Identification of insects, diseases and disorders in New Zealand blueberries

A manual to aid identification and control

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INTRODUCTION

This manual has been produced for New Zealand blueberry growers as an aid to diagnosis of pest, disease and disorders in blueberries. It is designed to cover fungal, bacterial, insect and other issues found in New Zealand blueberry orchards. It is a comprehensive list but not necessarily a complete list. The intention is to add newly discovered issues as they arise. It would help this cause if any pest or disease found in New Zealand and not listed in this publication could be photographed and a sample sent to the authors. If identification is not immediately obvious, the sample will be passed on to the MAF Biosecurity Investigation and Diagnostic Centre. Growers also have the option to send samples direct to Plant Diagnostics in Christchurch or AsureQuality in Auckland on a pay-for-sample basis. Growers are encouraged to monitor their properties regularly and look for pests and diseases. Early identification and control can avoid more serious problems later.

INSECTS

LEAFROLLERS:

Several species including *Epiphyas postvittana (*Light brown apple moth) (LBAM)

There are several species of leafroller caterpillars that can damage blueberries. Trapping numbers in recent years have identified that Light brown Apple Moth (LBAM) is by far the most common of the leafroller species found in blueberries in the Waikato. While the damage overall is slight, the contamination of leafrollers in export consignments can lead to total rejection of the consignment and the problem can therefore be very serious. Caterpillars often tunnel into fruit and protect themselves with silken coverings. This makes detection very difficult and control is essential before this development occurs. Monitoring populations in the crop could be very helpful in determining the need for chemical control, but thresholds for treatment need to be established. As an interim measure, 1 egg mass per hectare or 1 larvae per hectare, are suggested as action thresholds for countries where this is a potential issue. For local market 10 egg masses or 10 larvae per hectare might be appropriate.

Mating disruption using pheromone dispensers can be used for management of leafrollers. Use 500 dispensers per hectare or apply according to manufacturer's recommendations. Dispensers should be tied around a shoot near the top of the plant early in the season before the first flights of moths. Dispensers will normally last a full season. Dispensers should also be placed in surrounding areas and higher numbers should be placed on the side of blocks from where the prevailing winds come, but otherwise distributed evenly throughout the block. This technique works best when large areas are treated, or in enclosed areas like tunnel houses.

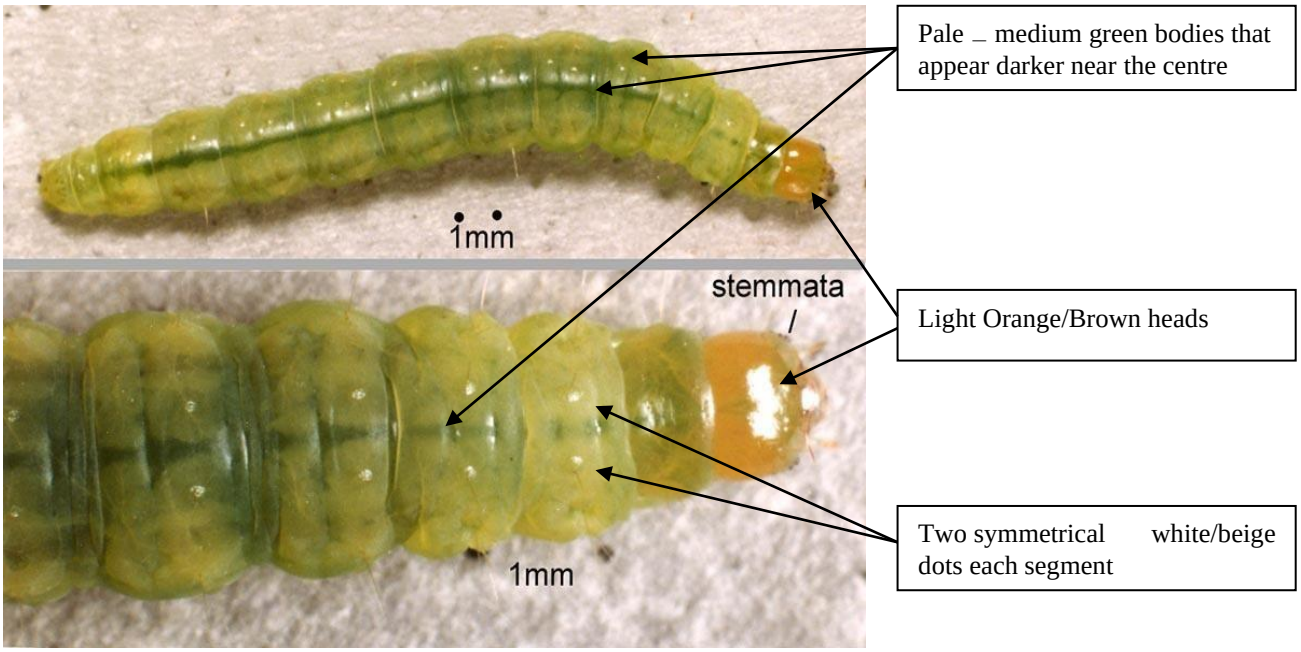
Several chemicals and biological control agents are available to give control including chlorpyrifos, Lannate®, methoxyfenozide, *Bacillus thuringiensis* (Bt) and Success™. There are several generations per year. Rabbiteye types often harbour overwintering populations on leaves that don't drop, and particular attention should be paid to these types, with extra controls over winter if necessary.

Leafrollers have four developmental stages—egg, larva (or caterpillar), pupa, and adult (or moth). Adults lay eggs in mass on smooth surfaces. They eventually hatch out and are called larvae or caterpillars. Larvae of these leafrollers form protective shelters made of web and the leaf they are feeding upon. As the leafrollers mature, they'll reach a stage where they pupate within the rolled leaf. After a period of around 1 – 3 weeks (various on species), they will emerge from the protective shelter as flying adults/moths.

There are a number of leafroller species and their lifecycles can vary dramatically between them. Usually females will lay between 10 – 500 eggs which can take between 5 – 30 days depending on temperature and species. They will moult as larvae between 4 – 6 times until reaching the final larval size. The time it takes larvae to reach full size from first emergence from the egg varies between species. The number of generations of leafroller varies between species but most will have at least 2 – 3 generations within a year, meaning it is possible to find all life stages on blueberries during any period of year.

How to Identify:

Light Brown Apple Moth Larvae (*Epiphyas postvittana*)



BLUEBERRY CANE BORERS:

Lemon Tree borer (Oemona hirta), Striped Longhorn (Coptomma sticticum)

Striped longhorn was first found in blueberries in 2004 and is very similar to the above picture of lemon tree borer also found in blueberries. Both insects have a wide host range, attacking many woody plants. The larvae tunnel into branches and can be the cause of die-back. They feed upon the pith of the branches which is used as a store of nutrients for the blueberries. Pith removal, therefore results in less desirable growth in plants and may reduce the number of buds/flowers.

Lemon Tree Borer

Lemon tree borers lay small whitish eggs in any dark grooves upon the blueberry surface including damaged areas. The preference is usually on smaller twigs, but eggs have been found on larger branches and main stems. After emerging from the egg, borer larvae will search for a section of wood that is about 10 to 20mmin diameter, where it will burrow in.

Over time, the larvae will widen its excavated hole to remove frass and dust that might otherwise block the tunnel entrance. This process aerates the internal tunnels and stops them becoming overgrown with fungal pathogens which would otherwise be prevalent in the moist conditions required by the larva. The larvae can also sometimes survive in dead wood providing it is damp enough, therefore it is important to remove and discard/burn any dead branches or plants. The larvae will remain within the host plant for several months (occasionally it can spend up to a year or more), eventually reaching around 35mm long. They then pupate which can take anywhere between 2 – 4 weeks, turn into an adult beetle, crawl out and fly away to find a mate.

The adults are typically nocturnal, making them difficult to find during the day but can be easily attracted at night with a flashlight as they are attracted to light. The adults are most prominent around December to March. It mainly flies in the evening or early morning, in spring and summer. The female beetle lays individual eggs on the stems of host plants, in vulnerable places, such as fresh pruning scars, damaged areas, cracks in the bark or where leaves attach to the stem.

Striped Longhorn

Adult longhorn beetles are dominantly active from early summer to mid-fall. They feed upon the bark of twigs periodically throughout the mating and egg-laying period. They are most active on warm days between mid-morning and early afternoon. During cloudy, cooler days they can be found resting in the foliage.

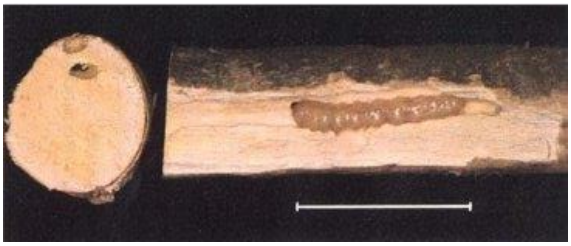
Female beetles will chew small grooves in the bark where they will lay a single egg about 5-7 mm in length. Sap stains can often be found as a result of this damage. On average, a female adult will live approximately 40 days and during that period can lay between 25-40 eggs. These eggs will hatch in one to two weeks.

Young larvae begin feeding in the phloem tissue where they gain most of their sustenance. As they mature, they migrate into the wood creating internal tunnels as they feed. These tunnels cause stress on the plant and dieback. In high enough densities, this can lead to plant death.

Cultural control is the most important, as this pest rarely causes major damage. Branches showing dieback should be pruned out below the tunnel chamber or base and any wood removed containing this pest should be burnt.

How to Identify:

Lemon Tree Borer grubs (*Oemona hirta*)



Grubs have black /dark brown head capsules and pale beige bodies. Typically if a grub is found in blueberries it will be either the Lemon Tree Borer or Striped Longhorn

OECOPHORIDAE

A Lepidopteran species has been found to be tunnelling into the stems and buds of blueberries. This is suspected as being one of the native insects in this family, of which there are over 200 species, that normally feeds on native *Ericaceous* plants. Full identification has not yet been possible.

At this stage it is not known whether this insect could be classified as a pest of sufficient significance of blueberries to require control. This pest does most of the damage by feeding on the pith within the stem, although it can damage buds as well. Control of insects that feed within plant tissues can be very difficult. Control measures are usually based around trying to control the early stage of the insect before it enters the stem.

SOIL PESTS:

Grass Grub (Costelytra zealandica)

This insect can cause major problems where numbers are high. Large numbers of larvae (more than 10 per spade full) will affect root mass and can cause growth restriction and in severe cases, death of bushes. Once they emerge from the soil, adults are known to feed upon new growth in blueberries.

Eggs are creamy white, about 1.5mm in diameter. Larvae are characteristically crescent-shaped with an amber coloured head. The rear end is discoloured if the insect is still actively feeding. Larvae grow up to 20mm long. The insect pupates in the soil and later a shiny brown beetle about 10mm in length emerges. The beetle emerges in October to November and flies at dusk when temperatures are over 10°C. The adults have also been observed feeding upon new growth and developing fruit, thereby making it unmarketable (similar to bronze beetle). Mating occurs shortly after emergence and eggs are usually laid close to the point of emergence, so infestations often remain localised. Grubs hatch after 16-21 days and then proceed through three instar stages. The first lasts for 3 months from November to January. The second instar stage lasts 5-10 weeks and is the best time for chemical control measures, as the insect moves close to the surface. The third instar lasts until June. In late winter grubs stop feeding and enter the pupal stage that lasts 4-6 weeks.

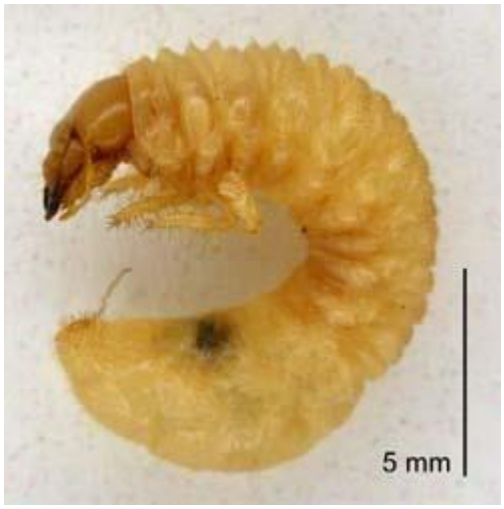
Targeted chemical control in areas of infection using chlorpyrifos products, some formulated as slow release, are effective. Biological control agents have been developed especially for pasture situations based on the bacterium *Serratia*, but these need to be incorporated into the root area to be effective and this can be difficult in blueberries.

Adults are typically found above the soil between October and December. They lay their eggs in the soil from mid-November and these will hatch late December to Early January. The resulting larvae feed upon root masses in the soil until they pupate. Pupation occurs between Late September to Mid November. Most root damage occurs during the larval stage especially around March, April and May.

How to Identify:

Grass Grubs

Diagram courtesy of Agriseeds

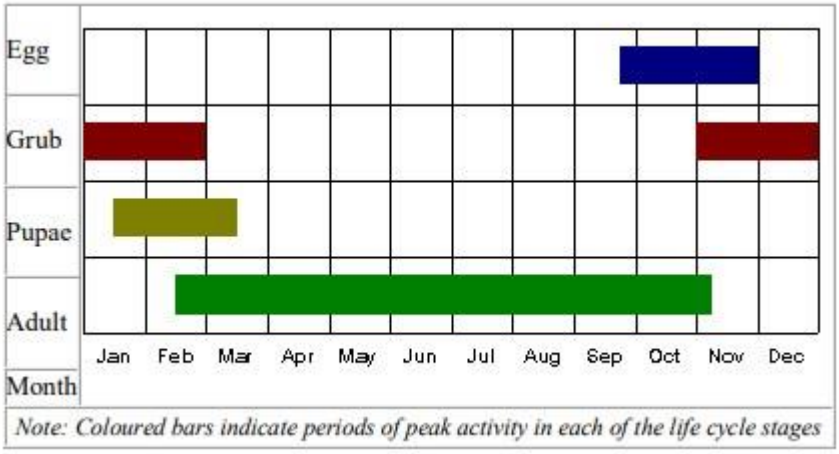


African Black Beetle – (Heteronychus arator)

The African black beetle shares a number of similarities with grass grubs. Their larvae look very similar (black beetle larvae is slightly larger at 25 – 30 mm long) and cause the same type of damage to blueberry roots. As adults, they're fairly distinguishable with the black beetle having a shiny black surface and are around 12 to 15 millimeters long while the grass grub has a brown surface and is 10 millimetres or smaller.

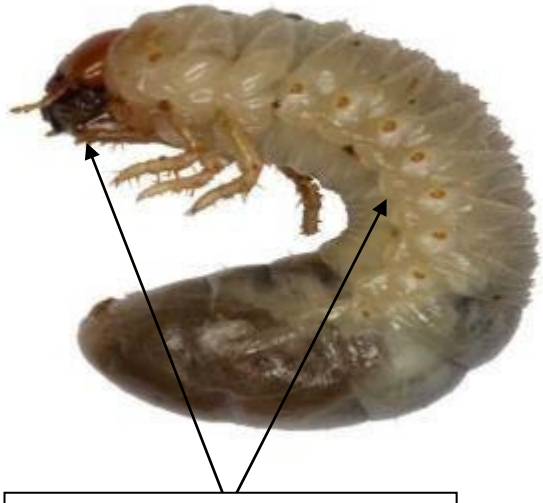
They are most prevalent in summer and early autumn where drier climates during spring and summers favour population build-ups. Most damage is caused by larvae feeding on root mass and underground stems of young plants while adults often kill growing points leading to central shoots withering and dying. Chemical control works best against the larval stage to prevent the larvae feeding on young plants; chemicals should be applied at planting and before root flushes each year. Few chemicals are active in the soil as most are quickly broken down by soil bacteria. The two older organo-phosphates presently listed are under threat and no chemical alternatives have yet been identified. Work is progressing on biological control alternatives.
Black beetle have one generation per year, yet it is possible to find all life stages of the black beetle out of phase with the main generation. In some areas one fifth of the population will overwinter as late stage larvae or pupae. Adults which develop from these stage lay their eggs in January and February, therefore it's possible to find all stages of black beetle in the soil at the same time.

Adult females can lay around 7-10 eggs in the soil from late September to late December. Larvae grow have three instars over the summer and pupate in February-March. New adults begin to emerge from late February and feed actively for the next few months. Following a summer drought, massed flights can occur in autumn. Adults overwinter in the soil, emerging in spring to start feeding again and to lay eggs.



Note: Coloured bars indicate periods of peak activity in each of the life cycle stages

Identification:



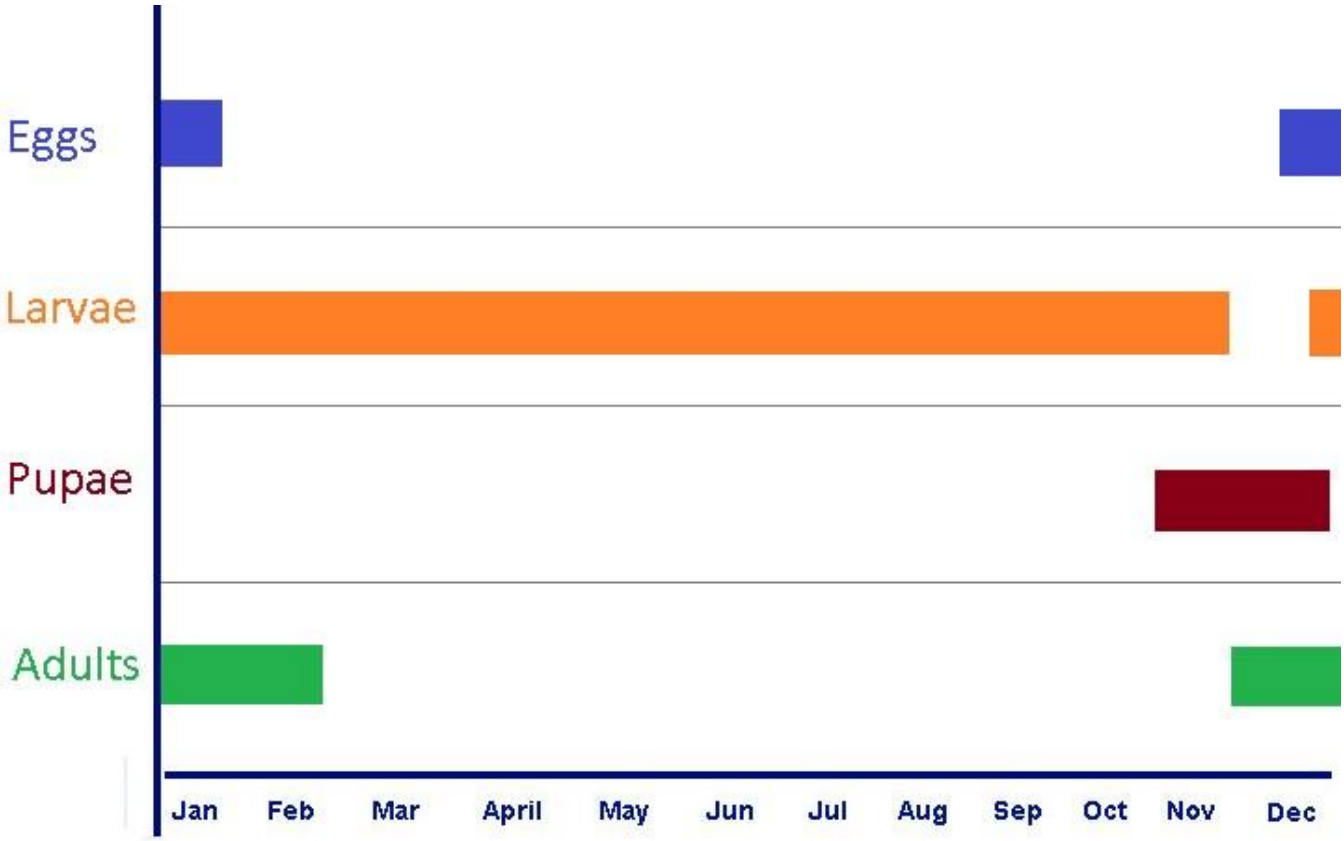
Biege Body with brown head capsule

Thick black elytra

Black Vine Weevil – (Otiorhynchus sulcatus)

The black vine weevil can be a major issue for a number of commercial crops. As larvae, they feed upon the roots of a number of plants, and as adults they strip the foliage. The larvae are legless, small (around 7mm) and cream/white coloured and are only found in the soil. Adults are typically a dull black, around 1cm long and only come out of the soil at night to feed upon leaves.

There have been a number of innovative methods developed overseas for controlling black vine weevil. These include placing sticky traps around the base of plant trunks which will catch the weevil as they try to move up the plant in the evenings. Overseas options also include a parasitic nematode found in the soil and a fungal pathogen which has proven to be deadly to the weevil (unfortunately none of these two options are currently available for NZ growers).
The black vine weevil has a single generation per year, but can have up to two in greenhouse conditions. They overwinter as larvae and resume feeding in the spring, which is when the heaviest damage to crops can occur. In late November and early December the larvae pupate for about 10 days. The adults will emerge December/January and begin to lay eggs after feeding for 2-3 weeks. Eggs are laid every day on the ground where they will remain in leaf litter or at the base of plants. Newly hatched larvae will then feed until it is time to overwinter. A few adults may also overwinter and emerge in early spring.



Timeframe of black vine weevil stages

Current chemical options are:

- Chlorpyrifos

- Diazinon

Cream coloured body with brown head capsule
Note: No legs present

Mottled dull black and yellowish spots upon its elytra
Long antennae

Springtails

Springtails are an anomaly in the scientific community. A number of experts believe springtails are pests of plants in that they feed upon root mass and can damage and stunt crops through excessive feeding. However other experts believe springtails are harmless detritivores that do not negatively impact plants in any way (in fact, they recycle nutrients through their droppings allowing plants to uptake these essential nutrients). With the research divided on springtails, it is difficult whether to consider them friend, foe or neutral.

Despite this ambiguity, if springtails are found in great quantities around the root systems of plants, it may pay to regularly monitor the health of the blueberry plants over the course of the season and report any interesting findings. They can be found as a variety of forms, but are typically very small (around 1mm) and are often found in big congregations of hundreds, if not thousands of individuals.

No control is recommended for springtails at this point.

BEETLES:

Bronze beetle (Euclaspis brunnea)




This is a native pest that causes considerable damage to blueberries in spring and early summer attacking fruit, stems and foliage. The pest undergoes four life stages: egg, larvae, pupae, and adult. Damaged caused to blueberries by this pest is done by the adult life stage, although minor root damage has been known to be caused by the larvae. They have a characteristic habit of jumping with a snap if disturbed. The eggs are deposited in the ground between the rows and in headlands in an earthen capsule and these hatch 2-3 weeks after being laid. The tiny white larvae live on grass roots but do no appreciable damage. They transform to the pupal stage, which lasts 3-4 weeks before emerging as adults in spring and early summer.

Control of the adult stage doing the damage is extremely difficult, as pesticide restrictions limit the ability to use the type of materials likely to be active against this pest and to give a sufficiently quick knockdown to limit the damage. The most recent suggestions for control are to target the grass areas between rows and the headlands with materials such as chlorpyrifos during the early larval stages in March and April. Biological control options using endophytes associated with specific grass species are a possibility to be trialled.

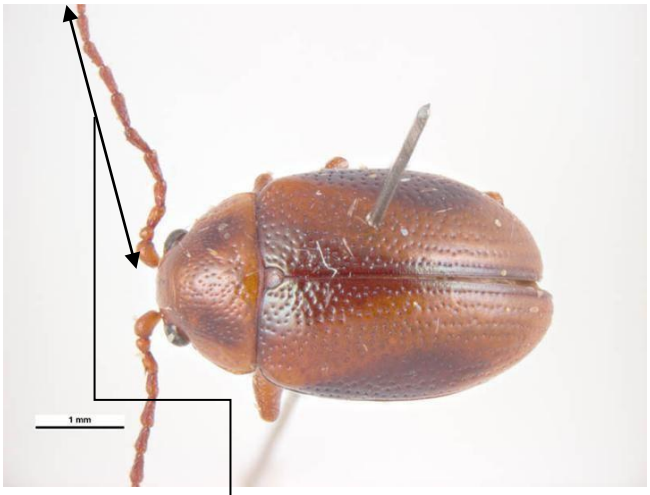
Cultivation during the egg-laying period has been effective in other crops in the past, but this is unlikely to be a practical proposition for most blueberry growers.

Adult brown/bronze beetles emerge from their pupae in October, November and December when. In later weeks after pupation, they congregate in huge numbers and they feed on fruit trees and shrubs which can become severely defoliated.

Eggs are laid in the soil during summer months and will normally hatch after about 2 weeks. The small larvae then feed on the roots of grasses until spring, growing to around 20-25 mm long.

During late autumn and winter the larvae do not feed in the top 5cm of soil, instead they are usually found about 15 cm below the surface. The most effective treatment is targeting these larvae around February to March.

How to Identify: Bronze Beetle



Antennae is as long as the body of the beetle

Darkened edges of elytra

APHIDS:

Melon aphid (Aphis gossypii)

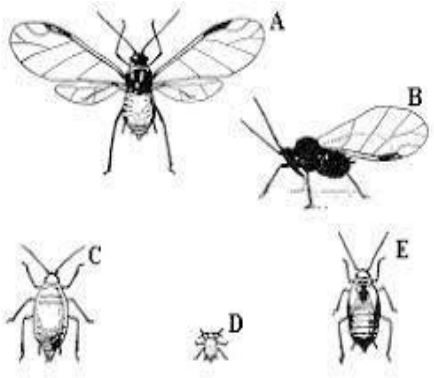
This aphid is common in New Zealand mostly on cucurbit crops, but is occasionally seen on a wider host range. Large numbers can build up rapidly, but blueberries are not a preferred host of this or in fact any other aphid species in New Zealand. Two forms of the aphid are commonly seen, with wingless females being yellow to green and 1.5-1.9mm long. Winged females are mostly black. This aphid can be a minor problem in greenhouse situations.

Aphid control can often be achieved biologically by maintaining lacewings and ladybird populations. Feeding damage is rarely serious enough to justify chemical control. If this situation arises, control can be achieved with a number of chemicals such as Applaud®, chlorpyrifos, Movento, and Lannate™, but these chemicals should not be applied when flowers are present (due to impact on bee populations).Observe the withholding period according to the intended market/s.

Female nymphs hatch from eggs in the spring on a number of different host plants. They may feed, mature, and reproduce parthenogenetically (reproduce without mating with a male) on a host plant all summer, or they may produce winged females that disperse to secondary hosts and form new colonies.

The dispersants typically select new growth to feed upon, and may produce both winged and wingless female offspring. Under high density conditions, deterioration of the host plant, or upon arrival of autumn, production of winged forms dominates. During periods stressful to the host plant, small yellow or white forms of the aphid are also produced.

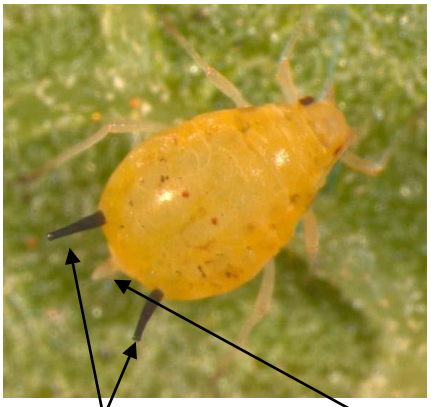
Late in the season, winged females will seek out primary hosts, and eventually both males and egglaying females are produced. They mate and females deposit yellow eggs: eggs are the only overwintering form under cold conditions. Under warm conditions, a generation can be completed parthenogenetically in about seven days.



A – B: Winged Adults; C: Wingless Adult; D – E: Nymphs

How to identify: Melon Aphid

Wide variety of colourations from pale yellow to dark green/black



Siphunculi typically dark

Cauda typically pale

SCALE INSECTS:

Chinese Wax Scale (Ceroplastes sinsensis)

These are large unarmoured scales with a thick covering of wax. Along with the crawler stage (the white star-shaped insects in the above photograph), they suck sap from the plant and excrete large quantities of honeydew from their bodies. Sooty mould (a black fungus) grows on the honeydew and can cover the branches and foliage of heavily infested plants. Mature females are up to 7mm long, 5mm wide and 4mm high. Normally there is a single generation each year. Eggs are laid under the female in January and February and most eggs hatch by early March. Young stages are found on foliage and shoots. Development continues during winter and spring with the adults maturing on woody parts by December.

Where scale are present in small numbers, they can be squashed. Wax scale can be well controlled by natural enemies if their activity is not disrupted by the use of broad-spectrum insecticides. The endemic waxeye bird is a natural predator of scale insects. Encouraging these and other insect eaters during late autumn and winter may be an option, but waxeyes are also fruit eaters as well, so this could lead to other problems.

Chemical control options include:

- Movento: Effective against most sucking insects including scales. Best used when juveniles have hatched from eggs (around November – December). Withholding period -
- Applaud® (buprofenzin): May be useful postharvest when scale crawlers are still small. Not registered for blueberries. Test a small area first and check for phytotoxicity.
- Chlorpyrifos (various brands): Normally very effective against crawler stage in particular. Commonly used in combination with mineral oils. Use restricted to pre-flowering or postharvest because of persistent residues. Not registered for use on blueberries but has been used by several growers without problems.

- Lannate
- Oils (mineral and fish): Used at various strengths according to the season. Effective on adults. Works by smothering the insect. Not registered for use on blueberries.
- Lime sulphur: Used at 7 litres/ha before bud break. May burn foliage if applied directly. Not registered for use on blueberries. Effective on adults.
- Calypso® (thiacloprid): May be useful postharvest when scale crawlers are still small. Not registered for use on blueberries. Test a small area first and check for phytotoxicity.

There is only one generation of Chinese wax scale per year in New Zealand. They overwinter as immature and adult females. The new generation is produced through summer months and the young tend to settle on the leaves before moving to the stems. Males are found as immatures but apparently do not develop to adult, and are not necessary for reproduction.

How to Identify: Chinese Wax scale

Young instars take on a star shape with white 'prongs'

Adults look like miniature turtle shells with small protrusions on the top and sides

Black or Olive scale (Sassetia oleae)

This scale is primarily a pest of citrus and passionfruit vines and is widespread in all citrus growing areas in New Zealand. They are also found on many ornamental shrubs, especially oleanders. Mature females as shown in the photo are 3-5mm long, brown or black and have a tough outer skin. These are not especially common on blueberries. All stages are found in winter. Large numbers of eggs are produced under the female scale in November/December, with the main hatch occurring in December and January. After feeding for 4-6 weeks, the young crawler stage migrates to woody parts of the plant.

Black scale has either one or two generations per year depending on climate. Although black scale males are known to occur, they are very rare and reproduction is mainly parthenogenic, meaning the female black scale adult doesn't have to mate with a male to produce offspring. Mature females may produce more than 2,000 eggs each, and the egg color changes from pale yellow to orange as the eggs mature. Eggs are laid directly under the adult female body, and the subsequent egg hatch may take 2 - 3 weeks to complete.

First-instar nymphs (called "crawlers" until they settle and start to feed) are pale yellow to light brown and very small, making them difficult to detect without a hand lens. After hatching from eggs, crawlers may spend up to seven days searching for a feeding site, typically on foliage. Black scales go through two more immature stages, or instars, before becoming adults. There is very little nymph development during the summer, as summer heat hampers its development and survival.

The final instar nymphs tend to migrate from leaves to twigs, where they will typically overwinter. In spring, the late third instar begins to enlarge. By November most black scales have progressed to the adult stages. This is the period of rapid growth and when the most honeydew is produced. The adult female's coloration changes from dark brown to black as she matures.

Controls are the same as for other scale insects, but should be timed to coincide with the main hatch period when oil sprays may be effective, i.e. at crawler movement: October/November

How to Identify: Black or Olive scale

Black/Olive Scales get darker and larger at later instars

Have a similar appearance to rock limpets at the beach. Tallest point is the centre of the scale

Cottony cushion scale: Icerya purchasi

This scale is uncommon on blueberries, but often seen on hydrangeas. This pest is of Australian origin and infests a wide range of host plants. The large fluted cottony mass is characteristic only of the mature female. The corrugated sac serves as protection for eggs, which may number 500-800. Young nymphs are reddish-brown with black legs and settle on twigs or along mid-ribs and veins of leaves. Later instars migrate to larger twigs and branches and are rarely found on fruit.

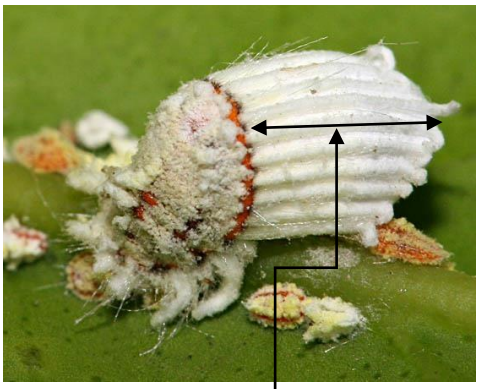
Cottony cushion crawlers emerge from the white sac of an adult female scale. The crawler settles on a leaf or twig and moults twice for a total of 3 nymphal instars. The third instar moves to thicker twigs and moults into an adult female. The minute red-winged male is rarely seen, and females don't need to mate to reproduce young. The entire lifespan takes about 12 weeks to complete.

Eggs hatch into crawlers in a few days during warm weather but take up to two months to hatch in winter. The crawlers are red with black legs and antennae. They settle along leaf veins and begin to produce the white cottony secretion they are known for. Immature scales look reddish for a short period of time before they begin producing more cottony secretions.

Cottony cushion scale has two to three generations a year. Unlike most other scales, it retains its legs and its mobility throughout its life. Cottony cushion scale completes its life cycle in three months during warm weather conditions.

This pest is usually controlled adequately by two natural enemies *Rodolia cardinalis* and a small parasitic fly *Cryptochetum iceryae*. If chemical control is required, treat as for other scale insects.

How to Identify: Cottony cushion scale



White cotton-like secretions at base of scale

Orange periphery of scale. Individuals range from beige to black

Latania Scale (Hemiberlesia lataniae)

The latania scale established in the North Island of New Zealand (and is now also in the South Island) in the 1980's and has been known to be a pest of many different host species, especially agricultural crops. It is an armoured scale where the pest secretes a waxy shell (its epicenter appearing dark or yellow). These scales feed on the leaves, bark, and fruit of blueberry. Fruit with this scale are usually unmarketable.

Temperature, humidity, and rainfall are important factors that influence the length of time each lifestage of the latania scale. The scale can complete its lifecycle (from egg to adult) within 30 days. Eggs are laid under the armoured carapace of the female where they develop and hatch.

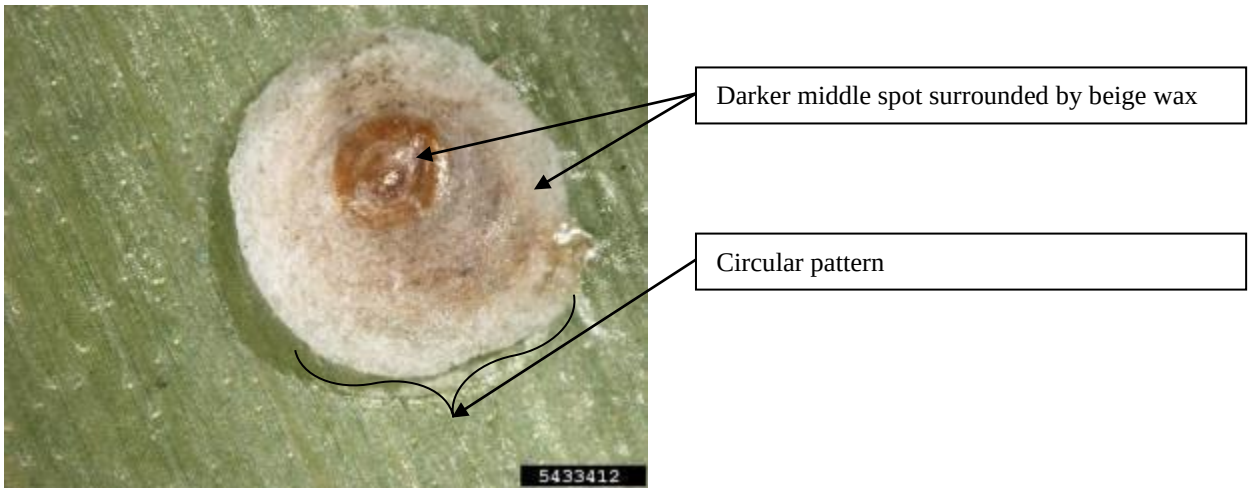
The nymphs that hatch out of the eggs are called crawlers. They are the only lifestage that have legs and are motile. Crawlers may stay under the maternal armour for several hours until outside conditions, especially temperature and humidity, are favourable. After a period of wandering, they flatten against a leaf or stem and begin to secrete their armour.

Newly settled nymphs insert their piercing-sucking mouthparts into plant tissue and start feeding on plant juices. Female nymphs shed their skin twice as they grow and develop. Males have 5 stages of development (crawler, nymph, pre-pupa, pupa, and adult) and do not get any larger during the last three stages.

Female latania scales appear larvae-like. They remain under armour in one place throughout their lives to feed and reproduce. Males appear very different, they are tiny, winged creatures with eyes and legs. Mature males emerge from the armour in the late afternoon. They do not feed, and they live for only a few hours to mate. Latania scale has both bisexual and parthenogenetic races. Parthenogenic races can reproduce without males.

The predatory mite *Hemisarcoptes coccophagus* is a possible biological control option in New Zealand and has shown to reduce the pest's populations to manageable levels. If chemical control is required, treat as for other scale insects.

How to Identify: Latania Scale



Greedy Scale (Hemiberlesia rapax)





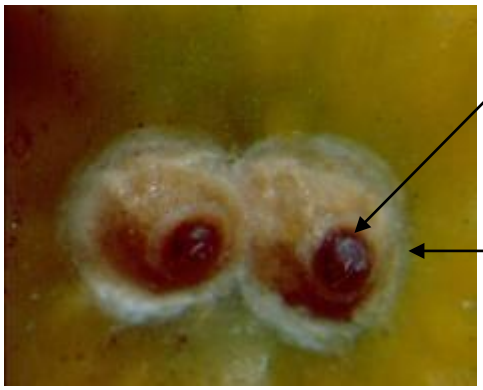
The scale (the yellow lumps) attaches to blueberry shoots, leaves and fruit by their mouthparts then produces a hard, grey-brown covering. Juvenile scales are mobile and crawl over the shoots and fruit, although some may attach themselves to the plant near their mother. There are two periods of juvenile crawler activity which occur from November to January and from March to May. Greedy Scale typically has two or more overlapping generations outdoors, but may have continuous generations in glasshouses with all stages present.

Scales hatch from an egg and typically develop through two growth stages before maturing into an adult. At maturity, adult females produce eggs that are usually hidden under their bodies, although some species secrete their eggs externally under prominent cottony or waxy covers. Eggs hatch into tiny crawlers which are mobile. Crawlers walk over the plant surface, are moved to other plants by wind, or are inadvertently transported by people or birds. Crawlers settle down and begin feeding within a day or two after emergence.

Settled nymphs spend their entire life in the same spot without moving as they mature into adults. The number of days for each developmental stage and the number of generations per year depend on temperature, humidity, and rainfall. 30 days is the approximate time to complete the life cycle from egg to reproducing adult.

It causes leaf yellowing, premature leaf drop, and dieback. Because of this it can cause problems in the exporting process. If chemical control is required, treat as for other scale insects.

How to Identify: Greedy Scale



MEALYBUGS:

Long tailed mealybug (Pseudococcus longispinus)

This is a relatively rare pest of blueberries. Mealybugs overwinter in crevices beneath loose bark, emerging in spring. Generation time is about 8 weeks in mid-season and it may have three generations per year. The insect sucks sap and excretes honey dew on which sooty mould can grow. Heavy infestations can cause stunting of growth. It can cause quarantine issues by hiding in the calyx end of fruit, so early season control is important.

A parasite has recently been introduced to control a different species of mealybug in apples. Parasitic control may be an option in the longer term. Where mealy bugs are present in small numbers, they can be squashed.

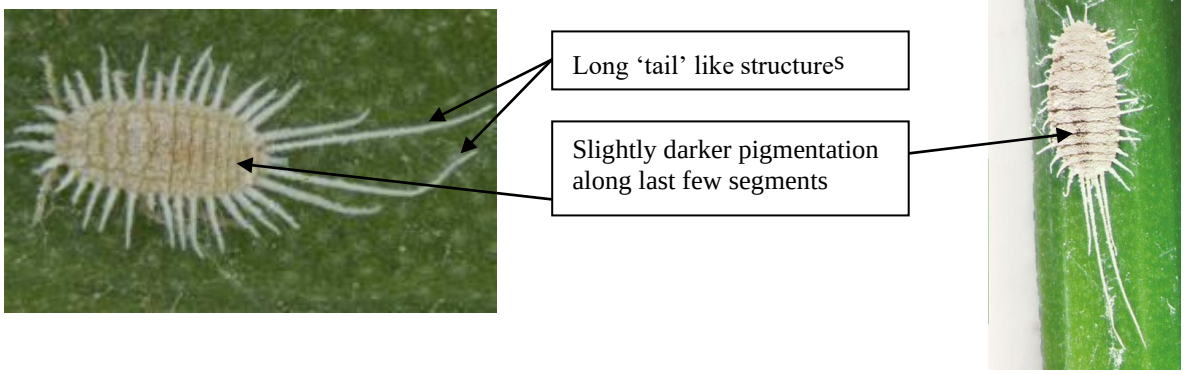
There is no visible egg stage of the longtailed mealybug. Nymphs hatch immediately upon oviposition. The female longtailed mealybug nymphs undergo three growth stages before reaching adulthood, whereas males undergo four. By the second instar, the nymphs have the white, waxy coating characteristic of mealybugs. Female nymphs increase greatly in size between the second and third instars, and the long 'tails' have developed. The males feed only during the first and second instars; the third instar is sometimes called the pre-pupal stage and lacks mouthparts. Female nymphs feed throughout all instars.

Female longtailed mealybug adults resemble third instars, except they are less flattened in appearance due to the development of their reproductive organs. Males of this species are more slender, darker in colour, and as adults are winged.

The female produces around 200 live young over a 2–3 week period. During summer the life cycle is completed in around 6 weeks (about 12 weeks in winter).

Chemical control options include chlorpyriphos, and Applaud®before flowering. Movento and Lannate® should be effective later in the season.

How to Identify: Long tailed mealybug



CICADA:

Unidentified but likely to be *Amphipsalta sp*.

Cicada egg batch in blueberry wood

Cicada nymph

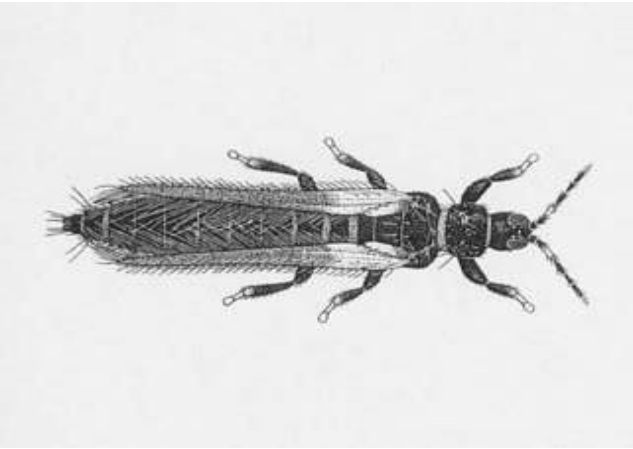
Cicadas have been a major issue for some growers in recent years. There are about 40 species of cicada native to New Zealand. The lifecycles have not been determined but it is known that the

wingless nymphs of the most common species live for several years underground, sucking roots. The adults will suck sap and females lay eggs in wood, which weakens branches.

The eggs and larval stages are the best life stages to target. Successful chemical options include using Engulf and Talstar EC to kill the eggs in the wood and/or soil before they hatch out. Eggs hatch out six weeks or so after laying so there is only a small window of opportunity to target them. Sprays should be applied in June. Note: This method of control is not ideal for later varieties. Further research suggests systemic bacteria may prove to be a suitable control method in the future.

THRIPS (THYSANOPTERA)

Thrips species feeding on blueberries have not been identified but are likely to be NZ Flower Thrips (Thrips obscuratus) or Onion Thrips (Thrips tabaci)



NZ Flower Thrips

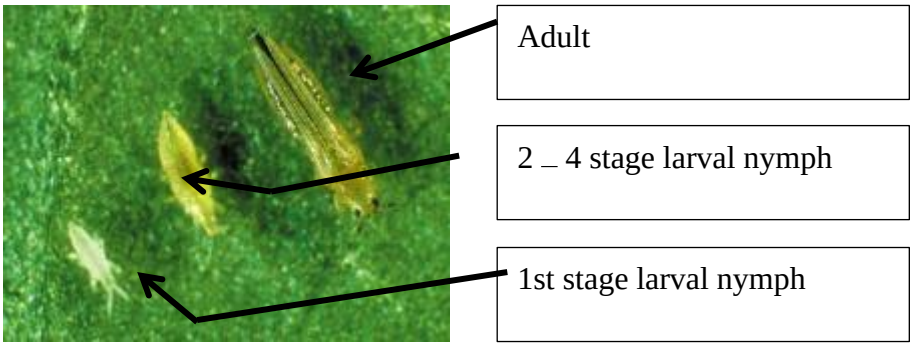
Onion Thrips

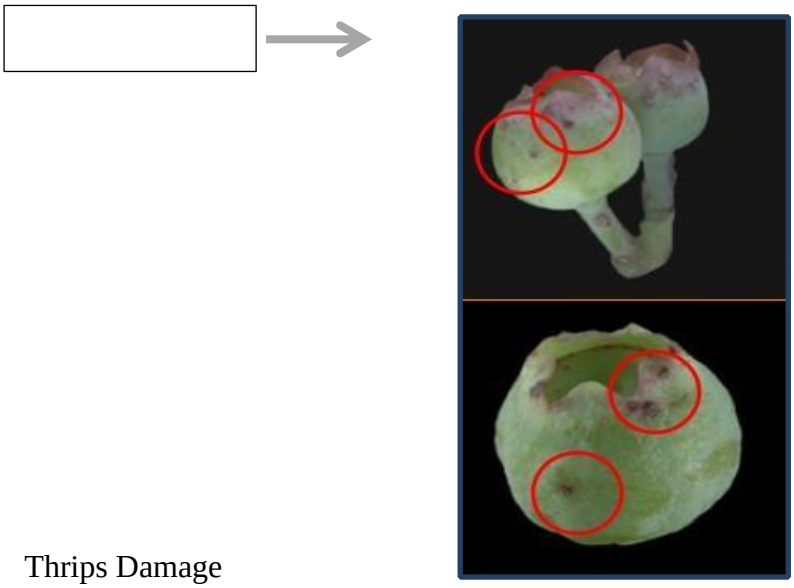
Thrips species can be major pests for a variety of crops. They have been found on blueberry leaves but the exact species has yet to be identified. All thrips damage the foliage of their host plants in the same way. Using their specialised mouthparts, they rasp the surface of the leaves which results in discolouration and unhealthy foliage. They also lay their eggs in the plant walls which hatch and can further damage the leaves creating access inside the plant for fungal pathogens. They can also be seen on new flowers, feeding on the petals and especially pollen and flower structures. At high infestations, the thrips can reduce effective pollination (and therefore fruit set) by significantly damaging the flowers present.

Details of the life cycle vary with host plant, locality, and time of year. Males and females occur throughout the year in the northern part of the North Island, but in regions with colder winters only females over-winter.

On warm, calm days females feed on nectar, petals, and probably pollen. Eggs are laid singly into the flower stalks, with a small portion of the egg remaining visible at the surface; old egg sites are surrounded by a ring of necrotic plant tissue. After hatching, the larvae move to the bracts at the base of the stalks to complete larval development. On apricots and nectarines the eggs are deposited under the epidermis of the calyx, but the larvae migrate to the inside of the flower. On roses the eggs are laid at the base of petals. The larvae feed deep within the bracts, around the unopened flowers and in the opened flowers. The pre-pupae drop to the ground, where they complete the pupal stage. A number of factors can impact the exact timing of each stage including host, climate, region etc.

In most cases, thrips can be controlled using the chemical ‘Success’ (active ingredient: spinosad). They can also be controlled with broad spectrum controls such as pyrethrums or oils. Biological controls are also available. Bioforce provides the following options: Orius, Hyper-mite and Mite-A, all of which attack different life stages of thrips.





Thrips Damage

SYMPHYLA

Symphyla are a broad group of invertebrates closely related to centipedes and millipedes. Many of their species are known to be occasional pests in the garden, where they live exclusively in the soil and can feed on fine plant roots. They inhabit all types of soils, especially very acidic soils, making areas

with blueberries ideal. A method for monitoring the presence of symphyla is placing a cut carrot or potato on the ground and covering it with a plastic pot. Check 1 – 2 days later for any specimens. Another suggestion is if 2 – 5 symphylans are found with each shovelful of dirt, then pretreatment might need to be considered.

Pyrethroids and other natural pesticides do not provide acceptable control. Pesticides generally provide the greatest amount of control when they are broadcast and incorporated, though banded and injected applications can provide an acceptable level of control. Unlike other soil organisms, they lack the ability to burrow through soil. Instead, they must take advantage of pores, seasonal soil cracks, crevices left by decayed roots, and burrows of other soil-inhabiting animals such as earthworms to move through the soil profile. Thus, practices improving soil health and structure (i.e. addition of organic matter, reduced tillage and use of raised beds) foster increased symphylan populations/damage as these facilitate their movement through soil to underground plant parts.

BAG MOTH: LIOTHULA SP.

There are several species of native bag moths that may occur from time to time on blueberries. None is of pest significance. Caterpillars of this insect live all their lives inside the bag and can travel remarkable distances. Moths are rarely seen, as they are short-lived and never feed.

No control is usually necessary.

MITES

Mites are small arthropods belonging to the class Arachnida and the subclass Acari. It is estimated that there are approximately 30,000 presently identified species in this group and as many as 1 million species

in total. No mites have been identified as causing plant damage issues in New Zealand blueberries. However, typical of minimally sprayed crops, there is a wide diversity of species that can cause biosecurity issues and this list can include several mite species.

White fungal mites

These small mites (barely visible with the naked eye) are detritus feeders and have been frequently identified on blueberry plants and fruit and have caused associated problems in export crops. These are often referred to as white mites although their colour can vary considerably depending on what they are feeding on. They feed on fungal spores and mycelium and are generally considered desirable. Treatment may be required when they cause problems in export shipments. They are generally susceptible to broad spectrum miticides such as abamectin.

Predatory Mite – Amblydromalus limonicus

A. limonicus is a relatively new predatory mite available through biological companies such as Bioforce and Zonda. This mite is a voracious predator capable of attacking a vast range of small prey species. Research has shown it is capable of significantly reducing a variety of thrips species' populations by

attacking the 1st and 2nd larval life stages. As a generalist predator it will attack most species that are smaller than it including other limonicus individuals if food becomes scarce.

Like with other predatory mites, limonicus have shown a vulnerability to some fungicides and entire populations can be decimated through the use of broad spectrum insecticides and miticides. To ensure healthy populations of limonicus in the blueberry crop, it is best to only use certain pesticides on higher-risk blocks.

Recent articles have suggested limonicus require higher humidity (around 70 - 80% or higher) and temperature (between 10 - 18°C) to flourish. This suggests limonicus might not survive at high population levels over winter. Application should be around August – October depending on variety.

Predatory Mite – Mite A (Neoseiulus cucumeris)

Mite A is a commercial product available from Bioforce. It is well known in its ability to control most thrips species found in New Zealand by attacking their 1st larval stage. It is best used in a preventative manner as opposed to a curative manner meaning it should be applied to the crop prior to rapid increases in thrips populations through the season.

Like with other predatory mites, Mite A have shown a vulnerability to some fungicides and entire populations can be decimated through the use of broad spectrum insecticides and miticides. To ensure healthy populations of Mite A in the blueberry crop, it is best to only use certain pesticides on higherrisk blocks.

Similar to limonicus, Mite A operates most efficiently in humidity levels between 70 – 80% and in temperatures between 10 - 18°C. They are known to die off over time and will need to be reapplied every season, especially after the application of various pesticides. Application should be around September – October depending on variety.

PREDATORS

Praying Mantis: Orthodera novaezealandiae

Praying mantis adult

Egg case

As pesticide use in blueberries drops, predatory insects like praying mantids begin to be seen. While mantids are not particular in what insects they consume, their presence indicates a desirable biological balance. Praying Mantids are not pests and are actually desired predators in crops as they control a broad range of prey (including many pests) depending on their life stage and what is available.

There are two species of Praying Mantises in New Zealand: The South African Praying Mantis (*Miomantis caffra*) and The NZ Praying Mantis (*Orthodera novaezealandiae*). The South African praying mantis was accidentally introduced to NZ and is slowly displacing the native species.

Lacewings

There are a number of lacewing species found in New Zealand, a vast majority belonging to the Hemerobiidae family, which are commonly called brown lacewings. Most of the species in this family are predatory often attacking smaller bugs than themselves. Their main benefit is that they are predacious as larvae as well as adults providing control of some pests throughout their lifecycle.

They are not currently available as a biological control from any commercial company but they will appear now and then in blueberry crops in search for some pest species. No information is currently available as to the effects of various pesticides on lacewing populations but it likely any broad spectrum insecticides or oils will have largely detrimental impacts.

POLLINATORS

Bumblebees

Bumblebees are by far the most efficient pollinators of blueberry due to their 'buzzing' technique which loosens pollen from the anthers which attach to the large hairs covering the bumblebees' bodies. These pollen grains are then transferred to the stigma of another flower.

There are four species of bumblebees found in New Zealand, *Bombus subterraneus*, *Bombus hortorum*, *Bombus ruderatus,* and *Bombus terrestris.* *B. subterraneus* is only found in lower Canterbury and around Dunedin. *B. hortorum* has a broader range around most of Canterbury and Dunedin and has been found in the Bay of Plenty. *B. ruderatus,* and *B. terrestris* can be found around all of New Zealand.

Some species of bumblebees have shorter 'tongues' and can have difficulties reaching deep enough into the flowers to extract the pollen and nectar. Due to this, there have been observations of some bumblebees chewing into the sides of the flowers to 'rob' the nectar. This results in little to no pollination for the damaged flower.

The most efficient bumblebee pollinator is the *B. terrestris* species. Due to their abundance, New Zealand wide distribution and their presence all year round, they will be the most common bumblebee to visit blueberry flowers.

Honey Bees (Apis mellifera)

Honey bees are the most commonly used pollinator in a wide range of crops. They are known to frequent blueberry flowers and facilitate pollination. While not as efficient as bumblebees, they make up for this in larger numbers especially when commercial hives are placed on field margins.

Various beekeepers can be approached to hire out their hives which can be placed near blueberry crops to facilitate pollination. Bee hives can reach populations in the thousands which can adequately supplement any pollination needs a grower may require.

Yet bees are often susceptible to various chemical applications and growers must be cautious not to apply certain insecticides that will harm these bees. A later section will detail which chemicals are known to have detrimental impacts on pollinator species.

Solitary Bees

New Zealand has a number of solitary bee species that frequently visit flowering crops during the sunniest parts of the day. Research suggests these solitary bees play a substantial role in pollinating all number of insect-pollinated plants. Observations have shown solitary bees do frequent blueberry flowers, likely supplementing extra pollination on top of any performed by bumblebees and honey bees.

Experts suggest the main solitary bee pollinator genus of blueberry is *Lasioglossum* which holds a number of different species. They are typically a smaller bee looking very similar to flying ants.

Yet similarly with other pollinators, solitary bees are very susceptible to certain insecticide sprays. Growers must time their sprays (or not spray at all) if they want to keep the population numbers of these important pollinators high.

CHEMICALS THAT IMPACT ON POLLINATORS

Many pesticides can impact on pollinating insects. Always read the label to check toxicity of chemicals to identify risks to pollinating insects. Some insecticides are safe to pollinators once the spray is dry. Spraying with these materials in the evening will usually protect pollinators but do not spray when

conditions mean that spray does not fully dry before pollinators will be out foraging the next morning. This especially applies to Lannate used to control bronze beetle that attacks foliage and developing fruit while some flowers are still present.

BIRDS (VARIOUS SPECIES)


Most fruit-eating bird species will attack blueberries if they have an opportunity. Common birds causing problems in New Zealand are blackbirds, thrushes, wax eyes, mynahs and starlings. Even netted crops come under attack, as birds have the ability to find any holes and then become very difficult to eliminate.

Other than netting, there are very few materials available in New Zealand able to be used on blueberries that are consistently effective in reducing bird predation. One possible option includes methyl anthranilate (Flock-Off) which reportedly acts as a repellent to some frugivorous birds. Current studies using this chemical in blueberries have shown mixed results in deterring birds. At this stage it can't be used close to harvest, though this may change in the future.

DISEASES

BACTERIAL BLAST:

Pseudomonas syringae

The organism gains entry at damage points such as wounds or leaf scars and infects the plant cambium, rapidly killing infected areas and causing dark brown cankers. Disease cankers spread from the entry point along the bark and can girdle complete stems, causing death of branches and even whole bushes. Diseased branches when cut can give off a strong distinctive odour. The disease is most active in cold, wet weather, and symptoms are most obvious in autumn, winter and early spring. Strains of this disease are also associated with development of ice crystals, so frost conditions favour its development. Where major plant die-back occurs, this becomes obvious from late spring. Rabbiteye varieties appear particularly prone to the disease especially 'Powder Blue' and 'Maru'.

Only two materials are available in New Zealand that are active against bacterial diseases: streptomycin and copper compounds. Both these products are only effective in protecting against the disease becoming established, so they need to be applied after events creating disease entry points, such as hail storms, and in the autumn at early leaf fall to protect leaf scars. Pruning off and burning any infected shoots will also help. Several sprays may be required at 14-day intervals on susceptible varieties. Do not mix copper with captan, especially flowable formulations, as damage may occur, especially to rabbiteye types. Pruning out infected wood and removing alternate hosts for the disease, such as stone fruit trees in the immediate vicinity, may also help in management of the disease.

ANTHRACNOSE:

Colletotrichum acutatum,Colletotrichum gloeosporioides

Anthracnose leaf and stem spots

Fruit rot symptoms

In wet seasons, this disease is probably the most serious problem in blueberries. To date, the disease has not been recorded in the South Island. It can cause fruit rots and spots on the leaves and the leaf stems. It overwinters in dead terminal twigs, and old infected fruit spurs. The main disease problem comes from infection from flowering time onwards that may develop into a black sunken fruit rot; when extreme, salmon pink spore masses cover the rotting area. Evidence from other countries suggests that trying to remove overwintering inoculum is not particularly effective in reducing infection the following season.

Chemicals for control can be divided into two main categories:

- Broad-spectrum protectant materials, which include mancozeb, captan, thiram, and chlorothalonil
- Materials that are site-specific and may have some curative action on recently germinated spores. This may include various combinations of eradicating recent infection, inhibiting sporulation, or reducing the growth of the fungus. Topsin®, carbendazim, and Octave® are chemicals known to have action against this fungal group but other chemicals in the DMI group are likely to be effective as well and some may be superior to Octave. Some of the chemicals in the strobilurin group are also likely to be effective. There has been little work internationally

testing chemicals for control of anthracnose on blueberries, so the effectiveness of these chemicals is unknown. Pesticide residue limitations are likely to limit use options of these chemicals on blueberries.

Chlorothalonil and mancozeb are the most persistent of the protectants. All protectants need to be applied before the disease becomes established. Where the disease has been a problem before, spraying should start in early spring and continue over flowering at 7 to 10-day intervals, especially in wet springs. Further work on optimum timing and frequency of materials is required for this disease in New Zealand conditions.

PHYTOPHTHORA:

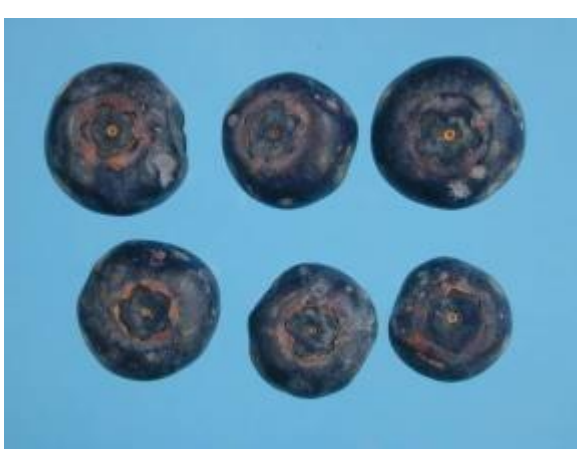
Phytophthora cactorum


Phytophthora is a major disease for a number of different crops. It can affect plants of all ages, where it causes severe root and crown rots. The disease spreads quickly in the soil when there are humid/wet and warm conditions. As a soilborne pathogen, Phytophthora can become a major issue if blueberry fields become saturated during heavy rain. Any wounds on a blueberry's basal stem or roots become an access point for phytophthora meaning any insect, mechanical or chance damage can result in infection. Plants typically die in groups in areas of rows or fields where water has sat for extended periods, especially in spring

There are limited controls for phytophthora given their unique reproduction system. The best options are using Ridomil (Actives: Metalaxyl-M and Mancozeb), and regular phosphorous acid applications. It is also wise to have the blueberries raised so they are not sitting in water during wet springs especially when plants are especially vulnerable to the disease. Mounding rows prior to planting can be helpful in avoiding plants sitting in water. Dipping plants in phosphorous acid (5ml/L) is helpful as a preventative treatment.

EARLY ROT:

Guignardia vaccinii (a.k.a.Phylosticta vaccinii)

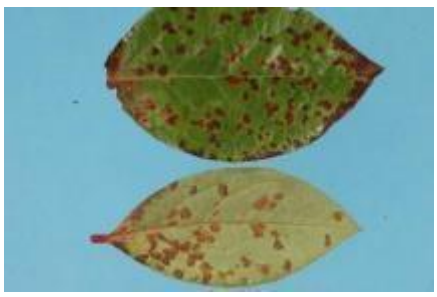



Identification of this disease was first confirmed during the 2003/04 season. It causes fruit and leaf spotting and has been the cause of rejections of fruit in recent seasons. It has caused major downgrading of fruit. Rabbiteye types, especially 'Maru', that are mostly evergreen are more susceptible, as the disease carries over from season to season on the foliage.

Control is based on protectant fungicides to prevent the disease from becoming a serious problem. Copper sprays, captan, thiram, and mancozeb should provide some protection while Topsin and carbendazim may also be effective. Finding a safe way of removing overwintering leaves should also help with disease control.

BLUEBERRY LEAF RUST:

Naohidimyces vacinii


Blueberry rust was first identified from the Waikato in January 2004. Symptoms start as reddish spots on the upper surface. Affected areas turn reddish brown and become visible on the lower surface. These lower spots later become covered by masses of orange-yellow spores. Severely affected leaves may develop autumn colourations and are commonly shed. Defoliation can be severe according to variety susceptibility.

The present thinking for rust control is that a three-pronged approach will be needed. The first approach is through variety choices. There is a considerable range in variety susceptibility to this disease and the first step is avoiding susceptible varieties when making planting decisions in rust-susceptible areas, which include all North Island areas north of Hawke's Bay. Existing varieties that are very susceptible should be removed from these areas.

The second approach is to attempt to disrupt the life cycle of the disease. The alternate host for this pest is a conifer *Tsuga* sp., which is not widely distributed in New Zealand. The disease can, however, overwinter on old leaves that remain on the bushes and recycle in this way. Research has shown that leaf removal is not a practical proposition except perhaps for nursery plants.

The third approach is to control the disease through chemical use. Copper is the most effective chemical trialled to date for control of this disease. The range of options is limited because of the lack of export residue tolerances for blueberries or unavailability issues. The main emphasis is on protection of new plant tissue, as there are no effective eradication materials once infection has established.

CULTIVAR RUST SUSCEPTIBILITY CHART

This list was updated at the Blueberry Growers meeting in September 2015. It was based on the collective knowledge of the people present at that meeting. Harvesting times are based on Waikato conditions.

Cultivar	Type	Ripening Time	Rust
Blue Bayou (F126)	SHB	3	4
Blue Moon (RH34)	NHB	4	1
Bluecrop	NHB	6	3
Brigitta	NHB	8	2
Burlington	NHB	8	2
Centra Blue	RE	14	1
Centurion	RE	12	1
Climax	RE	10	3
Delite	RE	10	4
Dixie	NHB	**7**	0
Dolce Blue (D122)	RE	10	2
Duke	NHB	5	0
Elliott	NHB	9	0
Island Blue	SHB	1	1
JU83	NHB	3	1
Marimba	SHB	1	2
Maru	RE	11	4
Misty	SHB	1	4
Nui/PBBB	NHB	2	3
Ocean Blue (F107)	RE	10	0
O'Neal	SHB	2	2
Ono	RE	10	1
Powder Blue	RE	10	1
Puru	NHB	3	2
Rahi	RE	11	3
Reka	NHB	3	4
Sky Blue (F110)	RE	11	1
Southland	RE	12	1
Sunset Blue (RH11)	NHB	2	0
Tifblue	RE	11	2
Velluto Blue	RE	10	0
Whitu	RE	10	0

Number	Start of harvest
1	Early November
2	Mid November
3	Late November
4	Early December
5	Mid December
6	Late December
7	Early January
8	Mid January
9	Late January
10	Early February
11	Mid February
12	Late February
13	Early March
14	Mid March
15	Late March

Rust Scoring System Rating
0 = No Rust 1 = 5% rust
2 = 25% rust
3 = 50% rust
4 = 75% rust
5 = Decimated by rust

SHB = Southern highbush blueberry
NHB = Northern highbush blueberry
RE =Rabbiteye blueberry

SHOOT DIE BACK

Botryosphaeria sp


Botryosphaeria (a member of the Fungi family: *Botryosphaeriaceae*) is a fungal disease that causes extensive damage to areas of cane, whole shoots and whole plants of blueberries. Several species can attack blueberries, with *Neofusicoccum ribis* being especially damaging but *Neofusicoccum australe, Neofusicoccum luteum* and *Neofusicoccum parvum* have also been identified in New Zealand blueberries. There is a range of varietal susceptibility to these diseases.

Botryosphaeria spores overwinter in dead material, and can enter plant tissue via cuttings, wounds, growth cracks, leaf scars or by direct contact with plant dermis (via pores, branches and stems that allow gas exchange).

The control of Botryosphaeria diseases is difficult, as information on disease control, especially chemical control, is very limited. Much of the work done on botryosphaeria has been carried out in vineyards and demonstrates that control and management can be achieved by using good hygiene methods after pruning. It is important to maintain healthy source blocks by spraying fungicides in order to produce healthy plants. The dead debris should be removed from the crop and preferably burnt, as this material can be a source of inoculum that can cause new infections. Pruning infected individuals before the fungi and or disease is spread extensively throughout the plant is also an effective method for preventing spread between other plants in the area. It is important to prune 15cm below an infection point to ensure the full extent of the disease is captured. Herbicide damaged areas increase the possibility of infection by Botryosphaeria, therefore care should be taken when applying herbicides not to damage the blueberry plants.



Cane dieback

The central pith is often darkened, and the leaves may be reduced in size and may be wrinkled. The following season, these canes will be dead. When removing diebacks it is important to prune out diseased stems 20-25 cm below any sign of disease or discolouration

Canker timing

On branches and trunks, Botryosphaeria can infect plants where there has been a winter injury, pruning wounds or any plant damage from hail or herbicides. Slightly sunken reddish/brown spots appear on the infected areas of bark. These then enlarge to form cankers, which can then enlarge slightly more each year. The bark usually dies and can, after time, be pulled away from the plant.

Leaf spots

Small necrotic spots form on the leaves and the surface of the leaf becomes wrinkled.

Several fungi have been found associated with twig and shoot die-back, so the causal organism needs to be positively identified before developing a control strategy. A recent survey of die-back causes has been carried out and *Botryosphaeria* species were the main cause of die-back problems. Other identified causes of shoot die-back include *Phomopsis* sp., and *Pestalotiopsis versicolor.* All are common causes of die-back and stem cankers and usually infect through a damage entry point.

Control normally consists of just removing the source of disease inoculum by pruning out dead tissue and burning the prunings. Protectant fungicides may help the disease from becoming a serious problem. Recent research suggests the fungicides Tebuconazole and Carbendazim have some effectiveness in controlling *Botryosphaeria* especially after damage-causing events like hail storms. Other materials used for anthracnose and/or botrytis control may also be effective.

BOTRYTIS:

Botrytis cinerea




Botrytis is a common disease of berry crops but in blueberries occurs mostly as blossom infection. In wet humid conditions, especially at flowering, the disease attacks flower parts and may spread to associated stems, although it will usually stop at a branch point. Berries that have been infected at flowering (especially where the flower does not detach) may continue to develop and later express as a postharvest rot.

Specific botrytis control measures are not normally required for this disease in most areas of New Zealand. Where blossom blight problems regularly occur, treatment at flowering with botryticides appropriate for the intended market may be justified.

CROWN GALL:

Rhizobium radiobacter (Agrobacterium tumefaciens)

This bacterial disease causes galls to form at the base of plants and on major roots. They vary in size and can grow up to 16cm in diameter. Infected plants may be stunted and foliage may discolour, taking on a reddish colour and then turning yellowish brown prematurely in late summer.

All blueberry varieties are susceptible and control of infected ground is very difficult. High rates of the fumigant chloropicrin have been reported to be effective. Where the problem is known to exist, minimising wounding of plant tissues, especially by soil dwelling insects, will help to contain the spread. Replacement plants should be dipped in Dygall™ before planting.

VIRUSES

BLUEBERRY MOSAIC VIRUS

This virus has only been found in blueberry plants (Vaccinium Spp.) and has been detected in both plants showing symptoms of its presence, and those without any signs of its presence. Plants visibly exhibiting symptoms will show mosaic-like markings and mottling on foliage in pink, yellow or yellowgreen patterns. Research overseas suggests the virus can affect fruit quality and may reduce the overall yield, yet there are no signs of these effects in NZ yet.

Control options at this stage are limited. It is thought to be transmitted by a soil-borne fungi and may also be spread through the movement of infected roots, soil, equipment, propagation material or during grafting. Evidence suggests it is not transmitted by fruit or seed. Growers practising good orchard hygiene may help to minimise spread of this virus within and between orchards.

DISORDERS OF BLUEBERRIES

REPLANTING AFTER PERSIMMONS

Normal on left, affected on right.

This problem was identified in one Waikato property. Plants in most of the block grew poorly without any specific symptoms other than poorer growth compared with plants in the outside row that grew well. No specific cause could be attributed to this problem other than a possible effect from residual chemicals associated with persimmon roots that previously were planted in the affected area. This has not been confirmed and no treatment has presently been identified to solve the problem.

FROST DAMAGE




While blueberries are quite tolerant of frosts, unseasonable frosts after fruit set can be devastating. Damage initially shows up in any of several ways as discoloured, misshapen or water berries. Soft young growing tips can also be affected. Affected fruit will usually subsequently turn brown and drop off. Partially damaged fruit may continue to develop but will be misshapen, may ripen prematurely and will be more susceptible to postharvest rots.

There are several options for frost management including sprinklers and adding heat. Windmills and helicopters can be useful where inversion layers are present and warmer air well above ground can be mixed with freezing air at ground level.

UNIDENTIFIED DISORDER – BARK SPLITTING

Bark at the base of the plant above has split. It is suspected that this has been caused by frost where relatively “soft” plants held in a nursery situation were planted out and exposed to a hard early frost in autumn before the plants are properly hardened. Secondary infection from bacterial blast has caused blackening of shoots above the site of the splitting.

RAIN DAMAGE

Ripening fruit expands rapidly in size during the final week before harvest. However, when wet conditions prevail during this period, some varieties are not able to expand their cells fast enough to handle the osmotic absorption of surface moisture.

Water management during the growing season (consistent moisture availability reduces splitting) and internal fruit quality factors including soluble solids content (high soluble solids can produce greater splitting) and especially cultivar susceptibility are all contributing factors.

HORMONE HERBICIDE TYPE DAMAGE

Symptoms of this problem are twisted growth of rapidly growing plants that may remain erratic for several months. Hormone herbicides can cause these symptoms. Young, actively growing plants are susceptible to drift from herbicide spraying in nearby areas.

Great care is required when using hormonal type herbicides to prevent the possibility of plant damage from drift.

BIRD/BEE DAMAGE TO FLOWERS

Suspected small bird damage to flowers

Honey bee ‘robbing’ nectar

Small birds and bees, especially the short tongued bumble bee can cause major issues on blueberry flowers. The problem occurs when small birds or bees bite into the side of the flower (thereby avoiding the reproductive parts of the flower) to drink the nectar and may even remove the flower in the process. Any damage to the flower creates wounds that fungal spores and diseases can access. Where there is no pollination, there will be no fruit set resulting in lower yields.

There is little that can be done to prevent this. It is likely to be learned behaviour from small numbers of small birds so deterrents may work. Stopping bumble bees from doing this is not possible. Damage is mostly limited to varieties with long corollas (collective petals).

LICHENS

Lichens are actually composed of two different organisms, an alga and a fungus, which grow together for mutual benefit. They come in a range of forms and colours including grey, green, yellow and white.

Lichens are not a disease issue but they are often found on plants that are not growing well because they are better able to intercept light on these plants. They can be a problem when they build up on bird netting, as this will interfere with light transmission through to the blueberry plants. They are a good indication of production occurring in a low pollution environment, as common air pollutants and acid rain will prevent their growth. Some insects and mites may use lichens as a place to hide over winter, but beneficial insects and mites will also use these hiding places. Generally, there is no justification for their removal on plants, although some growers use lime sulphur in winter to do this.

PETAL-LESS FLOWERS

Petal-less flowers are an unusual phenomenon that has been observed in some patches of blueberries. The cause is presently unknown. These flowers may still be pollinated but because petals are a cue to most pollinators, it is likely to result in less pollination.

No cure is presently known.

DISEASES OF NO SIGNIFICANCE

A number of diseases have been identified in recent seasons that are not covered in this manual.

These diseases include:

Gibberella baccata A secondary disease of no significance

Pseudomonas viridi flava A secondary disease associated with *Botryosphaeria*

Phoma sp. Phoma leaf spot, of no great significance

Septoria sp. An occasional leaf spot of no significance.

PESTS AND DISEASES NOT PRESENT IN NEW ZEALAND

Up to this point, this publication contains a list of pests and diseases found on blueberries in New Zealand. Further information will be added to this document as the issues are identified, photographed and suitable control mechanisms worked out. There are a number of potential biosecurity threats that are featured in this section of this publication. They are **not present** in New Zealand but we urge growers to keep a look out for these threats so that they can be eliminated before they become established.

At present there are very few viruses of blueberries known in New Zealand. There are a number of potentially very serious viruses reported overseas, including *Blueberry fruit drop, Blueberry scorch carlavirus, Blueberry shoestring virus, Blueberry shock ilarvirus, Tobacco ringspot virus, and Peach rosette mosaic virus*. It is important that growers are constantly vigilant for symptoms not previously seen, as early identification may enable the disease to be eliminated before it becomes a widespread industry problem.

Recently in the USA, the Spotted Wing Drosophila (SWD),*Drosophila suzukii,* has been causing major problems to blueberries. There is a risk that this insect will reach New Zealand and cause similar problems, so growers are asked to be vigilant and on the watch out for any fruit containing small larvae. The Queensland fruit fly (*Bactrocera tryoni)* was also detected in Auckland earlier in 2012 and also poses a huge risk to berry crops.

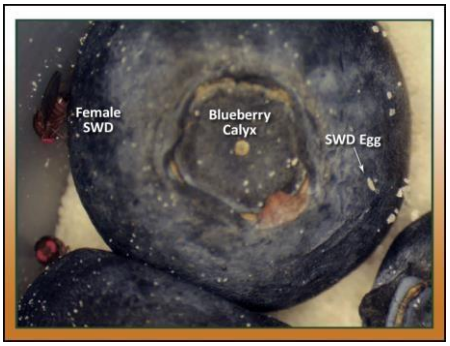
FRUIT FLIES

It is a likely risk that the Spotted Wing Drosophila (*Drosophila suzukii)* or SWD, and the Queensland fruit fly (*Bactrocera tyroni*) or Qfly, could one day enter and establish themselves as the most damaging pests in New Zealand horticultural crops. The increased importation of fruit from overseas

markets, expanding distribution of SWD and Qfly in temperate climates, and their wide host range (including blackberries, blueberries, cherries, figs, hardy kiwi, nectarines, peaches, plums, raspberries, strawberries, table grapes and tomatoes) are indicators that the SWD and Qfly could successfully establish themselves as major pest and spread throughout New Zealand horticultural crops if conditions were optimal, and given the chance.

Spotted Wing Drosophila (SWD), Drosophila suzukii

The damage that SWD poses is primarily due to the oviposition and pupation of eggs taking place both inside or outside the fruit. SWD directly damage fruit by burrowing, feeding and ultimately collapse from larval feeding. Further fruit deterioration can result from secondary fungal and bacterial infections.



QUEENSLAND FRUIT FLY (*BACTROCERA TRYONI*)

Queensland fruit fly (*Bactrocera tyroni*) or Qfly, is a native of Australia where it is considered to be the country's most serious insect pest of fruit and vegetable crops. In May 2012 a single male fruit fly was detected in the suburb of Avondale, Auckland. After rigorous checks by MPI there is no further sign of the Queensland fruit fly and New Zealand's fruit fly free status is confirmed.

Adult flies are about 6 to 8 mm long and are reddish-brown coloured with yellow markings.

There are four stages in the life cycle of a Queensland fruit fly: egg, larvae (maggots), pupa and adult. Completion of the life cycle is dependent on temperature and moisture. Eggs are laid beneath the skin of host fruit. Larvae do not have legs and have a pointy shape without an obvious head.

BIOLOGICAL CONTROL

With the changing customer landscape demanding reduced pesticide residues and increasingly stricter laws being put in place on broad-spectrum chemicals, growers have needed to find alternative methods to controlling pests in their orchards. Perhaps the most successful approach has been Integrated Pest Management (IPM) which incorporates softer chemicals, biological controls, monitoring and timing to achieve control of pest species.

With this approach to pest management, there has been a massive development into researching ideal biological controls. These include predators and parasitoids of a wide range of pest species found in orchards. Some of these biological controls can be encouraged to visit the crop naturally by reducing pesticide use (e.g. lacewings, ladybirds, hoverflies etc) whilst others can be purchased from specialist biological companies such as Bioforce and Zonda.

The important aspect of purchasing these biological controls is to know what predators/parasitoids control what pests. This section will provide some information on what various biological controls are available for growers.

1. *Amblydromalus limonicus* is a generalist predatory mite that will attack and feed on virtually anything smaller than itself (and sometimes the same size). It is known to feed upon two instars of thrips, other mite species and will likely attack the eggs of much larger organisms.

2. Mite A (*Neoseiulus cucumeris*) is another generalist predatory mite. Similar to Limonicus, it will attack and feed on a number of smaller organisms. While it is not as fierce and voracious as Limonicus, it is cheaper to purchase and can be an efficient biological control of thrips.

3. Mite E (Phytoseiulus persimilis) is a specialist predatory mite. It will only attack two spotted mites and it will do so very efficiently. Research and observations have shown that in ideal conditions, persimilis will completely control two spotted mites without issue (so long as pesticides have not been recently applied to the crop).

4. Orius vicinus is a hemipteran generalist predator. Unlike the aforementioned mite species, Orius can attack much larger prey species and will control a wide range of pests if there are sufficient numbers of them. Orius, however, is a much more expensive predator than the mites and requires certain environmental conditions to operate efficiently.

5. Parasitoids are also commonly available from biological control companies. They are more efficient at infecting certain aphid species. Usually parasitoids can only utilise a small group of species, so identifying the pest species is essential to know what parasitoids to purchase. This can be discussed with Bioforce for further options.

BIOSECURITY AND YOUR RESPONSIBILITY

Biosecurity risks are always a concern in New Zealand. Our isolation from the rest of the world has dramatically reduced the number of pests and diseases that negatively impact our berry fruit industries. This has been a substantial competitive advantage for New Zealand growers against berry fruit growers in other parts of the world. However biosecurity risks continue to be an issue with increased avenues for undesirable pests to enter the country – through imports, tourists, wind dispersal etc.

The invertebrate pest spotted wing drosophila or the mummy berry disease are major issues overseas and will cause serious economic harm to NZ berry fruit industries if either ever established in NZ. There are also a large number of other pests and diseases currently not established in NZ. Keeping these species from establishing in New Zealand is as much your responsibility as it is the government. Growers are the frontline defence against these invading pests. It is important that everyone plays their part in biosecurity by preparing for, and managing, biosecurity threats.

Spotted Wing Drosophila

Mummy Berry Disease

Newly introduced plant pests can arrive and spread on plant material, clothing, vehicles and equipment. Vehicles, farm equipment and people can carry plant pests on and off your property, especially associated with soil or plant material. Enacting cleaning protocols between farms, including vehicles and footwear is desirable to help minimalize biodiversity risks. Using an on-farm vehicle when possible when on a property to prevent cross-infection will also help.

Signage should be placed to inform visitors that biosecurity practices are in place. Use this signage to direct traffic to a designated parking area where visitors can make themselves known and vehicles and clothing can be assessed for risk.

Regular monitoring of your berries for plant pests and familiarising yourself with pests and diseases commonly seen in your crop is a must. New or unusual pests or diseases should be quarantined and kept in a small container. Contact your local technical advisor for identification and information on the obtained specimens.

Use pest-free propagation material sourced from reputable suppliers to avoid introducing new pests and diseases to your property.

Keep records that allow all materials moving on and off your property to be traced, as well as movement of contractors, vehicles and visitors.

MANAGING LEGAL RESPONSIBILITIES IN APPLYING PESTICIDES

New Zealand Agrichemicals are controlled as hazardous substances in New Zealand by the:

- Hazardous Substances and New Organisms Act (HSNO Act)
- Ozone Layer Protection Act – for methyl bromide
- Agricultural Compounds and Veterinary Medicines Act – for substances used in agriculture.

These three acts are to enforce that pesticides must only be used for the purpose described on the product label and that all the instructions on the label are followed. This is to protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms.

The HSNO act codes of practice form the basis of good practice for agrichemical use within New Zealand. It is highly recommended growers or any entity that intends to use pesticides in any way should first read the HSNO act, prior to pesticide usage.

All label directions must be read by or explained to the user before each use of the pesticide. All pesticide users should take reasonable care to protect their own health and the health of others when using a pesticide. They should also make every reasonable attempt to prevent damage occurring from the use of a pesticide, such as off-target drift onto sensitive areas or harm to endangered and protected species. It is also important for pesticide users to keep a record of what chemicals were used, when, where, and for what purpose.

The record of the pesticides used should include:

- full product name
- description of the crop or situation
- rate of application and quantity applied
- description of the equipment used
- address of the property, identification of the area treated and order of paddocks treated
- date and time of the application (including start and finish)
- name, address, and contact details of the applicator and of the employer or owner if an employee or contractor is the applicator
- estimated wind speed and direction (including any significant changes during application)
- other weather conditions specified on label as being relevant (e.g. temperature, rainfall, relative humidity)

Those applying pesticides should at a minimum have a Growsafe Certificate and be an Approved Handler. More information on acquiring these certificates can be found here: https://www.growsafe.co.nz/

DEVELOPING A SPRAY PROGRAMME

It can be difficult to develop a spray programme when there is little previous experience to call on. There is good evidence that in many sites in New Zealand that minimal pest and disease control sprays are essential each year in blueberry production. The key pest and disease issues most likely to cause problems are:

- Thrips
- Leafrollers
- Bronze Beetle
- Botrysphaeria
- Phytophthora root rot
- Rust

Any of the pests and diseases covered in this manual has the potential to cause production losses. However it is best to start with the premise that no chemical sprays are required. If monitoring identifies issues, or if problems were encountered in the previous season, then an appropriate programme should be developed incorporating treatments for those issues.

Initial plantings are unlikely to require any chemical sprays though they should still be monitored for any potential pest and/or diseases showing up. Regular monitoring for all pests and diseases mentioned in this manual should be done every few weeks during the growing season and especially during the first 5 years after initial planting to identify the first appearance of pest and disease issues.

Spray usage

Blueberries in New Zealand have a consistent history of having few pest and disease issues. This applies especially to newly planted areas that are likely to remain pest and disease free for several years. Specific programmes may often be required for particular pests and diseases that are causing problems on some varieties or on some blocks or parts of blocks. It is important to target those areas that have been identified following regular monitoring. Data from the previous season is also important in deciding what treatments are appropriate. For further information refer to the specific parts of this manual.

The following programme is designed to assist with control of these specific issues. Growers should mix and match treatments according to the targeted pest and disease issues and application should focus on the problem areas

Stage	Disease/Pest	Chemical options	Alternatives
Bud movement	Leaf spots, anthracnose,	Chlorothalonil	
	Bacterial blast, rust	copper spray	
	Scale	#chlorpyrifos and oil	
	Phytophthora	#phosphorous acid	
Over flowering	Anthracnose, botrytis	Switch (Note3)	Captan
	Bronze beetles	Lannate L (Note 1)	
Post blossom*	Anthracnose	Switch (Note3)	
	Rust	copperspray label rates	
	Mealy bug, scale	Movento	
	Leaf roller, thrips	#spinosad	Lannate L
	Phytophthora	#phosphorous acid (Note 2)	
Post harvest as required	Leaf spot, rust, blast	copperspray label rates	
	Phytophthora	#phosphorous acid	

No label claim exists for this product. Any use is at grower's own risk* Only choose chemicals suited to the markets intended
Note 1: Lannate should only be applied in the evening after bees have stopped flying
Note 2: Phosphorous acid has caused some phytotoxicity on fruit of some varieties. Do a check before using generally
Note 3: Do not use more than 2 applications

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