3 New Zealand's commercial production practices for apples

This chapter provides information on the pre-harvest, harvest and post-harvest practices of the New Zealand apple industry for the production of fresh apple fruit for export. The practices described in this section are considered to be standard practice for all export apple production and Biosecurity Australia has taken them into consideration when estimating the unrestricted risk of pests that may be associated with the import of this commodity.

While general information on New Zealand apple production is provided, the focus is on those practices relevant to the three pests that this review considers: fire blight, European canker, and apple leaf curling midge.

Figure 3-1 Map of New Zealand[4]

3.1 Climate in production areas[5]

Apple production in New Zealand occurs on both the north and south islands, with two main production districts accounting for nearly 90 per cent of the total plantings. The first and most significant of the production districts is Hawke's Bay, which includes the adjacent cities of

[4] Map from http://www.newzealand.com/travel/images/maps/bloggers/newzealandmap_large_en.jpg

[5] Climate descriptions are taken from http://www.niwa.co.nz/education-and-training/schools/resources/climate/overview

Napier and Hastings. Hawke's Bay is located on the east coast of the north island at a latitude of 39.5°S, placing it slightly south of Melbourne, Victoria.

The second major production district is around Nelson located at the northern end of New Zealand's south island at a latitude of 41.3°S. Nelson is at a latitude similar to Devonport, Tasmania.

The third production district of note is Central Otago, located in the southern central region of New Zealand's south island and includes the cities of Alexandra, Clyde, Cromwell and Queenstown. At a latitude of around 45°S, the district is slightly further south than the southernmost parts of Tasmania.

New Zealand has a wide range of climatic conditions, from warm subtropical conditions in the northernmost areas of the north island, to cool temperate conditions at the southernmost areas of the south island. Severe alpine conditions also occur in the mountainous areas of the southern island.

The two largest production areas, Hawke's Bay and Nelson are located close to the coast and therefore do not experience extreme temperatures, the proximity of the Southern Ocean moderating the climatic conditions. Hawke's Bay is sheltered by mountains to the west and experiences warm, dry summers. Summer daytime temperatures reach 28°C, but rarely exceed 32°C. Winter is mild to cool.

Nelson has similar summer conditions, also being dry, though with temperatures reaching 26°C and only occasionally exceeding 30°C. Winters are colder than in Hawke's Bay, but are still regarded as mild.

In contrast, the Central Otago region, being further inland to the other regions experiences more severe winter conditions. Winter temperatures are very cold with frequent frosts and with daytime temperatures rarely exceeding 11°C. The Central Otago region receives only around one-third the total rainfall experienced in Nelson and Hawke's Bay.

The graphs presented below provide an indication of average daily maximum and minimum temperatures, as well as average rainfall for four sites in New Zealand where apples are grown. While only a small proportion of export apples are grown there, the Waikato district, represented by Hamilton, is included because it provides an indication of the climatic conditions in the north of the island. Substantial research into apple production has also been undertaken there. The graphs indicate the similar summer temperatures in all of these regions, though also highlight the comparatively cold winters experienced in the Central Otago region. The annual rainfall, based on a 30-year average is 360mm for the Central Otago, 803mm for Hawke's Bay, 970mm for Nelson, and 1190mm for the Waikato.

For comparison, the annual rainfall based on a 30-year average in major apple production regions in Australia is 779mm for Stanthorpe, 967mm for Batlow, 454mm for Goulburn Valley, 1008mm for the Adelaide hills, 887mm for Huon Valley and 899mm for Donnybrook. Graphs are also presented for major apple production regions in Australia (Figures 3-2 to 3-11).

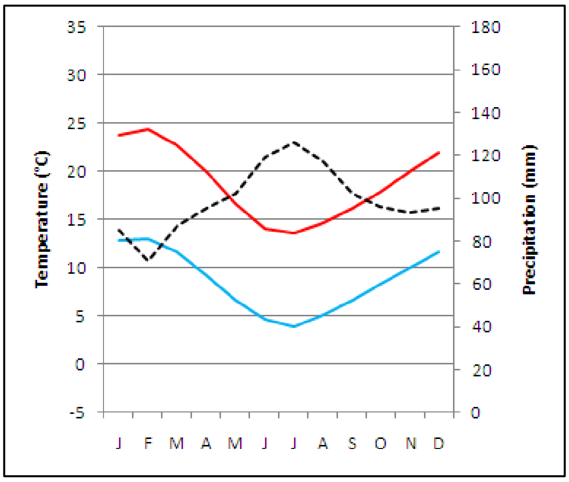


Figure 3-2 Maximum and minimum temperatures and mean monthly rainfall for Hamilton (Waikato) 1971–2000[6]

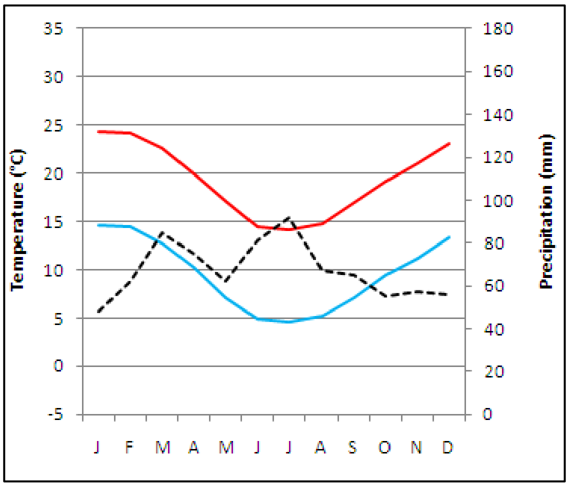
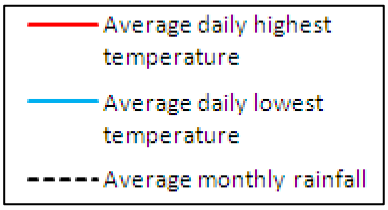


Figure 3-3 Maximum and minimum temperatures and mean monthly rainfall for Napier (Hawke's Bay) 1971–2000[6]



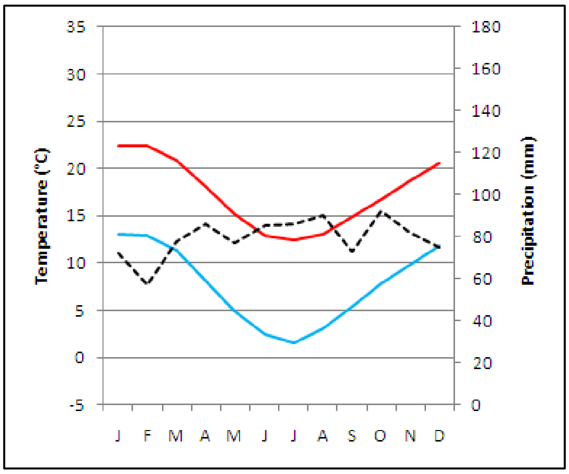


Figure 3-4 Maximum and minimum temperatures and mean monthly rainfall for Nelson 1971–2000[6]

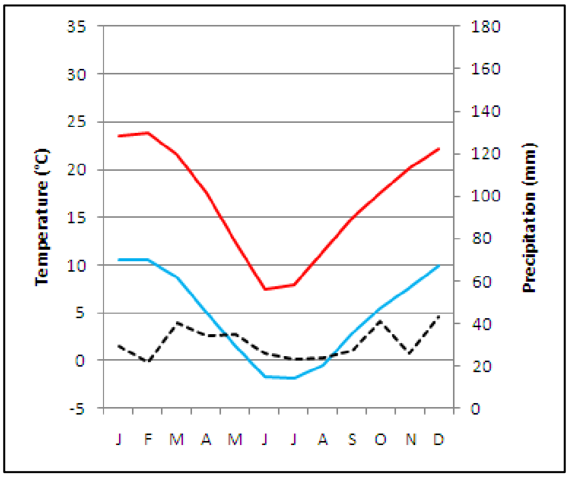


Figure 3-5 Maximum and minimum temperatures and mean monthly rainfall for Alexandra (Central Otago) 1971–2000[6]

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[6] Climate data from National Institute of Water and Atmospheric Research. http://www.niwa.co.nz/education-and-training/schools/resources/climate

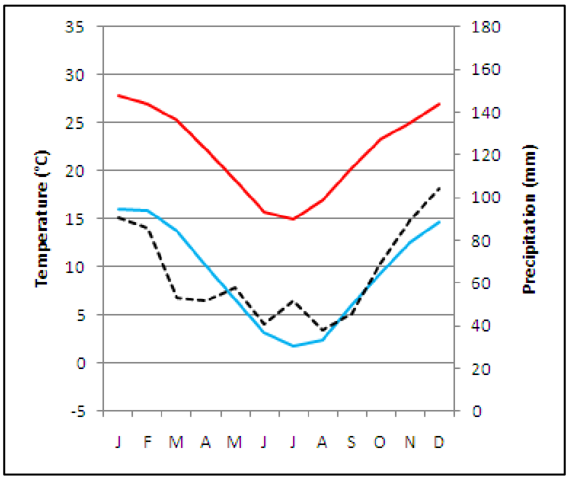


Figure 3-6 Maximum and minimum temperatures and mean monthly rainfall for Stanthorpe, Qld. 1981–2010[7]

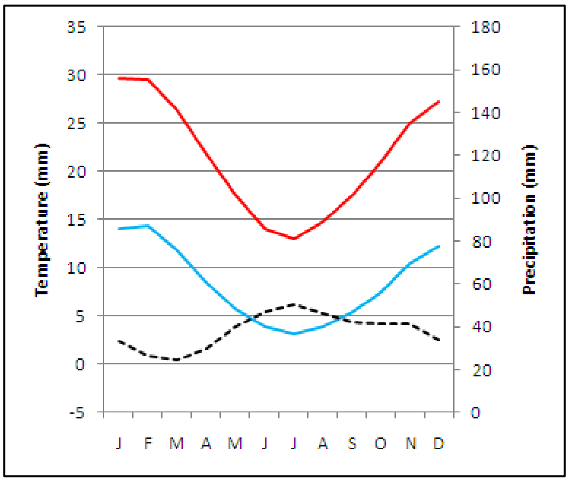


Figure 3-8 Maximum and minimum temperatures and mean monthly rainfall for Tatura, Vic. (Goulburn Valley) 1981–2010[7]

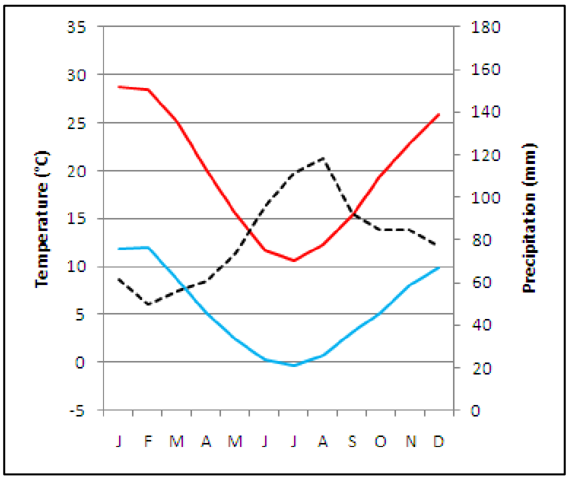


Figure 3-7 Maximum and minimum temperatures and mean monthly rainfall for Batlow[8], NSW 1971–2000[7]

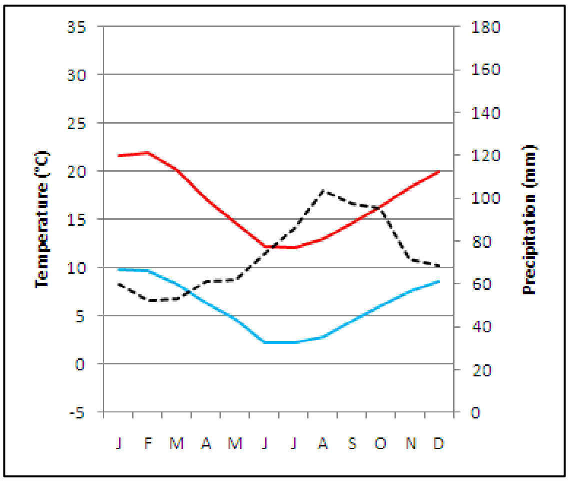
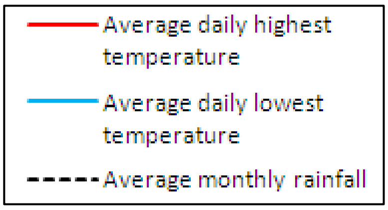


Figure 3-9 Maximum and minimum temperatures and mean monthly rainfall for Geeveson, Tas. (Huon Valley) 1981–2010[7]



[7] Climate data from Bureau of Meteorology http://www.bom.gov.au/climate/data/index.shtml?bookmark=200

[8] Batlow data taken from Tumbarumba weather station

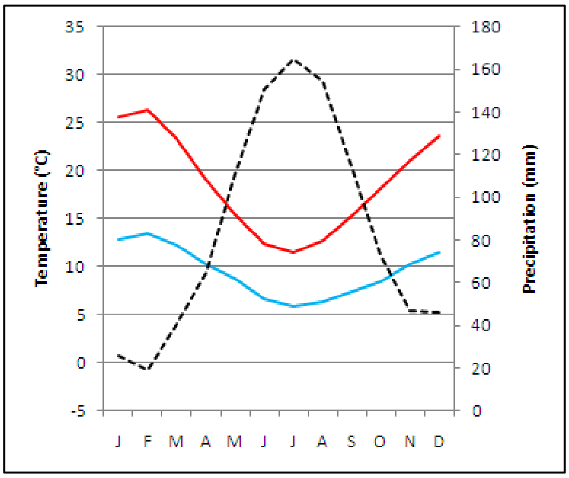


Figure 3-10 Maximum and minimum temperatures and mean monthly rainfall for Lenswood, SA (Adelaide Hills) 1981–2010[7]

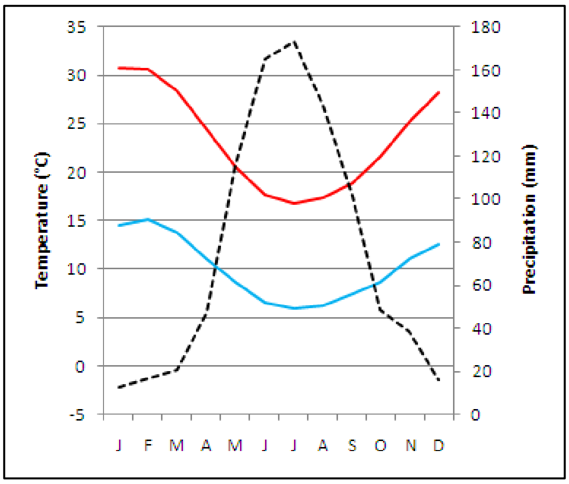
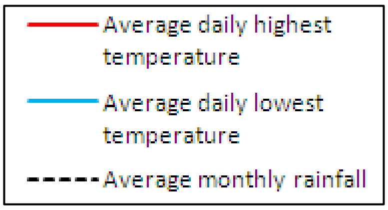


Figure 3-11 Maximum and minimum temperatures and mean monthly rainfall for Donnybrook WA 1981–2010[7]



3.2 Pre-harvest

3.2.1 Orchard layout

For registration and trace back purposes, apple orchards can be divided into a number of smaller units. These include the orchard, the production site and variety/orchard blocks.

An orchard is defined as the total planting in a single location and has its boundary defined by the registered owner/grower. An orchard is covered by a single Registered Property Identification Number (RPIN). Depending on size, orchards may be divided into a number of production sites. Division into production sites are for administrative and pest management purposes.

Most orchards, if not all, grow a number of different varieties of apples and may have multiple plantings of a particular variety in different areas within the orchard. Within an orchard, each continuous planting of a single variety of apple is defined as an orchard block or variety block. Fruit being packed in a packing house, fruit can be traced back to a specific orchard block and in some cases specific rows within that orchard block.

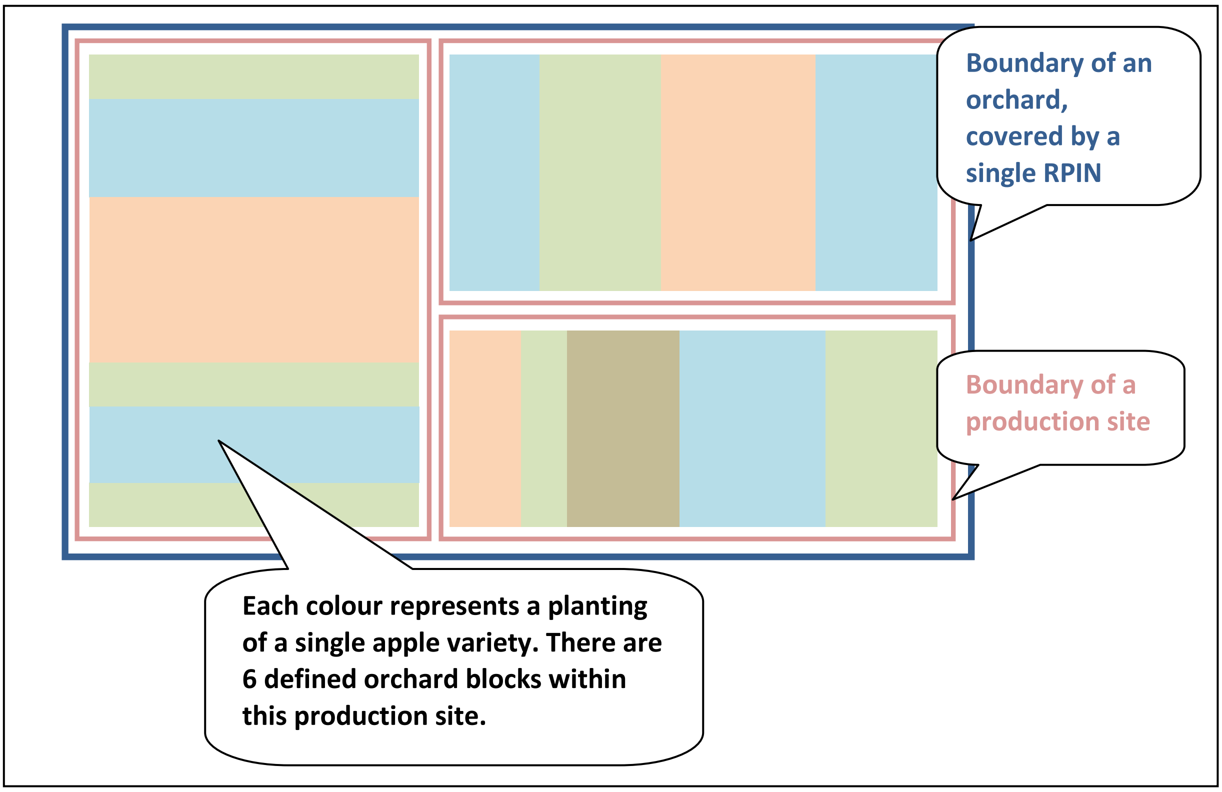


Figure 3-12 Representation of divisions within an orchard

3.2.2 Cultivars

In 2010 there was 9 061 hectares of apple and pear production in New Zealand, with 60 per cent of this in the Hawke's Bay district and 28 per cent in the Nelson district (Pipfruit NZ 2010). The Central Otago region is also noted for apple production, but includes only 4 per cent of New Zealand's total number of hectares under production. This is a slight increase over the total planted area of 8 896 hectares in 2009.

While a range of apple varieties are available in New Zealand, the varieties with the greatest planted area in 2010 were Royal Gala (27 per cent), Braeburn (21 per cent), Jazz™ (11 per cent), and Fuji (11 per cent). Other varieties include Cox, Cripps Pink (Pink Lady), Granny Smith, Pacific Beauty™, Pacific Queen™, and Pacific Rose™ (Pipfruit NZ 2010). Pear orchards make up only a relatively small proportion of the total pipfruit production, with 431 hectares reported in 2010.

3.2.3 Cultivation practices

Commercial apple plantings in New Zealand are typically grown on grafted rootstock. The use of grafted rootstocks, particularly clonal rootstocks, is preferred as it allows for control over tree size, ripening of fruit and may also confer resistance to certain pests and diseases. While a range of rootstocks are available, the New Zealand industry indicated that the M9 variety is most commonly used for new plantings (BSG 2011). M9 rootstock produces a small tree around 3–4 metres high which bears large fruit, comes into commercial production within three years from planting and is considered fully grown in five to six years. Plantings of apple trees on M9 rootstock have a between tree spacing of one metre and a between row spacing of three metres. M9 rootstock or another dwarfing variety is preferred due to the moderate growth habit and shorter trees which assist with pest management, spray application and harvesting.

Canopy management varies between orchards, dependent largely on age, though most trees are pruned and trained to keep most growth parallel to the row. Branches are trained into a mostly horizontal position to encourage fruit bearing over vegetative growth. While the canopies are open, reflective sheets on the orchard floor are used for up to two weeks prior to harvest to promote full fruit colouring.

Orchard irrigation is most commonly delivered by drip irrigation (BSG 2011). Overhead sprinklers are not commonly used in New Zealand apple orchards, their use being mostly limited in use to the Central Otago Region. Use of overhead irrigation in other regions is avoided due to the potential to result in problems with apple scab (caused by *Venturia inaequalis*) early in the season (MAFNZ 2011). Where used, overhead sprinklers can assist in managing the potential for frost damage.

According to the Pipfruit Industry Statistical Annual the 2009 export production was 302 075 tonnes from 8 484 hectares, or an export yield of around 35 tonnes per hectare across all varieties of apples. In addition to this there was an export yield of 5 421 tonnes of pears from 412 hectares (Pipfruit NZ 2010). Export yield does not include fruit for the domestic market, or for processing and juicing facilities. The World Apple and Pear Association reported a total 2009 New Zealand production of 466 000 tonnes (WAPA 2010), or around 54 tonnes per hectare. However, these figures are inferred values from export volumes and average pack-out (MAFNZ 2011). Significantly higher yields are reported in a number of the orchards visited in March 2011, with yields of 75–100 tonnes per hectare expected from recently established orchards (BSG 2011).

3.2.4 Pest management

In 1996, the Integrated Fruit Production program was first introduced for New Zealand pipfruit. In subsequent years it was rapidly adopted by the apple and pear industry with 100 per cent adoption for export grown fruit reported by 2001 (Wiltshire 2003). The IFP program has been further developed with the Apple Futures program (Pipfruit NZ 2008a) with an emphasis on managing chemical residues to the lowest levels possible. In 2010, 87 per cent of total planted area was managed under IFP (including Apple Futures), 11 per cent as organic; while only 2 per cent of the total planted area produced solely for the domestic market (Pipfruit NZ 2010).

While the IFP program is proprietary information that covers all aspects of pipfruit production in New Zealand, it contains information that is relevant to the management of the pests and diseases considered in this review. Those key aspects of the IFP program are outlined below.

Fire blight management

In New Zealand, management of fire blight focuses on reducing inoculum levels through cultural practices in the orchard and use of chemical or biological controls during the most susceptible infection period, blossom time. The decision to apply chemical or biological control measures is supported by a computer model based warning system that considers temperatures, wetness periods and fire blight prevalence in the surrounding area. The model operated by Pipfruit New Zealand is available to registered growers through the Pipfruit New Zealand website and is derived from the Maryblyt and Cougarblyt models developed in the USA and adapted for New Zealand conditions.

The risk period for infection by *E. amylovora* in New Zealand is during blossom. Unlike some other regions of the world, New Zealand's apple growing areas do not experience severe frosts later in the season that can cause cracking of branches that provide opportunity for secondary infections. The risk factors for fire blight infections are:

- Open flowers are present with stigmas and petals intact
- 110 degree hours greater than 18.3°C have accumulated after the first bloom
- Dew or at least 0.25mm or rain on the day of infection has occurred; or at least 3mm rain on the previous day
- An average daily temperature of 15.6°C

When considered in light of potential inoculum levels, fire blight symptoms in orchard, in adjacent orchards, and in the district, growers are provided guidance on whether sprays are required. The final decision on whether control sprays will be applied is made by orchard managers.

For chemical control, the antibiotic streptomycin is registered for use. Sprays are applied during high risk climatic conditions when blossoms are present. Orchard managers aim to apply the spray 12–24 hours prior to a rain event to allow time for it to dry and also ensure the application is made late in the day as it is degraded by ultraviolet light. According to orchard managers streptomycin use is limited due to chemical residue restrictions imposed by markets such as Europe (BSG 2011).

Alternatively, the biological control *Pantoea agglomerans* (synonym *Erwinia herbicola*) (known as Blossom Bless) is available to orchard managers. Blossom Bless is a commonly occurring bacterium that can be sprayed onto susceptible tissue where it competes for infection sites, reducing the opportunity for *E. amylovora* to infect the tissue. Usage of Blossom Bless is varied, though multiple applications are common. Depending on the risk posed by fire blight, Blossom Bless may be applied at 10 per cent, 50 per cent, and 80 per cent blossom, the effect being cumulative.

Finally, bud break promoters are used in some orchards to accelerate the budding process and reduce the period of time that susceptible host tissue is present on the tree. The mild conditions in New Zealand can result in blooms being present on trees for a number of weeks. Budding promoters can reduce this period to around one week.

Frequent inspection of orchards is recommended by the Pipfruit IFP manual, which is consistent with recommendations made around the world. Inspections are targeted to find distinctive blight symptoms or “shepherd’s crooks” on terminal shoots. It is recommended that symptomatic shoots or branches are pruned out, with the cut to be made 45–60cm below the symptoms. This should be augmented with removal of any symptomatic tissues during winter pruning, along with removal or monitoring of alternative host material in the area surrounding the orchard.

Overhead irrigation is not recommended and is rarely used outside the Central Otago district. When used, overhead sprinklers are a management tool for frost protection, therefore being used when conditions are unfavourable for *E. amylovora* infection.

Data from the 2009–10 season indicates that of all registered apple production blocks in New Zealand, 3.3 per cent received at least one streptomycin spray and 5.0 per cent received at least one Blossom Bless spray. Note, however, that these may include blocks that utilised both control measures and that sprays are applied based on estimates of potential infection not actual infections.

During a verification visit in March 2011, officials from the Biosecurity Services Group had the opportunity to discuss the recommendations of the Pipfruit IFP program with orchard owners, orchard managers, and pest control consultants in both the Hawke’s Bay and Nelson districts. The only variation to the measures as described above was the pruning of symptomatic tissue. Some orchard managers stated their experience that immediate pruning of ‘shepherd’s crooks’ was not necessary in their orchards where the incidence of symptomatic tissue was extremely low (BSG 2011). Those orchards were observed to have only the occasional fire blight strike and were producing high yields of commercial quality fruit.

In considering those orchards where either a low incidence of fire blight symptoms were observed or which had a history of some fire blight infection, orchard managers described a “severe” incidence as an average of around one strike per tree. During the verification visit some trees were observed as having multiple strikes, though the adjacent trees were seen to have either one strike or no strikes. No bacterial oozes were observed on any of the blighted limbs.

European canker management

According to the Pipfruit IFP manual, European canker is only considered a problem in high rainfall areas such as Auckland and Waikato. It may occasionally also pose problems in Gisborne and Nelson. Spread of European canker is attributed to introduced nursery stock as well as localised spread from neighbouring infected trees.

Control for European canker focuses on removal of any visible cankers during the winter pruning period when the symptoms are most easily observed. Removal is through pruning, ensuring that cuts are at least 10cm below the lowest observed canker to ensure that any infected wood is removed. Pruning cuts are then recommended to be covered with a sealing paint that includes an antifungal agent, carbendazim. It is then recommended that any infected material be removed from the orchard and burned.

Antifungal chemicals used for other more economically concerning pathogens are also considered effective against European canker and contribute to the general control in orchard. These include sprays to manage black spot (*Venturia inaequalis*, apple scab) and powdery mildew (*Podosphaera* sp.).

During site visits in March 2011, orchard managers in the Nelson region reported that European canker was known from the region, but uncommon in orchards. For example, only a single tree on a 40 hectare property had been identified with symptoms during the last 5 years and the infection was traced back to the introduced nursery stock. At a second orchard in Nelson, it was reported that symptoms could be found if one were to look hard enough for long enough.

Apple leaf curling midge management

Under the IFP program, specific monitoring and control programs for apple leaf curling midge are only recommended for blocks of young trees and trees that have recently been grafted. Both of these situations can provide the young, vigorous growth that adult apple leaf curling midge lay eggs onto and on which the developing larvae feed.

For orchards that have recently been planted, or newly grafted, sampling of 40 actively growing shoots from late November through to early December is recommended, with foliar application of diazinon if more than 50 per cent of the shoots are infested with eggs.

Monitoring should subsequently occur in January and February, also sampling 40 leaves with the action threshold again being reached of more than 50 per cent of the sampled leaves are infested with eggs.

In blocks of mature trees that are producing fruit, the parasitoid *Platygaster demades* (Hymenoptera: Platygastridae) and predator *Sejanus albisignata* (Hemiptera: Miridae) are considered effective in controlling apple leaf curling midge, provided that broad-spectrum insecticides have not been applied. Further, while insecticides such as diazinon are recommended as a foliar spray, application precludes fruit from entering a number of export markets due to chemical residue requirements. The IFP program does not recommend any specific monitoring program for apple leaf curling midge in producing blocks with mature trees. During the March 2011 visit, orchard managers explained that apple leaf curling midge is not an issue in mature trees as they don’t produce the required fresh growth for apple leaf curling midge throughout the season. Some orchards are now monitoring soil moisture to minimise vegetative growth during the season to maximise fruit production and quality.

3.3 Harvesting and handling procedures

The apple harvest season in New Zealand can commence from early February with varieties like Pacific Beauty™ and Royal Gala. The season extends until mid-late April with varieties like Cripps Pink (Pink Lady), Braeburn, and Fuji (Pipfruit NZ 2008c).

Prior to harvest, maturity is monitored by sampling twenty fruit per variety per block from the orchard and subjecting them to a series of tests: starch pattern index; background and foreground colour; fruit penetrometer; and soluble sugars (brix). The results of these laboratory tests indicate that fruit is either ready for harvest, or recommended to be re-tested after a nominated period of time (BSG 2011). This testing establishes whether the conversion of fruit starches to sugars has commenced, whether fruit sugars exceed a certain level, and whether fruit colour has developed sufficiently to meet market specifications. Harvesting will not commence until the maturity levels have reached a minimum level.

Due to the prolonged blossom period for apples in New Zealand, fruit can mature over a period of time and when harvest commences, it is common for a first pick to target only those fruit showing higher colour levels and therefore the appropriate level of maturity. Other fruit will be left to finish ripening and 'colouring up' for another 4–7 days before a second pick is undertaken. This process may be repeated as and if necessary and some orchards this season where onto their fourth pick.

Apples are hand-picked, with some assistance from either portable ladders or motorised 'cherry pickers' to reach higher branches. In-field, pickers grade out fruit with obvious signs of unacceptable damage, including cuts, bruises and tractor damage. Further, evidence of specific pests can be recorded on field bins to alert packing houses to any pest issues that may limit access to specific markets.

After harvesting into picker bags, fruit is transferred to field bins that hold approximately 400kg of fruit. Bins are consolidated at the orchard before being transported to the packing house. Each bin has an attached record that identifies the supplier, grower, orchard, variety, orchard block and picker that facilitates trace-back.

3.4 Post-harvest

3.4.1 Packing house

Apples will not be accepted by packinghouses unless spray diary clearance has been received from the Independent Verification Agency (IVA). At the point of receival, apples at all packing houses are sampled for maturity. As for pre-harvest testing, this includes starch pattern index, background and foreground colour, fruit penetrometer, and soluble sugars (brix). At this point, maturity of fruit is further defined into storage grades depending on how far fruit starch mobilisation has progressed.

The important test for establishing fruit maturity is the starch pattern index test. For the test, a random sample of apple fruit from bins are taken, sliced in half and the exposed apple flesh sprayed with an iodine solution. The presence of starch is indicated by a blue–black colour on the fruit where iodine has reacted with starches. Unripe fruit, where high levels of starch are present, develop an even dark colour across the entire fruit surface. As fruit reach maturity, starches are converted into sugars and instead of an even dark colour a distinctive pattern will develop on the cut surface of the fruit (Reid *et al.* 1982). As maturity progresses, the amount of colour reduces.

Fruit may then be processed immediately or sent into cold store for later processing, depending on fruit volumes and market demands. Having already tested maturity and colour of fruit, packing houses have a clear indication of market suitability of fruit prior to packing.

The first stage of fruit processing is the water dump where fruit are removed from bins into water which is circulated to move fruit towards the packing line. The second step is the movement of fruit into the high pressure washing stage. Here fruit move onto beds of brushed rollers that continually move fruit while they are subjected to a high pressure spray, the combined brushing and spraying removing contaminants and leaf material. During the March 2011 verification visit, it was observed that each apple was subject to the high pressure spray for between 30 and 60 seconds whilst being continually turned due to the counter rotating rollers. This exposed all surfaces of the fruit to the high pressure spray. Any contaminating material was seen to be blown past the brushed rollers, away from the fruit.

Subsequently, apples are then passed back into a water bath (which is separate from the dump tank), or directly onto rollers and conveyors that take them into the packing house.

All packing houses observed during the verification visit utilised Nylate® as a post harvest sanitiser. In water, Nylate® breaks down to two biocidal agents, hypochlorus acid and hypobromus acid. In some cases, the Nylate® was applied in the dump tank, in other cases after the high pressure washing. In all cases, application of Nylate® was monitored, automatically or at specific times, for both concentration and pH.

Grading and sorting of apples was observed to follow a number of different practices. In some cases, the first stage was hand sorting of apples as they entered the packing house to remove apples with damage or other symptoms that would make them not suitable for market. Fruit was then directed to electro-optical grading equipment to determine fruit colour, size and weight before being directed to specific packing lines.

Alternatively, some packing houses have more advanced grading equipment that allows both grading and defect detection. In that case, removal of damaged apples still occurred prior to grading, though less staff were involved as the machinery was responsible for detecting minor defects that would otherwise have been removed by packing house staff.

After grading, all packing houses were observed to utilise a conveyor system that carried apples to the appropriate packing line where apples were “dropped” onto the appropriate packer’s table.

Apples that do not meet specification were consigned to either processing/juicing or to the domestic market. Those apples directed to the domestic market were observed to still be free of damage and rots, but were affected by symptoms of black spot (apple scab), russetting, or other quality parameters.

The most common form of packaging for apples is the 18kg carton which contains four or five layers of apples each on top of a moulded cardboard insert. The number of apples and exact weight depends on the size being packed, with between 95 and 150 apples being common. Each carton includes a lid. Also observed were single layer cardboard boxes, without lid, each containing around 40 fruit and weighting 6.5kg. Both of these forms of packaging are palletised for transport.

Packaging of apples in bulk bins, while not considered a large part of the market, does occur. Bulk bins are utilised where receiving markets specifically prefer to re-pack on arrival, with packing into small “clamshells” each with six fruit being an example of such packaging (BSG 2011). For the 2009–10 season, only 0.19 per cent of fruit was exported in bulk bins, and only to the UK and France (MAFNZ 2011).

During the packing process, phytosanitary and quality control inspections were undertaken by trained staff and monitored by an Independent Verification Agency. In some cases packing machinery was configured to randomly drop apples, at a specified rate and including all sizes, for quality control and phytosanitary inspection on a separate line. In other lines, these samples were taken as random boxes of packed apples. Any detection of pests or grading issues were recorded, and any symptoms of possible infestation examined further through fruit cutting.

Any outcomes from the quality control and phytosanitary inspections apply to the entire processing lot of apples on the packing line at that point in time.

3.4.2 Storage

After packing, palletised boxes of apples were moved to cold stores pending the building of an export consignment and subsequent export. As described by packing house staff, cold storage of boxed apples rarely exceed a few weeks.

Primarily, long term cold storage of apples occurs pre-processing and packing, with apples being stored in the bins they were harvested into. However, in some circumstances and for some markets storage in packed 18kg cartons may occur for up to a three month period. Apples stored for extended period of time are reinspected and/or tested for flesh firmness, sugar levels and any evidence of post-harvest degradation to ensure that the fruit still meets phytosanitary standards of the importing country and the quality standards expected by the importer (MAFNZ 2011).

Finally, some extended storage of pre-graded apples occurs for specific markets. In such cases apples that are of a specific size or colour to suit a particular market will be stored in bulk bins at the end of a packing line. The bins are then returned to cold storage with the packing house having knowledge of the exact size and quality. When required for market, such fruit is then returned to the packing line for packing into boxes. In effect this is a pre-sizing operation, modified to suit the packing lines in specific export packing facilities.

3.4.3 Export procedures

As export phytosanitary inspections are typically conducted as part of the packing house processes, apples are ready for export as soon as packed. Computer records determine which market any consignment is eligible for and are also the basis for phytosanitary certification by the New Zealand Ministry of Agriculture and Forestry.

In some cases an end point inspection will be conducted on a consignment rather than as an “in-line” process as part of the packing line process. In those cases the phytosanitary inspection required by the importing country is conducted by consignment by grower lot.

3.5 Production and export statistics

In the 2009 season, New Zealand is reported to have a total apple production of 466 000 tonnes (WAPA 2010). Of this, the Pipfruit Industry Statistical Annual 2009 reported a 2009 export apple production of 302 705 tonnes, an approximately 16 per cent increase over the 2008 season (Pipfruit NZ 2010). The remainder, or around 35% of the crop, was available for domestic consumption or processing.

New Zealand apple producers are heavily export focussed. Important markets include the United Kingdom, the United States of America, the Netherlands, Belgium, Taiwan, and Hong Kong. Each of those markets imported over 10 000 tonnes of New Zealand apples in 2009 (Pipfruit NZ 2010).

Considered by growing region, approximately 66 per cent of the export fruit came from the Hawke’s Bay district, 28 per cent from the Nelson district, and 3 per cent from the Otago district, these figures corresponding closely to the acreages in these regions.

Consistent with the planted acreage per variety, Royal Gala and Braeburn are exported in the most volume, with Royal Gala having the greatest export production in the Hawke's Bay district and Braeburn in the Nelson district. Fuji and Jazz are the next two varieties exported in the greatest volume (Table 3.1). Individually, other varieties of apples each make up less than 5 per cent of the total export volume.

Table 3.1 Export volume and percentages of each variety of fruit for exports from New Zealands three main apple production regions (Pipfruit NZ 2010)

	Hawke's Bay	Nelson	Central Otago
Braeburn	29.3%	41.3%	17.0%
Fuji	11.8%	2.8%	7.1%
Jazz	3.8%	14.3%	5.4%
Royal Gala	39.1%	27.2%	26.4%
Total apple exports (tonnes)	202 138	80 485	10 081

3.5.1 Export season

New Zealand's primary export markets are in the Northern Hemisphere and include the United States of America, the Netherlands, Belgium, Germany, Taiwan, Hong Kong, Thailand, and the United Arab Emirates (Pipfruit NZ 2010). New Zealand fruit is supplied into these markets to meet counter seasonal demand.

Apple exports begin almost immediately with the first harvest of apples in February and continue in significant volumes until around July (MAFNZ 2011). Apples can be stored for long periods and growers and packers have the option to hold apples in cold store immediately after harvest, or after packing processes until required on the market. The start of the season is principally defined by the availability of the New Zealand harvest, while the end of the season is determined by the first availability of apple produced in the northern hemisphere.

While most exports to the Australian market would likely occur between late February and late August, it is possible that New Zealand apples could arrive in Australia all year round. However, it is understood that the majority of large cool store facilities in New Zealand do not operate all year round, with most produce having been exported prior to the southern hemisphere's spring (BSG 2011). Ultimately, economic factors and market access opportunities will determine the market window for New Zealand apple exports to Australia. This review considers the bulk of exports from February until August, with only lower volumes potentially entering Australia after August.