Identification of pests, diseases and disorders in New Zealand blueberries

A manual to aid identification and control

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Introduction

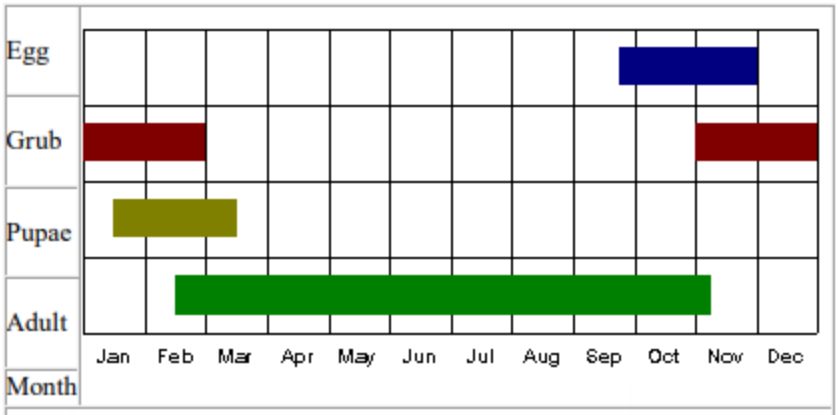
This manual has been produced for New Zealand blueberry growers as an aid to diagnosis of pest, disease and disorders in blueberries. It is designed to cover fungal, bacterial, invertebrate and other issues found in New Zealand blueberry orchards. It is a comprehensive list but not necessarily a complete 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 (photos can be sent to Rob@berryworld.co.nz). 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 Christchurch or 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.

Invertebrate Pests

African Black Beetle

The African Black Beetle (*Heteronychus arator*) is a reasonably rare pest of blueberries. As larvae, they have a C-shape (looking very similar to Grass Grub larvae) and feed upon blueberry roots. They range from around 25-30mm long. As adults they are quite distinctive with a black shiny surface and are around 12-15mm long.

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.



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

Biological Control

There are two biological products that are known to have some impact on African Black Beetle larvae. They are Nemastar (*Steinernema carpocapsae*) and Nematop (*Heterorhabditis bacteriophora*)

which are both parasitic nematodes. There is currently no information as to how effective these products are in controlling populations of the beetle though.

Chemical Control

Between November and late February, the best chemical applications should target the larval instars still in the soil around blueberry crops. Applying a soil-targeted drench using Chlorpyrifos (e.g. Lorsban) should significantly impact populations.

When adults are in flight (late February onwards), the best chemical applications are contact sprays such as Karate or Altacor. These chemicals are not necessarily IPM compatible and can be toxic to bees. It is important to note that these chemicals should be applied during the evening when pollinating bees are not present to prevent their unnecessary death.

Aphids

There is dominantly one species of aphid that utilises blueberry crops and that is the Melon aphid (*Aphis gossypii*). While it can be found on blueberries, this species (and many other aphid species) don't prefer blueberries. Instead they prefer other host plants. Two forms of the melon aphid can be seen, wingless individuals which are yellow to green; while the second are winged individuals which are mostly black. Both are around 1.5 - 1.9mm long. Aphids can become more of a nuisance under cover, greenhouses or environments where there is high humidity.

Biological Control

Aphid damage is rarely bad enough to warrant chemical control or expensive management measures. Typically an orchard undergoing integrated pest management practices (IPM) will passively encourage natural predators to control aphid species. The best aphid predators are lacewings (their larval and adult life stages) and ladybirds (their larval and adult life stages). Certain species of lacewings/lady birds can also be purchased from biological companies to boost natural populations in orchards.

Chemical Control

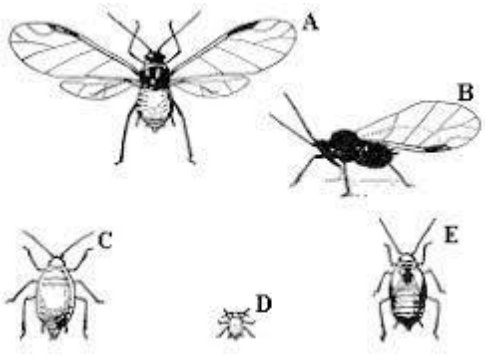
If aphid infestations do become a major issue (this is likely due to overusing broad spectrum chemicals that reduce predator populations) then there are a number of insecticide options available. These are best used as curative options instead of preventatives. See table of insecticidal options.

Chemical Active Ingredient	Example Trade Name
Sulfoxaflor	Transform
Methomyl	Methomyl
Pyrethrin	Pyganic
Spirotetramat	Movento
Fatty Acids	Clenza
Neem Oil/Azadirachtin	Naturally Neem

It is important to note that these chemicals should be applied during the evening when pollinating bees are not present to prevent their unnecessary death.

Lifecycle and Species Information

Melon aphids can reproduce parthenogenetically (without requiring a male) on host plants over the summer. Under warm conditions, a generation can be completed this way in about seven days. Most of these individuals will be wingless and will typically stay on the plant they were born on. However some individuals will be the second winged form (commonly in Autumn) which will be capable of dispersing to nearby blueberries or other secondary hosts to start new populations. Later in the season male and egg-producing female individuals will be produced. Eggs will be yellowish in colour and are the only form that can overwinter in cold conditions. These eggs will hatch mid-spring and will repeat the cycle.



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

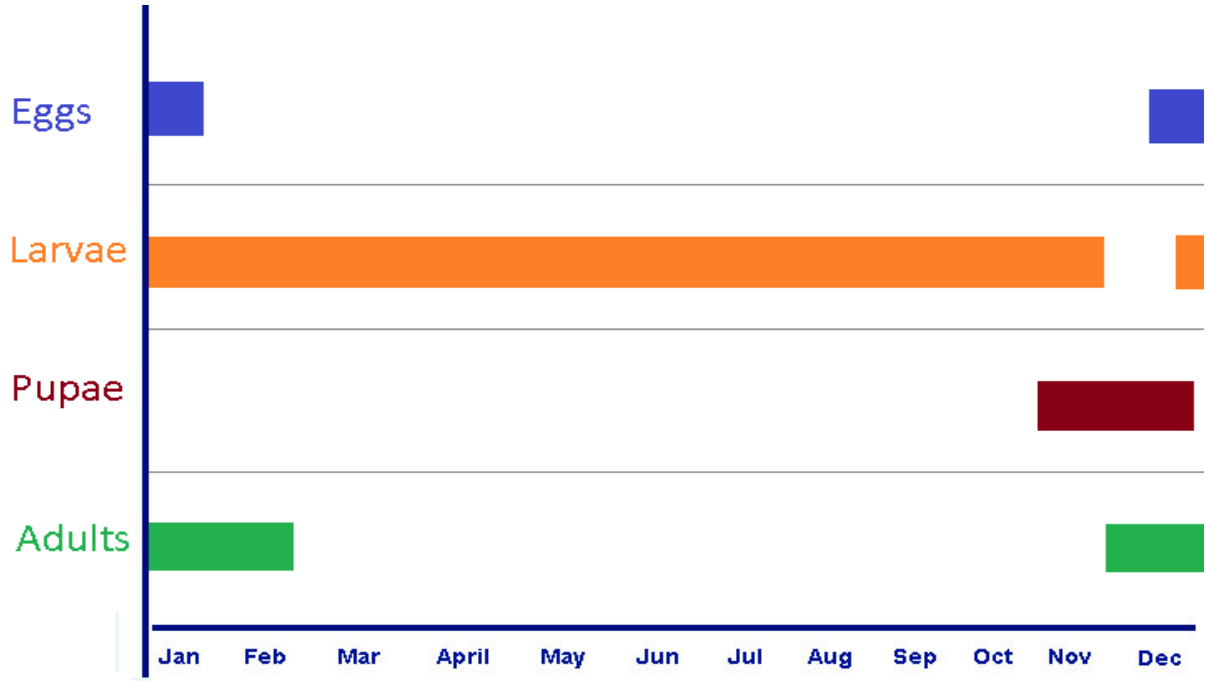
Bag Moth: Liothula Sp.

There are several species of native bag moths that may occur from time to time on blueberries. None are 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.

Black Vine Weevil

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.



Biological Control

There are three biological products known to have an impact on Black Vine Weevils though the efficacy of each product is not well known. These are: *Beauveria Bassiana* (Contego BB), *Steinernema carpocapsae* (Nemastar), and *Heterorhabditis bacteriophora* (Nematop). The former is a type of fungus that parasitizes invertebrates in the soil; while the latter two are parasitic nematodes.

Chemical Control

The best chemical applications should target the larval instars still in the soil around blueberry crops. Applying a soil-targeted drench using Chlorpyrifos (e.g. Lorsban) should significantly impact populations.

When adults are present (late November to Late February), the best chemical applications are contact sprays such as Karate. These chemicals are not necessarily IPM compatible and can be toxic to bees. It is important to note that these chemicals should be applied during the evening when pollinating bees are not present to prevent their unnecessary death.

Cultural Control

Blueberry growers overseas have used sticky traps around the bases of their blueberry bushes to great effect. The adult weevils emerge from the soil and climb up the trunks where they get stuck on the sticky traps. If weevils are a major issue, this control option combined with parasitic nematodes should be enough to manage this pest.

Blueberry Cane Borers

There are two species of cane borers that are pests in blueberries: Lemon Tree borer (*Oemona hirta*), Striped Longhorn (*Coptomma sticticum*). 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. Control for both species is exceedingly difficult given that most of their life stages occur within the blueberry pith where chemicals and biological have difficulty accessing.

Chemical Control

Chemical options are only applicable for adults as no suitable options exist for borers in their larval stage which are deep within the pith of the blueberry stems. General broad spectrum contact sprays are the only option and they include:

- Karate (lambda-cyhalothrin)
- Lorsban (chlorpyrifos)
- Sevin Flo (carbaryl)

These options are not IPM suitable and will have a severely negative impact on beneficials such as bees, predatory mites or parasitic nematodes.

Cultural Control

The best option for borer control is targeted pruning. Any blueberries showing significant dieback should be pruned out below the tunnel chamber or base (where the borer has burrowed into the wood) and any wood removed containing this pest should be burnt.

Bronze Beetle

The bronze beetle is a native pest that causes considerable damage to blueberries in spring and early summer attacking fruit, stems and foliage. It undergoes four life stages: egg, larvae, pupae, and adult. Damage is primarily caused by the adult life stage, although root damage has been known to be caused by the larvae which live in the soil. 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. They transform into the pupa stage, which lasts 3-4 weeks before emerging as adults in spring and early summer.

Biological Control

It is possible that generalist parasites such as *Beauveria Bassiana* (Contego BB), *Steinernema carpocapsae* (Nemastar), and *Heterorhabditis bacteriophora* (Nematop) will have an impact on bronze beetle larvae while they are in the soil. There is no information currently on the efficacy of these products on bronze beetle though.

Chemical Control

Similar to other beetle species with a larval stage in the soil, general broad spectrum contact sprays are the only option and they include:

- Karate (lambda-cyhalothrin) – for adults (warning toxic to bees)
- Lorsban (chlorpyrifos) – soil sprays for larvae
- Sevin Flo (carbaryl)
- Methomyl (methomyl)

There is also the possibility of using bifenthrin (Talstar) as a soil drench that has been applied as an excellent control of bronze beetle in grass turf. There is no information as of yet as to whether it would have a negative impact on blueberries when used in this way.

Cultural Control

One novel solution to bronze beetle has been to plant endophytic grass between blueberry rows. The larvae are targeted and killed by the endophytes which are associated with specific grass species. This is particularly suitable for blueberry growers as these grass species are often unsuitable as food sources for cattle and sheep (due to the nature of the endophytes) which are rarely allowed to graze in blueberry paddocks.

Cicadas

Cicadas can be an issue for some growers both at the larval life stage and as adults. There are about 40 species of cicada native to New Zealand. It is expected the cicada most likely to be a pest of blueberries is *Amphipsalta sp*. 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.

Chemical Control

Chemicals are the only option for controlling cicadas and growers want to specifically focus on targeting eggs and newly hatched larvae. Applying bifenthrin (Talstar) plus an adjuvant/penetrate (e.g. Engulf) around June will clear the wood of any eggs and/or soil. This control measure is unfortunately not suitable for earlier blueberry varieties due to the possibility of residue issues.

Grass Grub (*Costelytra zealandica*)

Grass Grubs 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.

Biological Control

Biological control agents have been developed especially for pasture situations based on the bacterium *Serratia* (*Serratia entomophila* is a good example), but these need to be incorporated into the root area to be effective and this can be difficult in blueberries. The parasitic nematode *Steinernema carpocapsae* is also known to be a good generalist control for grass grub larvae. It needs to be applied to the ground area around the blueberries and watered in well to help the nematode's survivability.

Chemical Control

Similar to other beetle species with a larval stage in the soil, general broad spectrum contact sprays are the only option and they include:

- Karate (lambda-cyhalothrin) – for adults (Toxic to bees)
- Lorsban (chlorpyrifos) – soil sprays for larvae
- Sevin Flo (carbaryl)
- Methomyl (methomyl)

Cultural Control

Planting endophytic grass between blueberry rows is a novel solution to targeting grass grub larvae. The larvae are targeted and killed by the endophytes which are associated with specific grass species. This is particularly suitable for blueberry growers as these grass species are often unsuitable as food sources for cattle and sheep (due to the nature of the endophytes) which are rarely allowed to graze in blueberry paddocks.

Leafrollers

There are several species of leafroller caterpillars that can damage blueberries. Light brown Apple Moth (LBAM) is by far the most common of the leafroller species found in blueberries in the Waikato. 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. 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.

Biological Control

Bacillus thuringiensis (Bt) has been shown to be effective in controlling lepidopteran species like leafrollers. For Bt to work it needs to be ingested by the pest species to have any effect so needs to be applied to the foliage and areas where the caterpillars will be present. Bt is also sensitive to light so it is best applied later at night or during overcast days

Chemical Control

There are a number of agrichemical options that control leafrollers including:

- Lorsban (chlorpyrifos)
- Methomyl (methomyl
- Prodigy (methoxyfenozide)
- Success (spinosad)
- Sparta (spinetoram)

Cultural Controls

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.

Mealybugs

Mealybugs have become a more common pest of blueberries in recent years. They live in the nooks and crevices of plants where they feed upon the internal juices using specialised proboscises. They excrete a honeydew substance where sooty mould can form over time. Heavy infestations can cause stunting of growth. It can also cause quarantine issues by hiding in the calyx end of fruit, so early season control is important.

The mealybugs are known to overwinter in crevices beneath loose bark, and will emerge in spring. 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). Generation time is about 8 weeks in mid-season and it may have up to three generations per year. While no biological options exist as commercial options, there was a parasitic wasp used in stonefruit for mealybug control. More work into identifying whether they would be suitable in blueberries is being done.

Chemical Control

The only controls for mealybug are chemical options. Before flowering the options are:

- Lorsban (chlorpyrifos)
- Applaud (buprofezin)

After flowering the options are:

- Movento (spirotetramat)
- Methomyl (methomyl)
- Transform (sulfoxaflor)
- Clenza (fatty acids) – may have some phytotoxicity issues
- Sevin Flo (carbaryl)

Mites

Mites are not a traditional pest of blueberries. In fact the species present are likely to be either fungal or tydeid mites both of which can be considerably helpful to blueberry plants. They clear away fungal spores (preventing certain diseases from establishing) or feed/predate on other pest species. However the reason they are considered pests of blueberries is solely due to their presence in export consignments. Many countries that detect moving mites on blueberry consignments will instantly reject it, causing some losses in profits. It's a difficult situation as it seems excessive controlling them throughout the season as they are actually beneficial (or at the very least neutral).

Chemical Control

The best option for control of mites would be chemical. These should only be used prior to harvest as a sanitising agent. Controlling mites earlier in the season is redundant. It is also important to be careful of withholding periods as applying these chemicals could leave unacceptable residues. Seek advice from chemical reps and Berryworld guidelines. Options include:

- Mit E Mec (milbemectin)
- Avid (abamectin)
- Omite (propargite)
- Oils are also an option but be wary of phytotoxicity issues
- Sulphur/lime sulphur applied in winter (summer sulphur applications may cause physical residues on fruit)

Oecophoridae

Oecophoridae is a family of small moths. Over the last twenty years there has only been one observation of this family of moth impacting blueberry plants. As such it is extremely rare and therefore there has been no further opportunity to identify the moth to species level. During the one recorded instance, it was shown to bore into the centre of blueberry plants (similar to a cane borer) where the caterpillar fed upon the pith of the plant, reducing its structural integrity and reducing its vigor. It was also noted as damaging newly forming buds on blueberry plants.

Due to its rarity, a recommended control measure has not been established. Yet as a lepidopteran species, certain options are more likely to have an impact such as *Bacillus thuringiensis* (Bt), spinosad, spinetoram etc. If this species is detected in one's orchard, it is highly recommended growers report it to Berryworld where we can learn from it, and improve control strategies and provide up-to-date information.

Scale Insects

There are a number of scale insect species that can be found on blueberries including: Chinese Wax Scale (*Ceroplastes sinsensis*), Black or Olive scale (*Sassetia oleae*), Cottony cushion scale (*Icerya purchasi*), Latania Scale (*Hemiberlesia lataniae*), Greedy Scale (*Hemiberlesia rapax*). Each species has varying life cycles and impacts on blueberry plants so it is important to be able to identify the right species prior to attempting control measures. It's important to note that very high populations of scale can be devastating on the performance of blueberries and therefore it is important they are adequately controlled.

Chinese Wax Scale (*Ceroplastes sinsensis*)

These are large unarmoured scales with a thick covering of wax. 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. Normally there is a single generation each year.

Black or Olive scale (*Sassetia oleae*)

Black or Olive scale is not too common on blueberries but can become an issue when nearby orchards grow citrus and/or passionfruit vines as these are their primary hosts. The scale can also be found near ornamental shrubs such as oleanders. Similar to other scale species, the Black or Olive scale feeds on the sap of plants and produces a honeydew substance. Sooty mould (a black fungus) grows on the honeydew and can cover the branches and foliage of heavily infested plants. Control measures should be timed to coincide with the main hatch period when oil sprays may be effective, i.e. at crawler movement: October/November

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. Cottony cushion scale has two to three generations a year. The entire lifespan takes about 12 weeks to complete. Similar to other scale species, they feed upon the sap of plants, reducing plant vigour and can excrete a honeydew substance where black sooty mould can form.

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.

Greedy Scale (*Hemiberlesia rapax*)

The greedy scale 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. It takes roughly 30 days 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.

Biological Control

Scales can be controlled by natural enemies if broad-spectrum insecticides have not been used. The endemic waxeye bird is a natural excellent predator of scale insects so encouraging these and other insect eaters during late autumn and winter is an option but not during fruiting seasons as waxeyes are also fruit eaters as well.

The commercial predatory mite species: *Hemisarcoptes coccophagus* can be used to control Latania scale

Chemical Control

Chemical control options include:

- Movento (spirotetramat)
- Applaud (buprofenzin)
- Lorsban (chlorpyrifos) - Commonly used in combination with mineral oils.
- Methomyl (methomyl)
- Transform (sulfoxaflor)
- Oils (mineral and fish)
- Lime sulphur - Used at 7 litres/ha before bud break. May burn foliage if applied directly.
- Calypso (thiacloprid)

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.

Symphylla

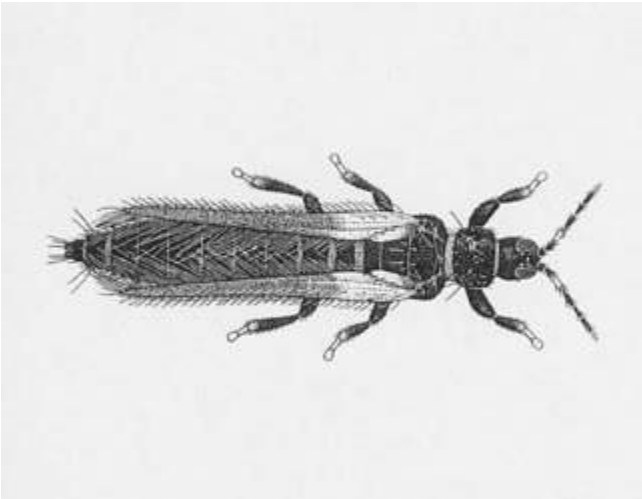
Symphyla are a broad group of invertebrates closely related to centipedes and millipedes. Many of their species are known to be occasional pests in the garden, where they live exclusively in the soil and can feed on fine plant roots. They inhabit all types of soils, especially very acidic soils, making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

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.

Chemical Control

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.

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.

One of the biggest difficulties with thrips in blueberries, is we're unfamiliar exactly what species we're dealing with. Other crops have shown there can be a huge variation in the types and number of species depending on the geographical location of the orchard. Historically it was believed that western flower thrips were the main thrips species found in blueberries, though no official work has been done to confirm this. Berryworld strongly advises growers to use the MPI invertebrate identification form in this manual (at the end of the Pests section) to send thrips samples in to get

identified. This will allow growers to figure out what species are present and will allow Berryworld to give much more specific control information and management options.

Biological Control

There are a number of predatory species that target thrips but they can take some time to establish in different crops. For growers that grow organically or implement IPM practices, natural enemies are also a great form of control for thrips. Commercial predators include:

- Limonicus (*Amblydromalus limonicus*) – Targets eggs, and first two larval instars
- Cucumeris (*Neoseiulus cucumeris*) – Targets eggs, and first larval instar
- Hyper-Mite (*Stratiolaelaps scimitus*) – Targets pupa in soil
- Orius (*Orius vicinus*) – Targets all thrips life stages but can struggle to establish on some crops

Chemical Controls

Historically the go to chemical control for thrips was Success (spinosad) but recent reports (2020 – 2021) have suggested that this chemical is no longer as efficient at controlling some species of thrips in blueberries. One of the major issues is that there are around 5 – 8 possible thrips species in blueberries each with varying tolerances to different agrichemicals. Until the species can be properly identified (it'll likely vary between properties and regions), the best chemical options are as follows:

- Sparta (spinetoram)
- Success (spinosad) – still efficient for some growers
- Transform (sulfoxaflor)
- Pyganic (pyrethrin)
- Clenza (fatty acids)
- D C Tron (Mineral Oil)
- Karate (lambda-cyhalothrin)
- Sevin Flo (carbaryl)
- Movento (spirotetramat)
- Naturally Neem (Neem oil/azadirachtin)

Beneficial Invertebrates

Bumble Bees

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. Some blueberry varieties also have 'deeper' flowers. 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

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.

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.

Praying Mantises

As pesticide use in blueberries drops, predatory insects like praying mantises begin to be seen. While mantises are not particular in what insects they consume, their presence indicates a desirable biological balance. Praying Mantises 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.

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.

Spiders

Spiders are perhaps the most common predator found in blueberry crops. There are many different species each with different ways of hunting/capturing prey including stalking them, building webs, ambushing etc. Most spiders are generalist predators meaning they will attack and feed on any potential prey (good or bad). This means they can be beneficial to blueberry crops in that they can feed on pests like aphids, weevils, thrips etc. However as they don't differentiate prey, they can also be a nuisance in that they will capture and feed on useful pollinators or even other predators.

Similar to other beneficial invertebrates, spiders can't survive in orchards where broad spectrum insecticides have been used. To encourage their presence, growers might want to adopt IPM practices or go organically.

Chemicals that impact 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 Methomyl used to control bronze beetle that attacks foliage and developing fruit while some flowers are still present.

Pest Identification Sheet

In an effort to help identify the pests in their crop, Berryworld encourages growers to collect specimens in small jars with some leaves/foliage and send them in to MPI for identification. The cost is $125 +GST per species (if you find two of the same species, the charge will still be $125 +GST).

This is in accordance with a new Berryworld initiative where all responses from MPI will also be sent to Berryworld. This allows us to map what pest species were found where, in what numbers roughly and at what time of the year. This will provide us with the information needed to find better control strategies.

As we begin to map out what species are found in what regions, we will be able to provide better advice as to control strategies tailored more specifically on areas and microclimates as well as growing systems.

See next page for Pest Identification form. Please print this, fill it out and send with any insect samples via courier to:

MPI Plant Health & Environment Laboratory

14 Sir William Pickering Drive

Burnside

Christchurch.

Attention: Diane Anderson.

Under the 'Submitter Reference/Comments' field please include the following:

Blueberry-Berryworld Pest Initiative

Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Lab Reference

Plant Health & Environment Laboratory Submission Form

ACTIVITY: ☐ GENERAL SURVEILLANCE ☐ POST BORDER ☐ RESPONSE and INVESTIGATION

☐ OTHER ACTIVITY – _____

Name and address for final reply:

_____
_____
_____
_____
_____

Email: _____
Phone: ( ) _____

Specimen Collection Date: _____

Collector's Name & Address if Different:

_____
_____
_____
_____

Email: _____
Phone: ( ) _____

Incursion Investigation contact, case number & name:

Investigation & Response phase: ☐ Investigation ☐ Delimiting Survey ☐ Response ☐ Ongoing Monitoring

Location (Crosby code): _____
Type of Property (e.g. glasshouse, home garden, TF):
_____
Country of Origin (if Post Border): _____

Site Owner/Contact: _____
Site Address: _____
_____
GIS Coordinates: _____

TYPE OF SUSPECTED ORGANISM:

☐ **Insect – Type:** _____
Life stage: ☐ Egg ☐ Larva ☐ Pupa ☐ Adult
Life state when found: ☐ Alive ☐ Dead ☐ Unknown

☐ Bacteria ☐ Fungus ☐ Nematode ☐ Virus

☐ Plant ☐ Seed

☐ Other: _____

HOST IT WAS FOUND ON:

Inanimate (container, pallets, etc): _____
Scientific Name: _____
Cultivar: _____
Common Name: _____
Type of Damage/Symptoms: _____
Number of specimens or affected plants found:
_____

Submitter Reference / Comments :

– LABORATORY USE ONLY –

Testing Discipline(s): ☐ Ento. ☐ Myco. ☐ Bact. ☐ Viro. ☐ Nem. ☐ Bot. ☐ Other (specify): _____

Comments:

Please note: this form is not to be used as a reply letter to the general public

Blueberry Diseases

Anthracnose

Colletotrichum acutatum, Colletotrichum gloeosporioides

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.

Bacterial Blast

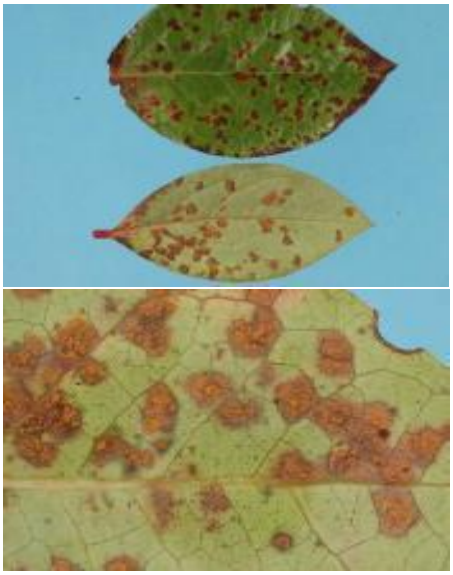
Pseudomonas syringae

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.

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. Lime sulphur has been used as well but can have phytotoxic effects. The main emphasis is on protection of new plant tissue, as there are no effective eradication materials once infection has established.

Variety Rust Susceptibility Chart

Variety	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

Blueberry Mosaic Virus

This virus has only been found in blueberry plants (*Vaccinium Sp.*) 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 yellow-green 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 fungus 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.

Botryosphaeria

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 fungus and/or disease has 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 then apply a suitable fungicide to the pruning wound to prevent future infection. Herbicide damaged areas increase the possibility of infection by Botryosphaeria, therefore care should be taken when applying herbicides not to damage the blueberry plants.

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.

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.

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 increased chances of 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.

Disease Identification Sheet

Growers that suspect they have a disease problem are encouraged to send samples down to Plant Diagnostics for identification. Identifying what the issue is greatly improves a grower's ability to manage their plants and prevent/cure any prevalent diseases.

Plant diagnostics fees vary on the type of the disease. The standard price is around $225 per sample though it can be less/more depending on what is required for identification. Plant Diagnostics will always confirm prices with you prior to performing the identifications.

See next page for Pest Identification form. Please print this, fill it out and send with any symptomatic samples to:

Plant Diagnostics Ltd

185 Kirk Road

Templeton

Christchurch 7678

Canterbury

PLANT
DIAGNOSTICS

Lab Accession No.

PLANT DIAGNOSTICS Ltd
PO Box 23122, Hornby, Christchurch 8441
185 Kirk Road, Templeton, Christchurch 7678
Phone: (03) 377 9026 Mobile: (027) 486 9026 Fax: (03) 332 9933
Email: enquiries@plantdiagnostics.co.nz Web: www.plantdiagnostics.co.nz

SPECIMEN SUBMISSION FORM

Name of Rep. _____
Company Address _____

Phone/Fax # _____
Email _____

AND/OR

INVOICE TO: (tick one)

Grower/Client _____
Business & Address/Location _____

Phone/Fax # _____
Email _____

Purchase Order # _____

Host/Plant Species/Cultivar	Date Collected

Symptoms/signs _____

Useful information (age of plant & location, soil mix/type, sprays, fertilisers etc.) _____

Dispatching Instructions prior to boxing or packaging

Where possible send 2-3 whole plants showing symptoms representative of the problem. Avoid specimens with severe rotting. Wrap roots with soil attached in damp (not wet) newspaper and enclose roots in a plastic bag secured around the stem. Place whole plant in a sturdy plastic bag containing 1-2 damp (not wet) paper towels. Fold top of bag over, do not seal. Place in outer packaging for courier dispatch.

Soil samples: Place into double sturdy plastic bags. Roots can be included with the soil. Whole plants can be cut into manageable sections before packaging for easier transport.

Please note: Our PO Box should only be used for letters and other correspondence.

Please do not post to our street address.

Please Courier to:

PLANT DIAGNOSTICS Ltd
185 Kirk Road
Templeton
Christchurch 7678
Canterbury

Couriers who service Templeton include:

- NZ Couriers (Recomended)
- Courier Post
- Fastway Couriers

Birds

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.

Biosecurity Issues (Not in NZ yet)

The organisms in this section are not currently in NZ but it is important for growers to be aware of potential biosecurity risks as if any of the mentioned pests establish in NZ, there'll be a major impact on berry fruit industries.

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.

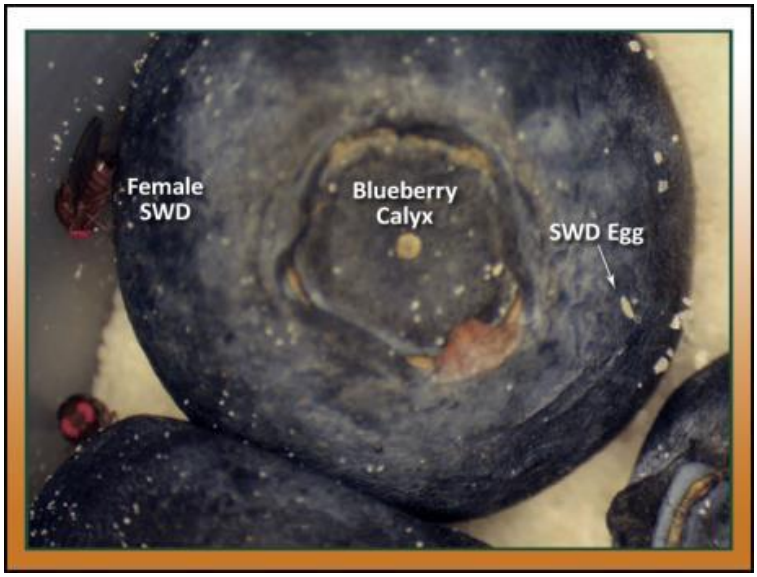
The invertebrate pest spotted wing drosophila or the mummy berry disease are major issues overseas and will cause serious economic harm to NZ berry fruit industries if either ever established in NZ. There are also a large number of other pests and diseases currently not established in NZ. Keeping these 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.

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.

Spotted Wing Drosophila

This species of fruit fly is considered to be the biggest concern for berry industries all across New Zealand. It has rapidly spread across continents all over the world but has not managed to establish in New Zealand or Australia yet (though there have been numerous incursions that have been detected and stopped early on).

The damage that SWD poses is primarily due to the oviposition and pupation of eggs taking place both inside and 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

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.

Disorders/Impairments of Blueberries

Replanting after Persimmons

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 variety susceptibility are all contributing factors.

Phenoxy-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

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.

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.

Northern Highbush Spray List

	Traditional/Broad Spectrum
	IPM Compatible
	Organic

System: Northern Highbush Covered/Uncovered – Early Season Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Success	spinosad	
Bronze Beetle	Karate	lambda-cyhalothrin	
	Lorsban	chlorpyrifos	
Aphids	Lorsban	chlorpyrifos	
Scale Insects	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Mealybugs	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Thrips	Karate	lambda-cyhalothrin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Switch	cyprodinil/fludioxonil	
	Bravo	chlorothalonil	Protectant
	Dithane	mancozeb	Protectant
Phytophthora	Phosgard	phosphorous acid	Protectant (can use over top of plants)
	Ridomil	metalaxyl-m/mancozeb	soil treatment
Bacterial Blast	Copper	cuprous oxide	Can leave a physical residue
Early Rot	Copper	cuprous oxide	Can leave a physical residue
Blueberry Leaf Rust	Dithane	mancozeb	Protectant
	Bacstar	Biological Control	Use with an adjuvant; It should be applied prior to or in the early stages of disease development.
	Copper	cuprous oxide	Can leave a physical residue
	Bravo	chlorothalonil	
	Lime Sulphur	sulphur	Potentially phytotoxic, use pre bud-break

Botryosphaeria	Dithane	mancozeb	Apply to pruning wounds
Botrytis	Switch	cyprodinil/fludioxonil	
	Clarity	Biological Control	Exempt
	Bravo	chlorothalonil	

System: Northern Highbush Covered/Uncovered – Close to Harvest Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Methomyl	methomyl	
	Prodigy	methoxyfenozide	
	Proclaim	Emamectin benzoate	
	Sparta	spinetoram	
	Delfin	Biological Control	
Bronze Beetle	Methomyl	methomyl	
	Pyganic	pyrethrin	
Aphids	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Pyganic	pyrethrin	
	Movento	spirotetramat	
	Aphidoletes	Biological Control	
	Aphipar	Biological Control	
	Clenza	fatty acids	
	Naturally Neem	Neem oil/azadirachtin	
	Orius	Biological Control	
Grass Grub (Adults)	Sevin Flo	carbaryl	
Scale Insects	Transform	sulfoxaflor	
	D C Tron	Mineral Oil	Potentially phytotoxic (higher percentage/strength can cause burning)
	Lime Sulphur	sulphur	Potentially phytotoxic, pre bud-break
	Naturally Neem	Neem oil/azadirachtin	
	Movento	spirotetramat	
	Sevin Flo	carbaryl	
Mealybugs	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Movento	spirotetramat	
	Clenza	fatty acids	
	Sevin Flo	carbaryl	
	Naturally Neem	Neem oil/azadirachtin	

Thrips	Transform	sulfoxaflor	
	Success	spinosad	
	Pyganic	pyrethrin	
	Clenza	fatty acids	
	Limonicus	Biological Control	
	D C Tron	Mineral Oil	
	Mite A	Biological Control	
	Sevin Flo	carbaryl	
	Sparta	spinetoram	
	Movento	spirotetramat	
	Orius	Biological Control	
	Hyper Mite	Biological Control	
	Naturally Neem	Neem oil/azadirachtin	
Mites	Limonicus	Biological Control	
	Mit E Mec	milbemectin	
	Mite A	Biological Control	
	Avid	abamectin	
	Kumulus	sulphur	(Not lime sulphur), Leaves a physical residue
	Omite	propargite	
	Varied	Oils	
	Naturally Neem	Neem oil/azadirachtin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Chief	carbendazim	
	Clarity	Biological Control	
Phytophthora	Phosgard	phosphorous acid	
Early Rot	Chief	carbendazim	
Blueberry Leaf Rust	Copper	cuprous oxide	Can leave a physical residue
	Sporekill	didecyldimethylammonium chlorine	
Botryosphaeria	Chief	carbendazim	
	Bravo	chlorothalonil	
Botrytis	Thiram	thiram	
	Mizar Granuflo	ziram	
	Captan	captan	
	Sentinel	Biological Control	
	Botry-zen	Biological Control	

Rabbiteye System Spray List

	Traditional/Broad Spectrum
	IPM Compatible
	Organic

System: Rabbiteye Covered/Uncovered – Early Season Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Success	spinosad	
Bronze Beetle	Karate	lambda-cyhalothrin	
	Lorsban	chlorpyrifos	
Aphids	Lorsban	chlorpyrifos	
Scale Insects	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Mealybugs	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Thrips	Karate	lambda-cyhalothrin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Switch	cyprodinil/fludioxonil	
	Bravo	chlorothalonil	Protectant
	Dithane	mancozeb	Protectant
Phytophthora	Phosgard	phosphorous acid	Protectant (can use over top of plants)
	Ridomil	metalaxyl-m/mancozeb	soil treatment
Bacterial Blast	Copper	cuprous oxide	Can leave a physical residue
Early Rot	Copper	cuprous oxide	Can leave a physical residue
Blueberry Leaf Rust	Dithane	mancozeb	Protectant
	Bacstar	Biological Control	Use with an adjuvant; It should be applied prior to or in the early stages of disease development.
	Copper	cuprous oxide	Can leave a physical residue

	Bravo	chlorothalonil	
	Lime Sulphur	sulphur	Potentially phytotoxic, use pre bud-break
Botryosphaeria	Dithane	mancozeb	Apply to pruning wounds
Botrytis	Switch	cyprodinil/fludioxonil	
	Clarity	Biological Control	Exempt
	Bravo	chlorothalonil	

System: Rabbiteye Covered/Uncovered – Close to Harvest Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Methomyl	methomyl	
	Prodigy	methoxyfenozide	
	Proclaim	Emamectin benzoate	
	Sparta	spinetoram	
	Delfin	Biological Control	
Bronze Beetle	Methomyl	methomyl	
	Pyganic	pyrethrin	
Aphids	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Pyganic	pyrethrin	
	Movento	spirotetramat	
	Aphidoletes	Biological Control	
	Aphipar	Biological Control	
	Clenza	fatty acids	
	Naturally Neem	Neem oil/azadirachtin	
	Orius	Biological Control	
Grass Grub (Adults)	Sevin Flo	carbaryl	
Scale Insects	Transform	sulfoxaflor	
	D C Tron	Mineral Oil	Potentially phytotoxic (higher percentage/strength can cause burning)
	Lime Sulphur	sulphur	Potentially phytotoxic, pre bud-break
	Naturally Neem	Neem oil/azadirachtin	
	Movento	spirotetramat	
	Sevin Flo	carbaryl	
Mealybugs	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Movento	spirotetramat	
	Clenza	fatty acids	

	Sevin Flo	carbaryl	
	Naturally Neem	Neem oil/azadirachtin	
Thrips	Transform	sulfoxaflor	
	Success	spinosad	
	Pyganic	pyrethrin	
	Clenza	fatty acids	
	Limonicus	Biological Control	
	D C Tron	Mineral Oil	
	Mite A	Biological Control	
	Sevin Flo	carbaryl	
	Sparta	spinetoram	
	Movento	spirotetramat	
	Orius	Biological Control	
	Hyper Mite	Biological Control	
	Naturally Neem	Neem oil/azadirachtin	
Mites	Limonicus	Biological Control	
	Mit E Mec	milbemectin	
	Mite A	Biological Control	
	Avid	abamectin	
	Kumulus	sulphur	(Not lime sulphur), Leaves a physical residue
	Omite	propargite	
	Varied	Oils	
	Naturally Neem	Neem oil/azadirachtin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Chief	carbendazim	
	Clarity	Biological Control	
Phytophthora	Phosgard	phosphorous acid	
Early Rot	Chief	carbendazim	
Blueberry Leaf Rust	Copper	cuprous oxide	Can leave a physical residue
	Sporekill	didecyldimethylammonium chlorine	
Botryosphaeria	Chief	carbendazim	
	Bravo	chlorothalonil	
Botrytis	Thiram	thiram	
	Mizar Granuflo	ziram	
	Captan	captan	
	Sentinel	Biological Control	
	Botry-zen	Biological Control	

Southern Highbush System Spray List

	Traditional/Broad Spectrum
	IPM Compatible
	Organic

System: Southern Highbush Covered/Uncovered – Early Season Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Success	spinosad	
Bronze Beetle	Karate	lambda-cyhalothrin	
	Lorsban	chlorpyrifos	
Aphids	Lorsban	chlorpyrifos	
Scale Insects	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Mealybugs	Lorsban	chlorpyrifos	
	Applaud	buprofezin	
Thrips	Karate	lambda-cyhalothrin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Switch	cyprodinil/fludioxonil	
	Bravo	chlorothalonil	Protectant
	Dithane	mancozeb	Protectant
Phytophthora	Phosgard	phosphorous acid	Protectant (can use over top of plants)
	Ridomil	metalaxyl-m/mancozeb	soil treatment
Bacterial Blast	Copper	cuprous oxide	Can leave a physical residue
Early Rot	Copper	cuprous oxide	Can leave a physical residue
Blueberry Leaf Rust	Dithane	mancozeb	Protectant
	Bacstar	Biological Control	Use with an adjuvant; It should be applied prior to or in the early stages of disease development.
	Copper	cuprous oxide	Can leave a physical residue
	Bravo	chlorothalonil	
	Lime Sulphur	sulphur	Potentially phytotoxic, use pre bud-break
Botryosphaeria	Dithane	mancozeb	Apply to pruning wounds

Botrytis	Switch	cyprodinil/fludioxonil	
	Clarity	Biological Control	Exempt
	Bravo	chlorothalonil	

System: Southern Highbush Covered/Uncovered – Close to Harvest Sprays			
Pest	**Example Trade Name**	**Chemical**	**Comments**
Leafroller	Methomyl	methomyl	
	Prodigy	methoxyfenozide	
	Proclaim	Emamectin benzoate	
	Sparta	spinetoram	
	Delfin	Biological Control	
Bronze Beetle	Methomyl	methomyl	
	Pyganic	pyrethrin	
Aphids	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Pyganic	pyrethrin	
	Movento	spirotetramat	
	Aphidoletes	Biological Control	
	Aphipar	Biological Control	
	Clenza	fatty acids	
	Naturally Neem	Neem oil/azadirachtin	
	Orius	Biological Control	
Grass Grub (Adults)	Sevin Flo	carbaryl	
Scale Insects	Transform	sulfoxaflor	
	D C Tron	Mineral Oil	Potentially phytotoxic (higher percentage/strength can cause burning)
	Lime Sulphur	sulphur	Potentially phytotoxic, pre bud-break
	Naturally Neem	Neem oil/azadirachtin	
	Movento	spirotetramat	
	Sevin Flo	carbaryl	
Mealybugs	Transform	sulfoxaflor	
	Methomyl	methomyl	
	Movento	spirotetramat	
	Clenza	fatty acids	
	Sevin Flo	carbaryl	
	Naturally Neem	Neem oil/azadirachtin	
Thrips	Transform	sulfoxaflor	

	Success	spinosad	
	Pyganic	pyrethrin	
	Clenza	fatty acids	
	Limonicus	Biological Control	
	D C Tron	Mineral Oil	
	Mite A	Biological Control	
	Sevin Flo	carbaryl	
	Sparta	spinetoram	
	Movento	spirotetramat	
	Orius	Biological Control	
	Hyper Mite	Biological Control	
	Naturally Neem	Neem oil/azadirachtin	
Mites	Limonicus	Biological Control	
	Mit E Mec	milbemectin	
	Mite A	Biological Control	
	Avid	abamectin	
	Kumulus	sulphur	(Not lime sulphur), Leaves a physical residue
	Omite	propargite	
	Varied	Oils	
	Naturally Neem	Neem oil/azadirachtin	
Disease	**Example Trade Name**	**Chemical**	**Comments**
Anthracnose	Chief	carbendazim	
	Clarity	Biological Control	
Phytophthora	Phosgard	phosphorous acid	
Early Rot	Chief	carbendazim	
Blueberry Leaf Rust	Copper	cuprous oxide	Can leave a physical residue
	Sporekill	didecyldimethylammonium chlorine	
Botryosphaeria	Chief	carbendazim	
	Bravo	chlorothalonil	
Botrytis	Thiram	thiram	
	Mizar Granuflo	ziram	
	Captan	captan	
	Sentinel	Biological Control	
	Botry-zen	Biological Control	

Chemical	Example Product	NZ Tolerance	Aus Tolerance	NZ/Aus WP[1]	HK Tolerance	Hong Kong WP	Taiwan Tolerance	Taiwan WP	Japan Tolerance	Japan WP	Codex Tolerance	Codex WP
#abamectin	Avid	0.1	0.02	3	NL	14	0.02	7	NL	14	NL	14
Biological Controls*	Biological Controls*	0	0	Exempt	0	Exempt	0	Exempt	0	Exempt	0	Exempt
captan	Captan	10	20	1	20	1	20	1	20	1	20	1
#carbendazim	Goldazim	5	NL	3	1	28	2	15	3	3	1	28
#buprofezin	Applaud	0.1	0.05	60	NL	BF	NL	BF	NL	BF	NL	BF
carbaryl	Sevin Flo	3	0.02	1	NL	BF	0.5	42	7	1	NL	BF
#chlorothalonil	Bravo	10	10	7	10	7	1	BF	1	BF	NL	BF
#chlorpyrifos	Lorsban	0.2	NL	BF	NL	BF	1	BF	1	BF	NL	BF
copper sprays:	Nordox	0	0	Exempt	NL	BF	0	Exempt	0	Exempt	NL	BF
cyprodinil/fludioxonil	Switch	0.5/0.5	3.0/3.0	28	NL	BF	3.0/2.0	28	5.0/2.0	28	10/2.0	28
#didecyldimethylammonium chlorine	Sporekill	0	NL	Exempt	NL	BF	NL	BF	NL	BF	NL	BF
#emamectin benzoate	Proclaim	0.1	0.07	10	NL	BF	NL	BF	0.1	10	NL	BF
Fatty acids	Clenza	0	NL	Exempt	0	Exempt	NL	BF	NL	BF	NL	BF
#lambda-cyhalothrin	Karate	0.1	0.2	14	0.2	7	1	7	0.5	7	0.2	7
mancozeb	Manzate	7	15	14	10	14	5	14	5	14	NL	BF
#metalaxyl-m/mancozeb	Ridomil	2.0/7.0	0.5/15.0	14	NL	BF	2.0/5.0	14	2.0/5.0	14	NL	BF
methomyl	Methomyl	0.5	2	2	6	2	2	2	1	2	NL	BF
methoxyfenozide	Prodigy	0.8	2	7	4	7	4	7	4	7	4	7
#milbemectin	Mit E Mec	0.1	NL	5	NL	BF	0.2	8	NL	BF	NL	BF
Mineral Oil	D C Tron	0	0	Exempt	0	Exempt	0	Exempt	0	Exempt	NL	BF
Neem oil/azadirachtin	Naturally Neem	0	NL	Exempt	0	Exempt	0	Exempt	0	Exempt	NL	BF
#phosphorous acid	Phosgard	0	NL	Exempt	NL	Exempt	NL	Exempt	70	7	NL	Exempt
propargite	Omite	3	NL	3	NL	BF	NL	BF	NL	BF	NL	BF
#pyrethrins	Pyrethrum	1	1	1	1	1	NL	BF	1	3	NL	BF
#spinetoram	Sparta	0.1	0.5	1	NL	BF	0.2	3	0.5	2	0.2	1
#spinosad	Success	0.1	0.7	7	0.7	7	0.4	7	0.4	7	0.4	7
spirotetramat	Movento	0.7	3	7	NL	BF	NL	BF	3	6	1.5	7
#sulfoxaflor	Transform	0.1	0.7	10	NL	BF	NL	BF	0.7	7	NL	BF
thiram	Thiram	7	15	7	10	7	5	7	5	7	NL	BF
#ziram	Mizar	7	15	14	10	14	5	14	5	14	NL	BF

Other materials and other export destinations: Use products only before flowering or check with Rob Silberbauer of Berryworld, ph 0211277328, e-mail rob@berryworld.co.nz about use options. Mineral oils and biological products are not usually covered by residue tolerances and are normally exempt

BF: Use only before flowering or after harvest NL: Not listed – normally non detectable is required although a default level of 0.1mg/kg applies in New Zealand and Canada

No label claim exists for this product. Any use is at grower's own risk

*In general biological controls are exempt but there are a few exceptions to this rule. Contact Berryworld or horticultural advisor to confirm.

Note 1: Australia will normally accept tolerances established in New Zealand on imported produce

The above notes on pest and disease control and pesticide residues are presented after consideration of the information available. However no assurances can be given on pest and disease control, or that plant damage will not result from use of this information. No assurances are given that produce, treated with chemicals according to the above list will be acceptable to the countries to which it may be exported. Berryworld Ltd and Blueberries New Zealand Inc disclaim all liabilities arising from the use of the above information. If in doubt contact your exporter or adviser.

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Biography

For further information on pests and diseases in blueberries, the following publications are suggested:

Which New Zealand Insect? Andrew Crowe. Penguin Books 2002 ISBN 0 14 100636 6

New Zealand Insect Pests D N Fero Caxton Press 1976

Compendium of Blueberry and Cranberry Diseases. F L Caruso and D C Ramsdell APS Press 1995 ISBN 0-89054-198-1

Blueberry Diseases in Michigan. Michigan State Extension Bulletin E-1730 www.msue.msu.edu/vanburen/e-1731.htm

Michigan State Blueberry Fruit Rot Identification Guide http://www.blueberryfacts.org/fruitrot.html