer or husk spot. Follow recommendations on pages 103, 107 and 111.

Prevention: Prevent unnatural nut drop by following the preventative measures for fruitspotting bug, nutborer or husk spot on pages 103, 107 and 111. Manage all orchard operations carefully to minimise natural nut fall.

Macadamia white scale

Latania scale

Scale insect infestation

Cause: Mainly macadamia white scale (*Pseudaulacaspis brimblecombei*) and latania scale (*Hemiberlesia lataniae*).

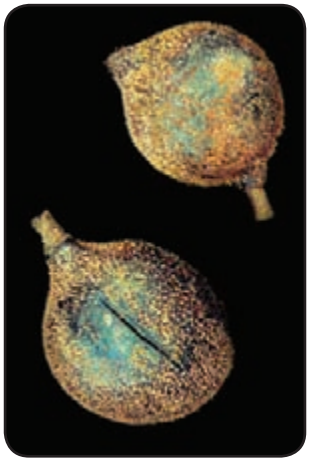
Identification: Appearance varies from small white 'snow-like' scale patches to small, greyish, discrete, circular, raised spots. Scales are up to 2 mm across. Scale insects may also affect leaves and branches – see symptoms on page 14.

Treatment: Spray affected trees with an appropriate registered insecticide. Spray only affected trees and trees in their immediate vicinity. Sprays should be targeted at periods when scales are moving to shoots and nuts. Seek specialist advice from a macadamia pest consultant as frequent use of some chemicals destroys the natural enemies and may encourage build-up of the pest.

Prevention: Regularly monitor trees so that the problem can be treated before it gets out of hand. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects. As scales are commonly introduced into an orchard on nursery plants, carefully inspect these on arrival. If detected, disinfest before use.

Typical symptoms of anthracnose husk rot

A range of symptoms of anthracnose husk rot showing the penetration of the fungus through the husk to the shell



Stilbella husk rot

Husk rot disease

Cause: The fungi *Colletotrichum gloeosporioides* (anthracnose) and *Stilbella* sp.

Identification: The fungi produces diffuse black spots 5 to 10 mm in diameter on the green husk. Spots coalesce to form a rapidly spreading, dark coloured greasy decay which penetrates to the shell. In wet, humid weather, a fungal spore mass develops in the centre of the spots. For the anthracnose fungus, this is greyish and waxy in appearance. For the Stilbella fungus, it appears as a myriad of small bright orange fruiting bodies. Affected nuts may drop prematurely and quality can be affected. The fungi usually enter through insect damage wounds.

Treatment: As damage is generally sporadic and of minor importance, treatment is generally not necessary. Copper fungicide sprays applied for other diseases may be of benefit where the problem is serious.

Prevention: Prevent husk damage by insects such as fruit-spotting bug and nutborer. Compost macadamia husks before use as mulch under trees. This helps reduce the level of fungal activity within the orchard.

Typical germination split in shell

Kernel discolouration

Early germination of nuts

Cause: Favourable conditions for natural germination in fallen nuts. These include excessive wet weather, heavy ground mulch or heavy leaf fall keeping nuts moist, or nuts being left on the ground for too long. In some varieties, nuts may germinate early while still in the green husk stage on the tree (known as pre-germination).

Identification: Shells split on the micropyle end of the nut, following the suture line. The kernel may have a brown or greenish discolouration of the keel end, and has a bitter taste.

Treatment: There is no treatment for affected nuts, which should be discarded during sorting.

Prevention: Harvest nuts regularly, particularly during wet weather. Manage mulch so that it is at a minimum level before the first nut fall. Do not plant varieties susceptible to pre-germination.

Sticktight nuts

Sticktight nuts

Cause: A characteristic of some varieties, particularly Own Choice. The problem may be worse in dry seasons. The nuts have the potential to act as a source for various pest and disease problems.

Identification: Desiccated nuts-in-husk remain in the tree after maturity. This is distinct from late maturity where the husk remains green.

Treatment: There is no practical treatment. Tree shaking may help to remove a large percentage of sticktight nuts.

Prevention: Avoid varieties such as Own Choice that are susceptible to the problem. Where irrigation is available, maintain adequate soil moisture during dry seasons.

Cracked shells. Note the variable cracking

Cracked shells. Kernel symptom showing mould growth

Cracked shells

Cause: Mechanical damage to nuts from harvester elevators or dehusking machines.

Identification: Shells are cracked along indiscriminate and variable lines. Mouldy kernels result from moulds entering the nuts through the cracks.

Treatment: There is no treatment for affected nuts, which shold be discarded during sorting.

Prevention: Reduce the risk of damage by careful handling of nuts during harvesting and dehusking. Monitor the de-husked nut-in-shell. If the number of cracked nuts-in-shell is too high, inspect dehusker for broken components and adjust pressure.

Typical damage. Note the insect faeces on affected areas

Adult moth – actual size wingspan of 25 mm

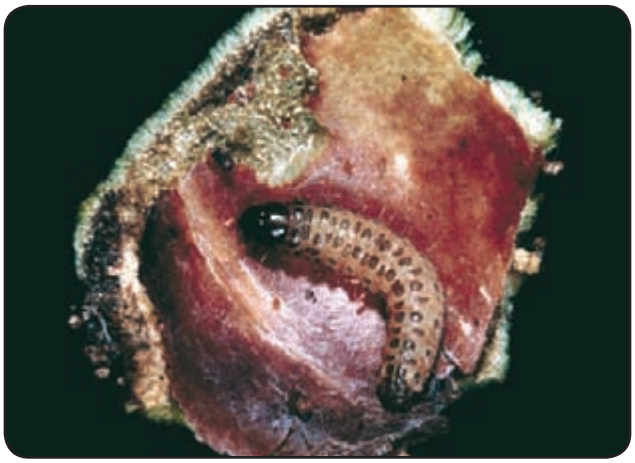
Yellow peach moth damage

Cause: Larvae of the yellow peach moth *Dichocrocis punctiferalis*.

Identification: Larvae burrow into the husk and while the shell is still soft, are able to tunnel through and feed on the kernel. Larval faeces often protrude from affected areas. The larvae are similar to those of macadamia nut borer, but are slightly larger (up to 25 mm long) and the dark spots on the body are larger and more oval in shape. Once the shell has hardened, tunnelling is usually confined to the husk. The insect has a preference for nuts in clusters and damaged nuts are often retained in clusters by insect webbing, long after the husk has died. Moulds may enter through entry holes, reducing kernel quality. Adult moths are orange-yellow in colour, with a number of conspicuous black spots on the wings and body, and with a wingspan of 25 mm.

Treatment: Specific treatment for this pest is rarely necessary, as sprays applied for nutborer generally keep it in check. Where necessary, spray affected trees with an appropriate registered insecticide.

Prevention: Regularly monitor trees so that the problem can be treated before it gets out of hand. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.



Larva on damaged nut –actual size 25 mm long

nut problems

Black shells – typical appearance

Black shells – kernel symptoms

Pale shells

Shrivelled kernels – pointed (top) and incomplete cotyledon (bottom)

Black shells

Cause: Nuts being left on the ground for too long. This causes the natural macadamia oil to exude through the shell. Note that husk rot may produce similar symptoms – see page 118.

Identification: Shells turn dark and in some cases have an oily appearance. While the nuts may appear sound, keeping quality is reduced. Kernels generally have a mouldy appearance.

Treatment: There is no treatment for affected nuts, which should be discarded during sorting.

Prevention: Harvest nuts regularly.

Pale shells and/or shrivelled kernel

Cause: Immature nuts dropped prematurely from insect damage, disease, moisture stress or nutritional problems. It can occur naturally in some varieties. Can be confused with early drop nuts that open up and expose shells to sunburn.

Identification: Shell colour is paler than normal; kernels are small and misshapen with either a large keel (pointed) or split, incomplete cotyledon. Oil content is lower than the commercially acceptable standard. Such kernels sink when oven dried and floated in tap water (specific gravity less than 1.0).

Treatment: There is no treatment for affected nuts, which should be discarded during sorting.

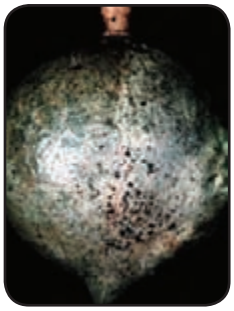
Prevention: Maintain good management of nutrition, soil moisture, pest and disease control during the final stages of nut development.

Flower thrips damage

Adult flower thrips (actual size less than 1.5 mm long)

Greenhouse thrips damage

Adult greenhouse thrips (actual size less than 1.5 mm long)



Redbanded thrips damage

Nymphs of redbanded thrips (actual size less than 2 mm long)

Thrips damage

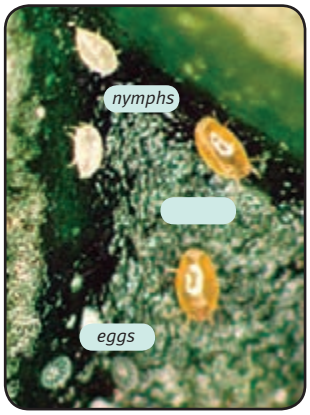
Cause: Flower thrips (*Scirtothrips* sp.), greenhouse thrips (*Heliothrips haemorrhoidatis*), and redbanded thrips (*Selenothrips rubrocinctus*).

Identification: Thrips feed on the outer husk, causing a brown or bronze discolouration. Yields or quality are not usually significantly affected. Adult thrips are tiny (actual size less than 1.5 mm long) and not readily visible to the naked eye. Adult flower thrips are orange-brown in colour, while adult greenhouse and redbanded thrips are black in colour. Nymphs of the redbanded thrips are distinctive with their light yellow colour and bright orange band. Flower thrips may also affect leaves and flowers – see symptoms on pages 16 and 84.

Treatment: As damage is generally sporadic and does not significantly affect yield, specific treatment is not normally required. Where necessary, spray with an appropriate registered insecticide. Spray only affected trees and trees in their immediate vicinity ('hot spots'). These are areas within the orchard where the pest is usually found each year. Heavy infestations are often reduced significantly following heavy rain – in these situations, spraying may not be necessary.

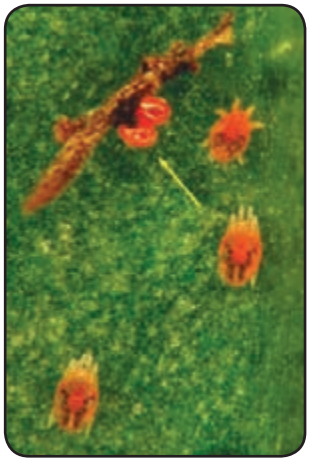
Prevention: Regularly monitor trees so that the problem can be treated before it gets out of hand. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Nuts damaged by broad mite



Close-up of broad mites – highly magnified – actual size less than 0.3 mm long)

Nuts damaged by citrus flat mite



Close-up of citrus flat mite adults (actual size less than 0.3 mm long) and eggs (arrowed)

Mite damage

Cause: The broad mite *Polyphagotarsonemus latus* and the citrus flat mite *Brevipalpus lewisi*.

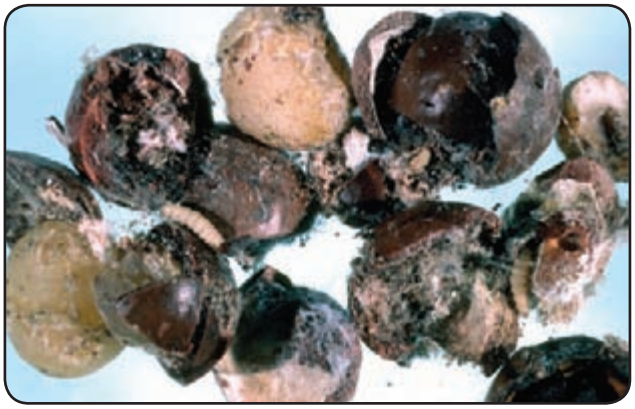
Identification: Both mites cause brown, rusty scarring of the husk. Yields or quality are not usually significantly affected. The mites are extremely small – less than 0.3 mm long – and are not visible with the naked eye. Broad mite also affects leaves and flowers – see symptoms on pages 18 and 92.

Treatment: As damage is generally sporadic and does not significantly affect yield, specific treatment is not normally required.

Prevention: Regularly monitor trees so that the problem can be treated before it gets out of hand. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Kernel grub damage. Note the larva in the lower nut (actual size up to 15 mm long)

Range of damage – internal damage (top and centre), entry hole (lower)



Damaged kernels showing larvae and extensive webbing

Kernel grub damage

Cause: Larvae of the kernel grub *Assara seminivale*.

Identification: Moths lay eggs on nuts in the field prior to harvest. Larvae gain access to the kernel either through an open micropyle, or when other insects such as nutborer or fruitspotting bug have damaged the shell. The larvae then consume the entire kernel, replacing it with a webbed mass of insect faeces. Larvae are cream coloured and up to 15 mm long. Where infested nuts are brought in from the field, the pest may also continue to damage nuts in storage.

Treatment: There is no practical treatment for affected nuts.

Prevention: Careful management of other pests such as nutborer and fruitspotting bug will prevent most kernel grub damage.

Feral pig damage

Wild dog damage

Animal damage

Cause: Eating of nuts by either feral pigs or wild dogs.

Identification: Pig damage can be recognised by the presence of small angular-shaped pieces of shell under the tree. Dog damage results in a more irregular range of damaged nuts and kernel, with some larger pieces and others with an obviously chewed appearance.

Treatment: If damage is extensive, controlled baiting may be required. This needs approval from relevant authorities. Electric fencing may be effective for pigs.

Prevention: The problem is very difficult to prevent, especially in orchards near heavily forested areas. Before the trees get too large, harvesting directly from the tree may be an option in orchards with a major problem. Ensure nuts are tested for maturity before tree harvest.

Open micropyle – left: typical symptoms; right: affected kernel from moulds entering the open micorpyle

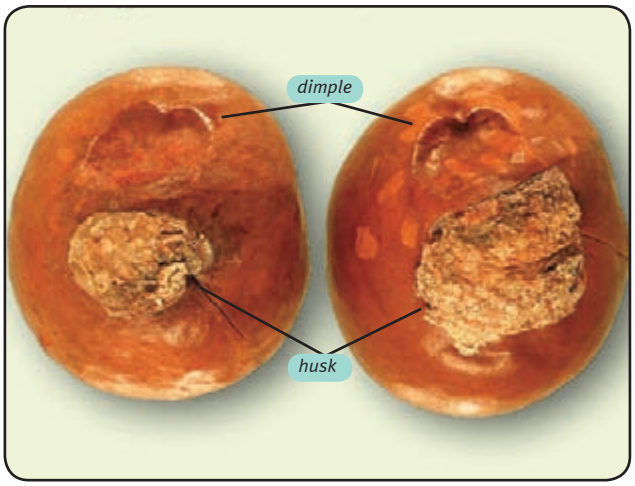
Open micropyle

Cause: A varietal weakness, mainly in 246.

Identification: The problem is an incomplete shell formation at the micropyle end. In some cases, the kernel even extrudes through the hole. The hole, sometimes up to 3 mm in diameter, lets in water, mould and insect pests. Not all trees are affected, and the problem varies from season to season.

Treatment: As the problem is varietal, there is no treatment. Harvest regularly to prevent deterioration of quality.

Prevention: Maintaining adequate soil moisture and nutrition during the cropping period may help.



Adhering husk. Note the dimple – another varietal characteristic

Adhering husk

Cause: A varietal characteristic, mainly in H2, 842 and 344.

Identification: Parts of the husk remain on the end of the shell after dehusking. After shelling, the husk particles may adhere to the kernel causing some discolouration.

Treatment: As the problem is varietal, there is no treatment.

Prevention: Where possible, avoid planting susceptible varieties.

Cornelian butterfly larva and damage (actual size of larva 25 mm long)

Cornelian butterfly adults – female (lower); male (upper) – actual size 40 mm wingspan

Nut stemborer damage

Cornelian butterfly damage

Cause: Larvae of the cornelian butterfly *Deudorix epijarbas diovis.*

Identification: Larvae tunnel into green nuts and eat the kernel. The slug-like larvae grow to about 25 mm long and are purplish brown with orange and green markings. Adult butterflies have a wingspan of 40 mm and are two-toned orange and dark blue (female) and overall dark blue (male).

Treatment: Specific treatment for this pest is rarely necessary, as sprays applied for nutborer generally keep it in check.

Prevention: Regularly monitor trees so that the problem can be kept in check. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Nut stemborer damage

Cause: The nut stemborer insect *Paranepsia amydra*.

Identification: Larvae tunnel into the nut stalk, leaving a circular hole surrounded by insect faeces. They feed between the husk and the shell, causing nut damage and premature nut fall. The insect may also affect shoots – see symptoms on page 64.

Treatment: Specific treatment is rarely necessary, as sprays applied for fruitspotting bug generally keep it in check.

Prevention: Monitor trees. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Twig girdler larva and damage. Mature larvae are easily confused with those of macadamia nutborer

Hail damage

Macadamia twig-girdler damage

Cause: Larvae of the macadamia twig-girdler *Neodrepta luteotactella.*

Identification: Larvae tunnel within the husk and kernel. Often large gouges are eaten in the surface of the husk. Damage can be similar to that of nutborer. Mature larvae are up to 25 mm long and a brown mottled colour with a black head capsule and longitudinal rows of dark-brown dots. The insect may also affect leaves – see symptoms on page 10.

Treatment: Specific treatment for this pest is rarely necessary, as sprays applied for other pests generally keep it in check.

Prevention: Regularly monitor trees so that the problem can be kept in check. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Hail damage

Cause: Impact damage from hailstones.

Identification: Hail impact results in spots and marks of variable size and shape. Damage is generally restricted to one side of the nut, in most cases on the exposed side of the tree.

Treatment: There is no treatment, but as damage makes the nuts more susceptible to insect damage and husk rot, extra attention should be given to management of these problems.

Prevention: Keep trees healthy to maintain as much protective canopy as possible.

Spray damage

Water stress

Spray damage

Cause: Damage from either emulsifiable concentrate insecticides applied under hot or slow drying conditions, or incompatible chemicals being applied in mixtures.

Identification: Symptoms vary widely depending on the cause. Common symptoms are an uneven bronzing or scarring of the husk surface. Damage is generally restricted to one side of the nut, in most cases on the side exposed to the spray.

Treatment: There is no treatment for affected nuts.

Prevention: Check the labels of chemicals to make sure they are compatible and are being used at the correct rates. Spray during the morning when the spray dries more quickly. Avoid spraying on very hot days. Regularly calibrate the sprayer and check nozzles for wear and tear.

Water stress

Cause: Lack of soil moisture during the nut growth stage. Damage occurs when this is followed by a period of adequate moisture.

Identification: Although the kernel is normal in size, the shell is usually thinner. As a result, the nut splits open when being handled after drying, exposing the kernel to mould and dirt.

Treatment: There is no treatment for affected nuts.

Prevention: Where irrigation is available, ensure trees are well watered during the nut growth stage. Use soil moisture monitoring systems such as capacitance probes or tensiometers.

Larva and damage

Close-up of larva (actual size up to 16 mm long)

Butterfly adult (actual size up to 60 mm wingspan)

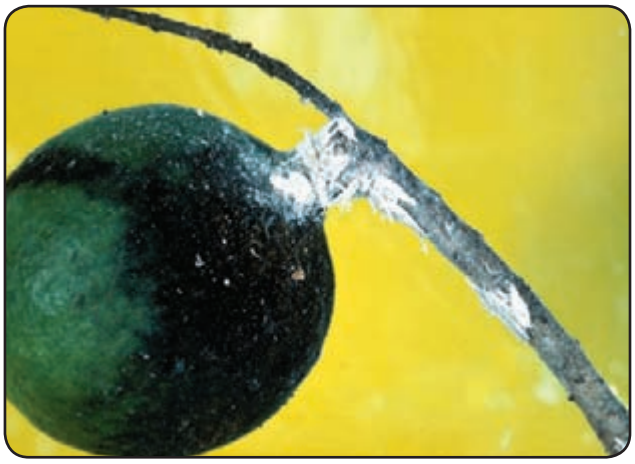
Pencilled blue butterfly damage

Cause: Larvae of the pencilled blue butterfly *Candalides absimilis*.

Identification: Larvae feed on newly-set nuts, where they chew holes in the husk surface and the nut stalks. Larvae are slug-like, up to 16 mm long, and with colour varying according to the diet. Adult butterflies have a wingspan of 60 mm and are two-toned dark blue and white.

Treatment: Specific treatment for this pest is rarely necessary, as sprays applied for nutborer generally keep it in check.

Prevention: Regularly monitor trees so that the problem can be kept in check. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.



Mealybug infestation. Note the sooty mould growth on the nut

Close-up of mealybugs (actual size about 4 mm long) with a larva of the predatory mealybug ladybird Cryptolaemus montrouzieri

Mealybug infestation

Cause: The hibiscus mealybug *Maconellicoccus hirsutus.*

Identification: The mealybugs generally congregate on the nut stalk where they produce honeydew secretions. Sooty mould often grows on the secretions. Adult mealybugs are oval-shaped, about 4 mm long, with thin filaments extending from the body, and covered by a thin coating of greyish-white mealy wax. The insect may also infest leaves – see symptoms on page 36.

Treatment: Treatment is rarely necessary as outbreaks are sporadic and natural enemies, mainly the predatory mealybug ladybird (*Cryptolaemus montrouzieri*), generally provide adequate control. Serious outbreaks are generally the result of frequent use of disruptive chemicals for other pests.

Prevention: Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Leptocoris bug damage (actual size of bugs 15 mm long)

Leptocoris bug damage

Cause: The scentless plant bugs *Leptocoris rufomarginata* and *L. tagalica*.

Identification: The bugs are similar in shape to fruitspotting bugs, but *L. rufomarginata* is slightly larger and *L. tagalica* slightly smaller. Both are reddish brown, with the translucent ends of the wing covers forming a steel blue to black patch. Individual bugs often go unnoticed in the trees and cause little damage. In some seasons bugs form aggregations of thousands causing significant damage to nuts.

Treatment: Specific treatment is rarely necessary, as sprays applied for fruitspotting bug generally keep it in check.

Prevention: Regularly monitor trees so that the problem can be kept in check. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Prominent suture

Prominent suture

Cause: A varietal characteristic. Some varieties with prominent suture lines are Daddow, Heilscher, 791 and 741.

Identification: The suture line is very obvious. However, unlike early germination (see page 120), it does not extend around the whole circumference of the nut.

Treatment: There is no treatment and nut quality is not affected.

Prevention: There is no need for preventative measures.

Bug damage to kernels

Adult bug (actual size about 15 mm long)

Nymphs and adult (actual size of nymphs 5 to 12 mm long)

Green vegetable bug damage

Cause: The green vegetable bug *Nezara viridula*.

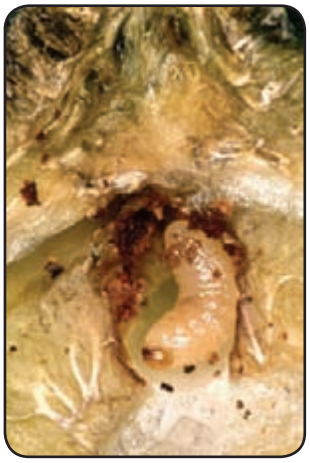
Identification: Adults and nymphs of the bug feed on macadamia nuts at all stages of nut development, but produce no external symptoms of damage. Damage is not usually recognised until the nuts have been shelled, when damage on the surface of the kernel is obvious. Damage consists of multiple, circular, cottony-coloured spots or depressions on the kernel surface. Adult bugs are shield-shaped, green in colour, and about 15 mm long. Nymphs are black, or green and black, and spotted with red, green and orange. Damage can be serious where macadamias are grown in close proximity to other major bug hosts such as soybean.

Treatment: During the early stages of nut development, specific treatment for this pest is generally not necessary, as sprays applied for fruitspotting bug keep it in check. However, where green vegetable bugs are active later in nut development, additional sprays may be necessary.

Prevention: Regularly monitor trees so that the problem can be kept in check. Use an integrated pest management (IPM) approach, which includes the use of less disruptive insecticides with minimal impact on beneficial insects.

Typical damage showing the egg-laying area and chew mark in the stalk to induce nut drop

Sectioned nuts showing the larvae inside the husk (actual size of larvae up to 10 mm long)



Close-up of larva inside the husk

Weevil adult – actual size 6 mm long

Sigastus weevil damage

Cause: The weevil *Sigastus* sp.

Identification: This pest is confined to a small area of the Atherton Tableland. It attacks nuts of about 5 to 10 mm diameter until mid-December. The female weevil scarifies an area of about 3 to 4 mm diameter on the husk and lays a single egg into it. The egg is either lodged within the husk or intrudes into the surface of the kernel. After the egg is laid, the weevil chews about half way through the nut stalk to induce nut drop. When the egg hatches, the larva consumes the entire kernel before pupating and exiting the nut as an adult. Fully grown larvae are up to 10 mm long.

After nut shells have hardened (about mid-December), and are no longer suitable for egg laying, adult weevils feed on the green surface of the husk, in some cases completely removing the outer layer. They also feed on young leaves. Adult weevils are grey and warty, and about 6 mm long. Up to 30% of the crop may be lost in unsprayed orchards.

Treatment: Sprays applied for beetles are also effective against adult weevils. Spraying needs to target the weevils to prevent egg-laying as larvae inside the husks are not affected. Where nuts are infested, larvae can be killed by sweeping the nuts into the interrow space, exposing them to full sunlight. This prevents the development of adult weevils.

Prevention: Regular, monthly monitoring of orchards is necessary to detect early weevil activity and determine the need for spraying.