Chapter 23

OTHER DISORDERS

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We strongly recommend you use this chapter in association with the DPI book "Pineapple Pests and Disorders" (1993). It contains detailed text and colour photographs to describe a comprehensive range of pests and disorders.

Biuret injury

Biuret is a by-product of manufacture found in various concentrations in the different formulations of urea. Biuret is toxic to plants when applied as a foliar spray and will accumulate with each application. Biuret toxicity can occur in pineapple where foliar urea sprays are the main source of nitrogen. Symptoms of damage include leaf-tip dieback. A distinct yellow band separates the normal green leaf tissue from the dried, brown leaf tip. Symptoms are more severe and more widespread as biuret levels accumulate. Yield is reduced substantially as levels accumulate. Some level of biuret injury is found in most pineapple fields.

The biuret content of urea is shown on the label. It ranges from 0.4% to 1.5%. This label information can be used to calculate the total amount of biuret applied to the crop over its life. Aim for no more than 10 kg/ha of biuret in the plant crop and an additional 5 kg/ha in the ratoon crop.

Blackheart

Also refer to the chapter on post-harvest management and packing for more information.

Blackheart is commonly found in Smooth Cayenne and Queen fruit maturing during winter and spring when the predominant weather is cool and cloudy. It is most common in the period from July to August. Blackheart can also develop post harvest in fruit stored under refrigeration. Fruit harvested in the cooler months is more prone to blackheart from cool storage than fruit harvested during the warmer times of the year. Many of the newer fresh market varieties of pineapple are more resistant to blackheart than Smooth Cayenne. *Refer to the chapter on fresh fruit varieties.*

Factors that create greater potential for blackheart

- Extended periods of cloudy weather
- Southerly aspects in winter (shading)
- Shading from belts of trees on the northern side of the field

There are no external symptoms of blackheart. Internal symptoms develop within 7 – 14 days. Typical symptoms are browning often near the core. Fruit with blackheart are unmarketable for both the processing and fresh markets.

Minimising blackheart

- In situations where there is fruit in winter avoid shading.
- Harvest at early fruit maturity.
- Ethrel ripening can minimise blackheart because it ripens the fruit before blackheart can develop substantially.
- For the fresh market, avoid placing fruit in cool storage and then returning to a warm atmosphere.

- For the fresh market, consider using one of the more resistant varieties. 73-50 has relatively good field resistance but will develop symptoms in winter fruit after extended cool storage and subsequent warming. MD2 has very good resistance and even the most challenging of storage will only develop slight browning in the core. The minor varieties 53-116 and 58-1184 also have good resistance. Aus-Jubilee has moderately good resistance. Cayenne is susceptible and Queen is very susceptible.

Butt (base) rot

The fungus *Thielaviopsis paradoxa* (which also causes water blister) is present in all pineapple fields and can invade planting material through the broken end especially during warm wet weather. A grey to black rot of the soft tissue develops leaving only stringy fibres at the base of the stem. Symptoms are only seen on tops and slips either before or immediately after planting and it can cause severe plant losses.

Minimising butt rot

- For tops and slips that are separated from the fruit or plant in the field, cure planting material in the sun without delay in no more than a single layer
- If wet weather occurs during separation of tops or slips from the fruit or plant treat broken ends with a registered fungicide immediately
- For uncured planting material (e.g. tops removed in the packing shed) treat with a registered fungicide as soon as separated from the fruit or plant
- Do not leave part of the fruit attached to the top when picking

Mouldy Stem-end

The moist stem-end of pineapple fruit is quickly colonised by fungi during storage even at temperatures of 15^{o}C. While these fungi might not be immediately invasive, their unsightly appearance can cause buyer resistance.

Micro Bruising

Micro-bruising is commonly seen in fresh market pineapple in retail outlets but is most likely caused during harvesting, packing or transport. Micro-bruising is bruising of the skin around the top of each fruit segment. Bruised areas dry and shrink during storage, particularly at temperatures above 15^{o}C to leave small brown depressions. Micro bruising gives fruit an unattractive scuffed appearance. Exercise care during harvesting and packing and avoid over-packing fruit.

Crown abnormalities

Abnormal crowns can be caused by genetic aberrations, nutritional deficiencies, sunburn, chemical injury and environmental conditions. Crown abnormalities occur regularly in pineapples. The symptoms can range from no crown at all, through to multiple crowns and excessive irregular crowns.

Minimising crown abnormalities

- Ensure a balanced fertiliser program. Calcium is particularly important.

- Minimise sunburn by using sunburn mixtures

- Avoid chemical applications during the period from induction through to flowering that might damage the plants

- High planting density can reduce crown abnormalities from sunburn, mainly in winter harvested fruit.

Fertiliser burn

Fertiliser burn results if fertiliser is incorrectly applied. While the green part of the leaf is very resistant to fertiliser burn the soft white tissue at the base of the leaves is easily damaged. High salt concentrations cause leaf cells to rupture. The whole centre of the plant can be completely burnt out. Side dressings can cause similar symptoms to urea heart rot (see later in this chapter) but without the odour and the growing point is rarely destroyed. Often, fertiliser residue can be seen at the base of the heart leaves. Foliar fertiliser burn is usually less severe than that of solids but may cause patches of dead tissue on the upper leaf surfaces. In severe cases the damage will completely cut through the leaves all at the same height.

Minimising fertiliser burn

- Damage from foliar fertiliser occurs only when errors are made in calculating concentrations or spray volumes or when boom sprays are incorrectly calibrated.

- Avoid applications of solid fertilisers to the centre of the plant.

Frost damage

Frost injury usually occurs when cold air accumulates in low lying areas, or where cold air moving from higher ground is trapped in the pineapple field by a belt of trees or other obstructions at the lower end of the field. Pineapple plants and fruit are very susceptible to frost damage. In mild cases, the upper surface of the leaves develop a red and white, flecked, scorched appearance. With more severe injury, the leaf and fruit tissue freezes, causing it to turn yellow and brown upon thawing. Young fields affected by frost during the vegetative phase can recover to produce an acceptable crop. Crops injured near flower induction will have reduced yields and in some cases malformed fruit. In many cases, severe frosts can kill the growing point of the plants and cause suckering.

Frost during fruit development can cause heavy losses. The fruit skin is damaged and interfruitlet cracks develop making fruit very susceptible to infection.

Minimising frost damage

- Plant crops in frost free sites.

- In frost susceptible areas, ensure that there are no barriers such as belts of trees and undergrowth at the lower end of the field that prevent the downhill drainage of cold air out of the field.

- In susceptible areas, avoid crop cycles which have developing fruit present in the winter period.

Refer also to the chapter on site selection.

Fruit cracking and stem splitting

Fruit splitting and stem splitting are relatively uncommon problems.

Rapid increases in fruit growth will cause fruit to split. If fruit that develop during relatively poor growing conditions such as cool, dry conditions and are then subjected to warm weather with abundant rainfall during the final filling, they will crack, mainly between the basal eyes of the fruit. Small cracks can also occur radially on the eye margins. Mite or mealy bug infestations, boron deficiency and frost might also predispose fruit to cracking.

Stem splitting usually occurs from spring inductions on crops due to be harvested in late summer – autumn when the young, developing fruit emerges from the heart during hot, humid weather. It is the change from slow to rapid fruit stalk elongation that triggers splitting.

Susceptibility to splitting varies between clones and hybrid varieties. Plants less tolerant to dryer conditions, e.g. 73-50, are more prone. Splitting and cracking can be minimised by ensuring more uniform availability of water by irrigation scheduling.

Case study: A significant number of Rough leaf fruit were observed in NQ in July '05 where the fruit stem was partially cracked off resulting in a lop-sided fruit that had to be discarded. These plants had flowered Feb/Mar then experienced very vigorous growth in hot humid weather and perhaps excessive nitrogen.

Fruit cripple

Fruit cripple is rare, and when it occurs it affects only a very small percentage of fruit.

A pineapple fruit is actually a collection of many small fruitlets fused together. Cripple is when some of the fruitlets in one position are damaged but growth of the other surrounding fruitlets in unaffected areas continues. It manifests itself as a crease or indent in the affected area of the fruit. The severity of symptoms depends on the number of fruitlets that fail to develop.

Likely causes of damage include insect feeding, chemical or fertiliser burn, hail or sun damage, especially during early development of the fruit. Cool conditions during flowering and very early fruit development might also cause similar symptoms in susceptible varieties such as MD2.

Fruit russeting

Certain cultivars, including 73-50 and Aus-Jubilee®, appear prone to skin russeting at certain times of the year. Russeting has been observed on fruit of susceptible varieties during winter and spring but is not normally seen in summer. Smooth Cayenne does not appear susceptible.

Symptoms include a brown russet and corking covering sections of the fruit. Severe russeting can sometimes result in skin cracking. The symptom is present over complete areas of skin, usually on the side of the fruit exposed to the strongest light, and usually on the upper edge of fruit segments (eyes). It is not localised between the fruitlets as with boron deficiency.

Fruit russeting appears to be principally a response to light damage at cool times of the year. It appears the fruit skin is unable to tolerate high levels of light after exposure to low temperatures. The plant responds developing russeting in damaged tissues.

There are other potential causes of fruit russeting and symptoms might differ slightly. Fruit russeting has also been attributed to feeding damage by pineapple fruit mites (*Steneotarsonemus ananas*) on the developing flower head but this has not been confirmed in Queensland. The pineapple fruit mite is very small and almost colourless. It is very difficult to observe but is relatively common.

Fruitlet core rot

Fruitlet core rot occurs sporadically, more often in fruit maturing in winter and spring. There are differences in varietal susceptibility with Queen more susceptible than Smooth Cayenne. 73-50 also displays a level of susceptibility.

The disorder is caused by the fungi *Penicillium funicolosum* and *Fusarium moniliforme.* Infection appears to depend on weather conditions during flowering with moist conditions being favourable. The pathogens are thought to invade the fruit through damage caused by mites feeding on the trichomes covering the young fruit and/or directly through open flowers. The pineapple fruit mite has been implicated.

Overhead irrigation should be avoided during flowering (petal stage).

Genetic off-types

The incidence of genetic off types in pineapple is not uncommon and certain off-types can accumulate in fields over time if continually replanted. The incidence is increased where tissue culture is used to rapidly multiply varieties. It is not uncommon to obtain 5-10% of off-types using tissue culture. The percentage can be higher if recommended tissue culture protocols are not followed.

The types of off-types you are most likely to see will probably be slightly different for the different varieties. In Smooth Cayenne they include the following:

- Spiny leaves - spines develop on the leaf margins.
- Variegation – variation in colour from green to white striping on the leaves.
- Knobs – small knobs 10 – 30mm in diameter on the base of the fruit.
- Collar of slips – fruit is completely surrounded by slips at the base of the fruit.
- Dwarf plants.

Minimising genetic off-types

Cull them from the field or at least separate them so that they won't be used as a source of planting material. *Refer to the chapter on planting material for more information.*

Hail damage

Hail damage is localised and sporadic varying in intensity and damage. Both fruit and plant can be easily damaged. In immature and mature plants, leaves are often lacerated resulting in reduced plant growth. Plants will recover but the more immature the plant the longer it will take to re-grow. Damage prior to sucker growth will create early and stronger sucker development. When fruit are damaged the injury can create easy entry points for secondary infection. In developing flowers complete eyes can be destroyed creating malformed fruit in severe cases or unattractive fruit for the fresh market.

To manage hail damage on immature and mature plants delay flower induction if possible until the plants have recovered and reached an appropriate size.

Herbicide damage

Damage from the three herbicide groups likely to be seen in pineapple

- Pre-emergent herbicides such as diuron, bromacil or ametryn can cause mild yellowing of the leaves and in severe cases leaf die back.
- Systemic herbicides such as glyphosate can cause yellowing of the contacted leaves, bleaching of the heart leaves and a cessation of growth.
- Hormone (phenoxy) herbicides can cause the growing points to bend and in severe cases will be parallel to the ground.

Minimising herbicide damage

- Follow label recommendations.
- Don't apply bromacil over actively growing plants, & only use low diuron rates.
- Calibrate application equipment.
- Avoid spray drift.
- NEVER use hormone herbicides in any pineapple spray equipment as even minute traces will cause premature induction of plants near maturity.

Interfruitlet corking

Interfruitlet corking can occur in Australia in fruit initiated in autumn and harvested in Nov-Dec. It is not considered common. Symptoms are sometimes confused with boron deficiency.

Hawaiian work suggests damage by the tarsonemid mite to the developing trichomes on the flower bracts in the period from just prior to open heart through to flowering is the primary cause of interfruitlet corking. In studies there, populations of this mite peak 6-7 weeks after initiation which coincides approximately with open heart. Fruit with interfruitlet corking often show shiny patches on the skin during early development where the trichomes (hairs) have been removed by mite feeding. One of the same fungi responsible for fruitlet core rot, *Penicillium funiculosum*, infects the skin through the superficial damage caused by the pineapple fruit mite feeding resulting in corking. In severe cases, corking surrounds the fruitlets and malformed fruit result.

Varieties vary in their susceptibility to interfruitlet corking. Smooth Cayenne and 53-116 are considered very susceptible, and 58-1184 is considered only weakly susceptible.

Boron deficiency will also cause symptoms of interfruitlet corking. Boron deficient fruit will usually also be smaller and more fibrous.

Nutritional deficiency and toxicity

A range of symptoms and disorders can be caused by nutritional deficiencies and toxicities. Generally you should use leaf analysis to diagnose nutrient levels rather than rely on identification of symptoms because the latter usually only show up once the problem is quite advanced. However, the more common symptoms include:

- Bent growing points - zinc deficiency
- Cracking between fruitlets - boron deficiency
- Yellow leaves but with green bands in shaded sections - magnesium deficiency
- Cut-off tips and scalloped margins to emerging heart leaves - calcium deficiency
- Large, dark olive to blue/black plants with wide leaves - nitrogen excess

Symptoms of a nutrient deficiency may actually be due to excess of another nutrient, inappropriate soil pH or damaged roots. *Refer to the "Pineapple pests and disorders" book for illustrations more detail and to the chapter on essential pineapple nutrients.*

Pineapple scale

Pineapple scale *Diaspis bromeliae* affects both the leaves and fruit of the plant. It does not directly affect yield but its presence on fruit can create issues at processing. Scale can contaminate the processing lines and create significant disinfestation requirements. *Refer to the chapter on registered chemicals for chemical control.*

Prickly eye

Prickly eye primarily occurs in fruit harvested during November – January. The symptoms arise when the early stages of flowering and fruit development take place during cold weather (e.g. winter in SE Queensland).

Prickly eye fruit have pronounced eyes in conical shapes. Internally the fruit are drier than normal and prominent cavities appear in the fruitlets. Prickly eyed fruit do not fill out properly and therefore yields are reduced. Fruit harvested from North Queensland rarely show this symptom. Apart from the unattractive appearance and low recovery in processing, prickly eye fruit have generally high sugars and low acid.

To manage this problem growers in areas which cannot produce symptom-free fruit in the susceptible months should avoid these production windows.

Seediness

Pineapple seed is very rarely produced in commercial plantings but may increase in frequency as new varieties become more widespread. It occurs when two or more varieties are grown in close proximity to each other, with flowering (petalling) at the same time. Honey bees are considered the main pollinators, although native bees, ants and various nectar-feeding birds may also be involved. Pineapple seed are small (2 X 5 mm), brown and hard and set within the flesh, about 10 mm below the skin. There are no external signs, and seed can only be detected by cutting the fruit.

To minimise seed in pineapple, keep different varieties apart or ensure there is no overlap in flowering. If different varieties are near each other and are flowering simultaneously then ensure there are no commercial bee hives in close proximity.

Numerous, very small, infertile seed can also develop in crownless but otherwise normal fruit which were treated with chlorflurenol at around flowering (naturals in a field being multi-propped).

Sunburn, boiled fruit, malformed, fan top

Sun can damage fruit particularly when fruit is maturing and cause significant economic loss. Secondary losses can occur as a result of sunburn during flower development and to leaves. Damage is incurred during very hot days (usually from December through to February) especially when there is no breeze to remove heat build up from around the plants (pineapple plants don't transpire enough to cool themselves).

Fruit showing a bleached yellow appearance on the exposed side of the fruit are suitable for processing but not for the fresh market. Severely damaged fruit where the blemishes are black, sunken beyond the skin and affect the internal ginaca slug are totally rejected. Severely damaged fruit often suffer secondary infections. Fruit of ratoon crops are more prone to severe damage because lodging is common, exposing fruit sides to the full force of the sun. Hot conditions can also cause premature flesh translucency and breakdown, commonly referred to as 'boiled fruit'. This disorder is particularly prevalent in fruit which have developed in winter and are subject to unseasonably hot spring conditions while they mature.

Damage to emerging flowers or very young fruit results in a range of fruit and top (crown) symptoms. Top damage most likely occurs from open-heart to red-bud and symptoms range from an absence of the crown to multiple crowns. High temperature damage to young developing fruit causes misshapen fruit typically hour glass or pear shaped.

Sunburn is minimised by protecting the fruit and relevant plant parts with foliar applications of a sun blocker (such as talc, bentonite & hydrated lime) or UV screen (e.g. Raynox®) in the hotter times of the year or by covering the fruit with paper bags. Usually several applications of spray-on protectants are required with re-application after rain.

Sunburn mixture for a 1000 litre quantity:

- 10 kg bentonite
- 50 kg powdered talc
- 10 kg hydrated lime (extra whitening)
- 600 mL raw linseed oil per 1000 Litres of solution (maximum safe amount 1L linseed oil per 1000 litres)

Translucency

Refer to the chapter on post-harvest management and packing for more information.

A slight to moderate degree of translucency is a normal part of the ripening process in most pineapple varieties. Severe or complete translucency in immature green skin fruit is considered a physiological disorder. Some varieties are more susceptible than others.

Severely translucent fruits are more susceptible to post-harvest mechanical damage, have shorter storage life and have poor flavour due to low acidity and undesirable esters associated with an accelerated fermentation. When the fruit is damaged by impact, leaking of juice from the damaged area is evident. Translucent fruit will not respond to ethrel ripening.

Severe translucence is due to premature ripening of the flesh. It is more severe and appears associated with high temperature about 3 months before harvest. Translucency has also been associated with variety, high nitrogen, low calcium, large vigorous plants, low planting density, and sunlight. The effect of irrigation is unclear at this stage.

Mild translucency does not affect fruit quality but can cause leakage of juice from the stem-end resulting in small pools of juice accumulating in tray liners. This can then attract vinegar flies thus reducing the attractiveness of the product to potential buyers.

Minimising translucency

- Do not apply excessive amounts of nitrogen because excessive levels of nitrogen will depress fruit calcium levels making the fruit more susceptible to translucency. This means reducing N rates if plants are droughted for a period (which will also lower fruit nitrate levels).
- Ensure soil calcium levels are adequate before planting.
- Do not apply more potassium than is required. Excessive K levels might reduce calcium levels.
- Ethrel-ripen the fruits (processing market only) when the desired TSS is reached, and harvest after 7 days.

Urea heart rot

During hot spring-summer periods, a rot can occur when dirty water is used in applying urea fertiliser. Bacteria in the water break down the urea releasing ammonia which quickly damages the soft tissue in the pineapple heart, then bacteria and other rot organisms quickly colonise the damaged tissue. The centre leaves of affected plants develop a soft rot and a foul odour, not unlike *Phytophthora* heart rot.

Minimising urea rot

- Use clean water for all boom spraying and flush out tanks and hoses before and after since old spray residues foster large bacterial populations

- Use a registered bactericide in urea mixes during spring and summer to disinfest the water.

Water blister

Refer to the chapter on post-harvest management and packing for more information.

The primary cause of water blister is a fungus *Thielaviopsis paradoxa* which also causes white leaf spot and butt (base) rot.

Water blister is widespread and more common in the warm, wet times of the year from January - April. It is a major post harvest disease creating most economic damage in the fresh market. As water blister takes 2 – 3 days to develop, it is not a common problem in processed fruit due to the short time period between harvesting and processing.

Water blister is a soft, watery rot of the fruit flesh creating a glassy, water-soaked appearance. Eventually the skin, flesh and core disintegrate and the juice leaks through the shell.

The fungus *Thielaviopsis paradoxa* enters the fruit rapidly, mainly through broken fruit stalks, cracks in the shell or bruised areas.

Managing water blister

- Handle fruit carefully.

- Reject damaged fruit.

- Treat the fruit with a registered fungicide within 5 hours of harvesting, especially if fruit is harvested during warm, wet weather.

- Hygiene - keep the packing shed and its equipment clean.

Water stress

Refer to the chapter on irrigation for more information.

Healthy pineapple plants do not require much water compared to most other horticultural crops. Pineapples are only likely to show symptoms of water stress during prolonged dry periods. Water stress can however cause a slowing in plant growth without obvious plant symptoms. This might contribute to a lower yield in some varieties or an increase in the incidence of natural initiation.

Any pest or disorder that destroys the root system will cause pineapples to be more susceptible to water stress.

The earliest obvious symptoms of stress are wilting of older leaves. If water stress is prolonged, the leaves become pale green, then tinged light brown and finally tinged red. The margins of the leaf roll downward and tip dieback occurs. Average fruit weight is reduced if severe water stress occurs during fruit development. Water deficit can also slow sucker development.

Minimising water stress

- Plant pineapple only in areas where rainfall is adequate unless irrigation is planned.
- Select soils that are well drained but have good water holding capacity.
- Control pests likely to damage the plant's root system.

Yeasty rot

The primary causes of yeasty rot are *Saccharomyces* spp which often invade damaged fruit mainly in the spring.

Yeasts ferment sugars producing mainly alcohol and carbon dioxide. The most obvious symptom of yeast rot is a bubbling exudation of gas and juice from skin where the damage initially occurred. The skin turns brown and leathery as the juice escapes and the fruit becomes spongy.

In spring, the rapid changes in fruit growth which occur when conditions change from being cold and dry to becoming warm and wet result in skin cracks which are easily invaded by yeasts. Frost and sunburn damage to fruit are other likely sites for infection.

Minimising yeasty rot

- Fruit with minor signs of cracking need to be harvested at early stages of maturity.
- Minimise damage to the fruit e.g. from frost and sunburn.

References and further reading

Broadley, R.H., Wassman, R., Sinclair, E. (1993). Pineapple pests and disorders. Qld DPI.

Rohrbach, K. G, and Johnson, M. W. (2004) Pests, Diseases and Weeds. In 'The Pineapple. Botany, Production and Uses'. Ed D. P. Bartholomew, R. E. Paull and K. R. Rohrbach. CABI Publishing. 301 p.

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