CHAPTER THREE

ON-ORCHARD MANAGEMENT PRACTICES

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER THREE
ON-ORCHARD MANAGEMENT PRACTICES

This chapter is diverse, covering a range of orchard management practices. Firstly, the New Zealand kiwifruit growth cycle is explained, and basic orchard management practices are identified. Lastly, an overview of risk management is provided, such as the adverse events that may occur on an orchard.

THE SECTION IS DIVIDED AS FOLLOWS

3.1 NEW ZEALAND KIWIFRUIT GROWTH CYCLE

The growing season for kiwifruit is long: up to 240 days. The New Zealand season begins with vine pruning in winter (June), which immediately follows the previous year's harvest. During the winter months (June to August) the vines lay dormant, allowing growers the opportunity to remove last season's fruiting canes and to select and tie down new canes which form the foundations for new growth.

Springtime (September to November) sees the kiwifruit vines begin to grow again. New shoots appear on the canes along with the first flower buds. When the flowers blossom, bees get to work pollinating the flowers. Pollinated female flowers transform into fruit.

As summer starts (December to February), kiwifruit vines undergo tremendous growth and growers frequently prune the vines to direct growth and manage the canopy (the canes can sometimes reach up to 5-6 meters in length during the growing process). The fruit grow quickly, and crop volume can be estimated. Growers selectively thin kiwifruit to optimise fruit size and taste (generally the less there are, the larger and tastier they grow).

As the weather cools in the New Zealand autumn (March to May) harvest time approaches. Fruit is tested for ripeness and when they pass a certain criteria for quality and grade, the kiwifruit are carefully picked by a huge team of workers. Once the kiwifruit have been picked, they are transported to the packhouse to be packed and stored ready for shipping and export. As the winter approaches, the leaves drop from the vines, signaling the end of another growing year. The vines move towards a dormant state and await the coming of spring.

Kiwifruit vines require sunshine, water, rich free-draining soil, with an ideal soil pH between 5 and 6.8 and winter chilling. To be productive, commercial crops require significant management. The aim is production of a crop of relatively uniform high dry matter fruit of the size preferred by markets.

Growers utilise a variety of mechanisms to get sufficient yields including:

- Selection of high-quality replacement cane in spring.
- Pruning – Removing poor quality and unwanted vegetative growth early.
- Budbreak sprays.
- Pollination.
- Bud thinning – Defect buds are removed before they develop into flowers to conserve plant carbohydrates.
- Fruit thinning – Defect fruit are removed as soon as possible to ensure allocation of carbohydrates to high-quality fruit.
- Girdling – Reduces competition for carbohydrates and ensures fruit attain maximum size and dry matter.
- Control of pests and diseases.

Below:
The New Zealand kiwifruit growing cycle showing the vine growth stage and orchard management practices on a seasonal basis

Season	Winter			Spring			Summer				Autumn	
	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY
	Dormant			Budbreak		Flowering	Fruit set		Fruit growth		Leaf fall	
	Winter prune		Budbreak sprays		Bud and flower thinning + pollination	Male prune		Canopy management + thinning +girdling			Harvest	

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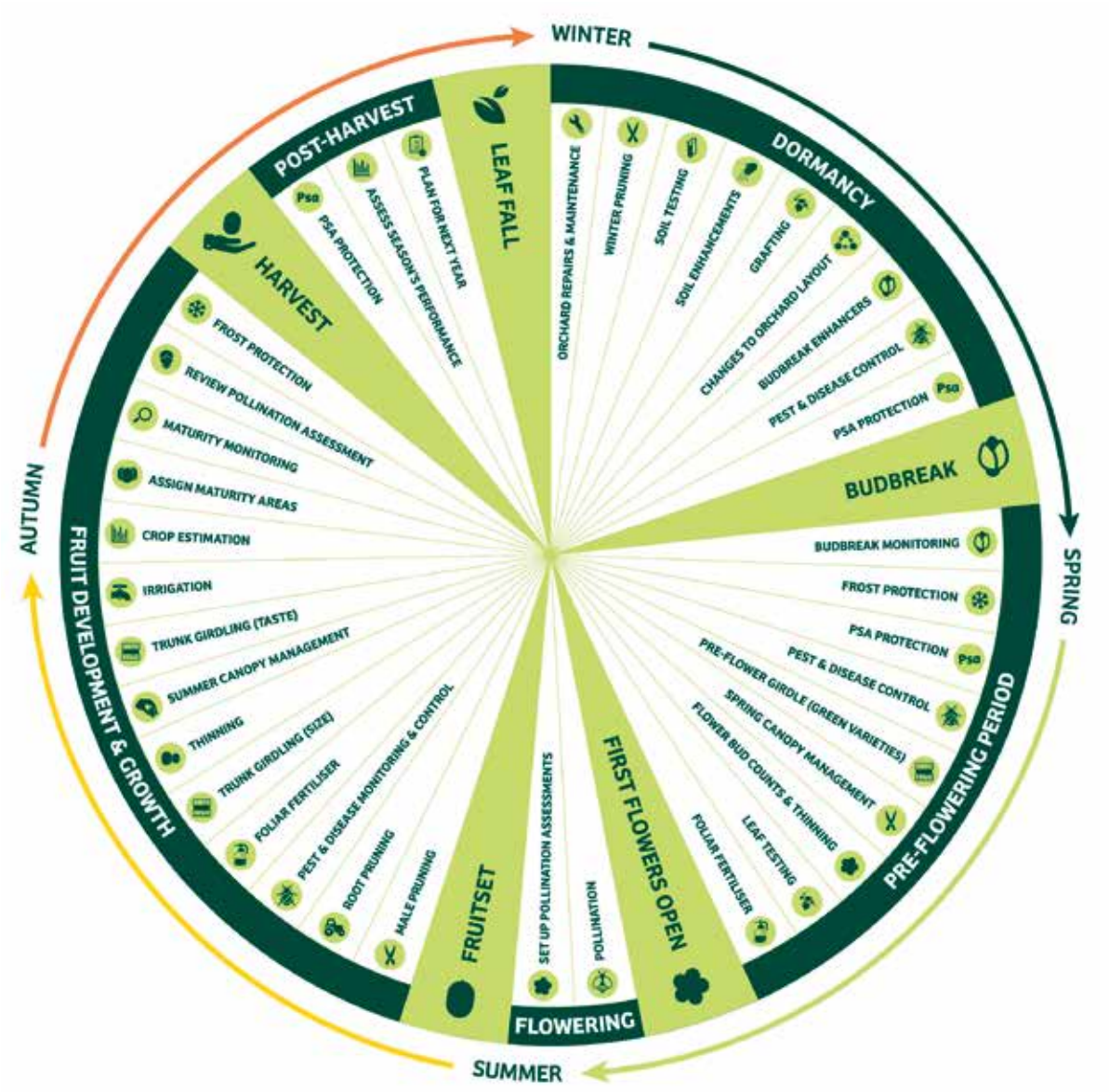


Above:
On-orchard kiwifruit production steps and key management actions

3.2 VINE MANAGEMENT – PRUNING

Successful orchard outcomes are achieved by promoting rapid canopy establishment before flowering, and then limiting canopy growth after flowering to reduce competition for resources with the growing fruit. Pruning is one of the most important aspects of vine management and plays a major role in getting a consistent, quality yield each season. Success depends on good open pruning to prevent the vines becoming dense and tangled. Open pruning allows space for bees during the flowering period, penetration of sprays, air movement around the vines, and enough light throughout the vines to minimise the conditions which favour fungal disease such as Sclerotinia. However, if too much canopy is removed there is a risk of sun damage to fruit as well as reduced photosynthesis.

Open vines provide adequate light needed to ripen the fruit and mature the fruiting canes for the following season. Good light levels are vital for dry matter and sugar level production in the fruit, which ultimately improves taste. This also aids fruit size and enhances the storage life of the fruit. The figure below shows an example of the different types of fruit wood that growers need to manage.

Right:
An even spread of high-quality winter buds

Winter Pruning

Winter pruning can constrain orchard performance if it is not carried out correctly. Winter pruning is done after harvest when vines enter dormancy, preferably after leaf drop so buds are easier to see. The aim is to set up bays with optimal high-quality winter bud numbers on canes that are evenly spaced throughout the canopy. Selection of the best canes to keep, and what to cut out, takes skill and experience. Canes are tied down immediately after pruning.

Even spacing has a great influence on the performance of the canopy the following summer. Consistent canopy density will reduce variation in fruit attributes (e.g., size, dry matter). Even cane and spur spacing results in a consistent summer canopy that produces optimum fruit size and dry matter (climate and summer vine management allowing) and is easy to manage and achieve good spray coverage.

Summer Pruning

Summer pruning involves managing the excess vegetative growth of the vine during the growing season to:

- ensure good light levels on the fruiting canopy
- ensure quality fruiting wood is produced for next year's canopy
- reduce the amount of carbohydrates demanded by the actively growing leaves allowing resources to be redirected to the fruit
- allow good spray coverage

The removal of excess growth also helps to prevent tangles which ultimately saves workload and costs during the following winter prune.

Pruning male vines after flowering/pollination and in summer keeps the vines compact so that they do not shade the female vines or cause tangles. As some male cultivars are more susceptible to diseases such as Psa, keeping a compact vine structure over summer also allows for better spray coverage.

Right:
Grass growing beneath a well-maintained open light canopy
(Shane Max, Zespri OPC)

Far right:
Poorly maintained with low light levels have led to shading and leaf drop
(Shane Max, Zespri OPC)

Right:
Regrowth's and tangles in gold kiwifruit
(Shane Max, Zespri OPC)

Far right:
A non-terminated cane is shown on the left and a terminated cane on the right
(Shane Max, Zespri OPC)

The key to summer pruning is timing. Timing depends on several factors, including but not limited to vine age; orchard environment; climate; canopy vigour; fertiliser use; the layout and structure of the orchard; and the size of the block. These factors will vary between and within orchards.

Key considerations for achieving good results from pruning are:

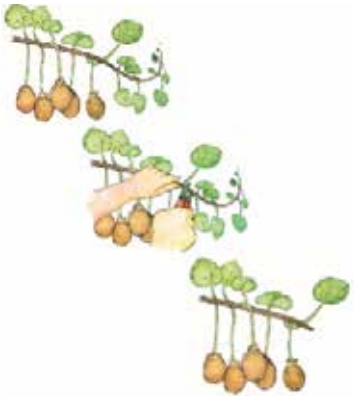
- Tip squeezing non-terminating shoots in the fruiting canopy to approximately four to six leaves past the last flower. The best time to do this is just as the earliest shoots begin to tangle.
- Removing vigorous excess canes, and canes with no fruit (blanks), as they will compete with fruit growth and increase shading.
- Self-terminated shoots do not need to be cut or shortened as these will not continue to grow or cause shading and are potentially the best cane to leave for next year's fruiting wood.
- Late growth (after flowering) should be removed as canes grown before flowering are always more fruitful than late grown canes.
- Shaded cane or spurs need to be removed, as wood that is exposed to sunlight will always produce more flowers and better-quality fruit.
- Canes growing back over the leader need to be removed as they are difficult to tie down and are not optimal for vine structure and growth.

Zero-Leaf Pruning and Tip Squeezing

Both zero-leaf pruning, and tip squeezing are management practices that are used to help maintain optimal light levels and to reduce vegetative vigour.

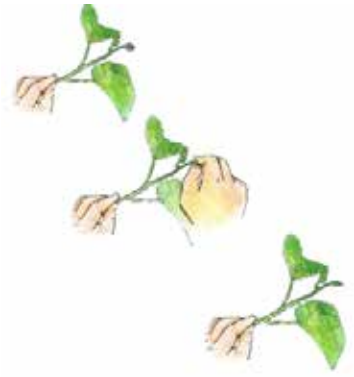
What is Zero-Leaf Pruning?

Zero-leaf pruning involves pruning selected fruiting shoots just above the last (distal) fruit on a lateral so that there are no axillary buds from which secondary re-growth can develop. If this technique is done correctly, the vines are not too vigorous and virtually no re-growth will occur from the zero-leaf pruned shoot. This technique is primarily done to save on pruning costs later (by reducing tangles). However, any pruning cut increases the risk of Psa infection due to creating a soft tissue wound. It can also impact on availability of quality wood for the following season if too many shoots are pruned.



What is Tip Squeezing?

Tip squeezing (or crush tipping) involves damaging the growing tip of actively growing shoots preventing further extension. Unlike straight pruning or removal of the tips, which can stimulate secondary growth from lateral buds, tip squeezing leaves the shoot tip damaged but not broken. If undertaken, tip squeezing is conducted several times (approximately five times dependent on canopy vigour) throughout spring and summer and minimises the need to summer prune.



Right:
A strong shoot about to be zero-leafed

Far right:
An actively growing shoot tip prior to squeezing (left), and the controlled damage of the intact shoot tip following squeezing (right)

3.3 BUDBREAK

Budbreak refers to when the buds on dormant canes open and start growing shoots and then flowers in Spring. Timing and quality of budbreak depends on winter chilling. Winter chilling is measured from the start of May each year (typically measured as the number of hours below 7° Celsius or the average temperature across May, June and July). Timing of budbreak is affected by temperatures up to the start of budbreak, but number of flowers can be affected by temperatures between budbreak and flowering. The colder the winter, the earlier budbreak will begin, and the more king flowers will come from each bud.

There are advantages in having a more uniform budbreak across a production block, as well as maximising the number of quality flowers while minimising the spread in timing of flowering. Several different chemicals can be applied to the vines during dormancy to enhance budbreak, the most frequently used being Hydrogen Cyanamide (marketed under different trade names, the most common being Hi-Cane). These products can make up for reduced winter chilling, allowing for kiwifruit production in warmer parts of the country and in the future with warmer winters.

Timing of application is critical with budbreak enhancers. Hydrogen Cyanamide is most effective when applied 35-25 days before natural budbreak. Determining when that budbreak "day" would occur can be difficult (natural budbreak takes 10-30 days to complete). It will vary by region, but wood quality, cropping history and orchard management can also impact on timing of budburst. Models exist based on mean monthly temperature data from previous years, but it is not an exact science. Gold3 and Red19 have earlier budburst than Hayward.

In October 2021, the Environmental Protection Authority (EPA) reassessed the ongoing use of Hydrogen Cyanamide through public consultation. The outcome of the consultation is not expected to be known until mid-2022. Meanwhile research continues on alternative chemicals to Hydrogen Cyanamide, the effect of different management techniques, and development of future kiwifruit varieties that will be less reliant on budbreak enhancers.

Right:
Stages of bud break.

3.4 POLLINATION

Right:
Male kiwifruit flowers

Far right:
Female kiwifruit flowers

Pollination is an important aspect of commercial kiwifruit production. Kiwifruit are dioecious; this means that the female (pistillate) and male (staminate) reproductive organs occur on separate plants. This makes pollination and the mix of male and female plants on orchard vitally important to achieving economic success.

Financial returns are dependent on the number of fruit, their size, and the percentage of dry matter in the fruit, all of which are dependent on achieving adequate pollination. Pollination is managed to a much greater extent in kiwifruit than in other crops, and the costs involved are also greater.

Achieving full pollination of kiwifruit flowers is difficult:

- Pollen must be moved large distances as male and female flowers are borne on separate vines.
- Pollination characteristics (timing, flower receptivity, bee visits required etc.) differ between the different commercial varieties, making management more complicated where more than one variety is being grown.
- Male flower pollen release and Female flower receptivity is not always synchronous. Different male cultivars flower at slightly different times from October to December. Hayward female flowers, once open, are receptive for 6-7 days with bud-burst enhancer use (10-15 days without), Gold only 2-3 days. Exact timing of flower opening depends on region, altitude, and season (average temperature).
- Female flowers need to receive thousands of pollen grains for full pollination, unlike flowers of other fruit crops that only require a few pollen grains.
- It takes many bee visits to each flower before full pollination is achieved (up to 40 bee visits for Hayward flowers, 6 for Gold).
- Fruit size (and therefore the value of the crop) is in part determined by the number of seeds the fruit contain. Export size Hayward fruit contain at least 800 seeds, Gold at least 200 seeds, and Red 250 seeds.
- Kiwifruit vines have relatively few flowers and require high levels (>80%) of fruit set (a flower becoming a fruit) compared to pip and stone fruit crops that need only a low percent fruit set.
- The flowers are not highly attractive to insect pollinators since they do not produce nectar.
- Some varieties flower late in the spring and consequently compete for insect visitors with other plants flowering at the same time.
- Kiwifruit vines were introduced into New Zealand from China, so they are without the natural insect pollinators with which they co-evolved.
- The crop needs high shelter belts to protect the vines from wind damage, which reduces pollination by wind.
- In New Zealand, vines are grown close to the ground instead of up forest trees (their natural habit), further reducing the level of wind pollination.
- Wet and/or cold weather can disrupt pollination. Flowers open and pollen release (dehiscence) is strongest in the morning, but this can be delayed in poor weather. Bees will also be less active.

	Characteristic	Hayward	Gold3	Red19
Males	Ploidy (sets of chromosomes)	Hexaploid	Tetraploid	Diploid
	Maximum effective distance to females	4-6 metres	7+ metres	6-7 metres
Female Flowers	Dehiscence	5 days	2 days	?
	Stigma Viability	8 days	2 days	4 days
Honey bee Pollination	Number of visits	40	6	?
	Min No Seeds	800	200	250
	Max number of seeds	1,200 - 1,500	600-800	600-650
	Foraging bees/1000 flowers	20	6	?

Figure 5. Comparison of pollination related characteristics between varieties. Red figures are indicative and require further research to confirm.

Kiwifruit orchards are pollinated by bees. Very few growers maintain their own beehives, most relying on the beekeeping industry to supply hives for the few weeks over flowering/pollination. The number of hives, when they are brought in, and their positioning is important. Stocking rates will vary (9-12 hives/ha); less for orchards surrounded by other orchards, more for isolated orchards. In Green orchards the bees are bought in once 20-30% of female flowers are open, earlier in Gold and Red orchards. Sunny sheltered sites help encourage bee activity.

Kiwifruit flowers do not have nectar, the usual reward for pollinators, they are only attractive because of their pollen. As a result, beekeepers supplement the bees with a sugar and water mix to reduce the chance of them foraging beyond the orchard. It is important that growers remove other flowers from the orchard and surrounding areas during pollination e.g., by mowing the sward.

Many agrichemicals are toxic to bees so crop protection sprays must be avoided or timed very carefully during flowering/pollination. Overhead cover e.g., for frost or hail protection, can also disrupt bee navigation.

Right:
Two traditional double box hives used for kiwifruit pollination

Growers supplement beehives by applying additional pollen to kiwifruit vines through other means. This activity is called supplemental or **artificial pollination.** Male only orchards are used to produce commercial supplies of pollen or growers can have some of the flowers on their own male vines picked and processed (milled) before the female flowers open. The cost of pollen varies (±$5000/kg in 2019), partly due to flower collection being extremely labour intensive, with 100kg of male buds needed to produce 1kg of pollen. The amount of pollen used will also vary with the situation, and the number of applications. Given the high cost of milled pollen, research is ongoing into bee-collected pollen. In this method, returning bees pass through a tube or screen as they enter the hive that collects the pollen they are carrying. This pollen can then be reused in one of the methods below.

Right:
Bees entering a hive through a pollen trap. Note the yellow pollen pellets that are dislodged by the tube without harming the bee

To see more about how pollen is processed go to
https://www.sciencelearn.org.nz/image_maps/10-processing-pollen

Methods of artificial pollination include:

Wet application – spraying a pollen/water mix directly on to female flowers. This is useful when bad weather reduces bee activity or there are no bees, when few male flowers are left or if there are competing flowers around the orchard. Can be labour intensive if using handheld applicators.

Dry application – blowing pollen onto the canopy which is then redistributed by bee activity. There are a variety of vehicle mounted applicators available on the market. This method may be less labour intensive but there can be considerable wastage of pollen.

READ MORE HERE:

https://www.sciencelearn.org.nz/resources/99-pollinating-kiwifruit

https://www.sciencelearn.org.nz/videos/19-artificial-pollination

3.5 THINNING

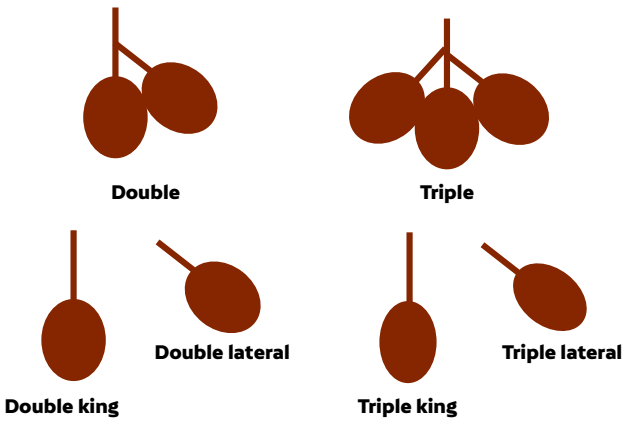
Thinning is undertaken multiple times throughout the growing season to get the optimal amount of exportable yield. Too many fruit on the vine can reduce the overall quality of the fruit by reducing average fruit size and taste. Thinning can start as soon as buds develop. Defect flower buds are removed before they develop into flowers. Lateral flower buds are removed as the fruit they produce is always substandard to that of the king flower. Removal of these buds aid pollination as bee visits are not wasted on flowers that will not become exportable fruit. It is best practice to set the desired number of buds in winter pruning, it minimises flower/fruit thinning costs and doesn't compromise fruit dry matter.

Right:
Removal of lateral flower buds is ideal before pollination.

During thinning, growers target a number of areas. They include:

- The removal of low value fruit (misshapen, damaged, undersize).
- Adjust fruit load per shoot to obtain minimum leaf: shoot ratios (2-3 leaves per fruit).
  - Spurs 1-2 fruit (approx. 5 leaves).
  - Medium terminated shoots 2-6 fruit (7-21 leaves).
  - Long terminated shoots 4-6 fruit (14-40+ leaves).
- Removal of lateral fruit as the king fruit is always larger and has higher dry matter than the lateral fruit.
- Remove more fruit from heavily shaded parts of the vine as this fruit tends to be of lower dry matter.

A final round of thinning may be completed to remove fruit with obvious defects (flats and fans, hayward mark (green), blemish that is dark coloured and larger than 1cm^2) and soft or damaged fruit before it is harvested as such fruit incurs expense when it must be removed during packing.



3.6 GIRDLING

Trunk girdling is used to increase dry matter, increase fruit weight, and increase the number of flowers the following season. Girdling refers to the removal of a thin strip of bark from around the circumference of the vine trunk or cane. This bisects the phloem so prevents the flow of carbohydrates to the roots, meaning more is allocated to the fruit in the time that the girdle is open. The plant grows a callus that heals over the girdle, reconnecting the phloem, usually within a few weeks.

Girdling is carried out at least twice in a season. A girdle applied in the spring increases fruit size. The summer girdle allows the fruit to attain a higher dry matter and can increase return bloom in some varieties. A pre-flowering trunk girdle is used by some growers to prevent or halt flower bud infection caused by bacteria, like Psa, in green cultivars.

Trunk girdles are easy to apply, with the use of a tool or a girdling chain. The tool is a double-bladed knife which cuts and removes a thin slice of bark from the circumference of a trunk. The chain is a blunt chainsaw chain with a handle at each end that is pulled back and forth to remove the bark.

Far left:
Severe girdle-cut through both the phloem and xylem. Pen shows where girdle should have finished
(*Shane Max, Zespri OPC)*

Centre left:
Correct girdle
(*Shane Max, Zespri OPC)*

Centre right:
Three healed girdles
(*Shane Max, Zespri OPC)*

Far right:
Chain used for girdling
(*Shane Max, Zespri OPC)*

Right:
Girdling knife

Technique is important. If the girdle is too shallow and has not gone through the phloem (the cambium), the root system will still be able to compete with the fruit. If the girdle is too vigorous and cuts through the xylem (the wood) it will disable the supply of water and nutrients to the canopy. The girdles will also be slower to heal, and vines will be at greater risk of disease infection. Shallow girdles are easily identified as the left-over phloem material oxidises quickly and turns brown. Using a girdling chain is generally faster but comes with increased risk of xylem damage.

Hygiene is crucial with either method: both tools and chains should be sanitised between plants, and the girdling cuts should be sprayed with a protectant solution (e.g., copper) as soon as they are completed. There is some evidence from trials in Europe that girdling may act as an elicitor and activate the plant's internal bacterial defence response, this reducing their susceptibility to Psa.

3.7 SOIL MANAGEMENT

Healthy soil is critical for success. Not only does the soil physically support plants and structures, it supplies water and nutrients to vine roots, regulates root temperature, and provides drainage from excessive rainfall. A healthy soil supports a population of microorganisms and earthworms that assist with these processes. Depending on their soil type, growers add extra organic matter in the form of compost, alongside the usual incorporation of mown grass, mulched prunings and leaves entering the soil. Ensuring drainage is sufficient is important as kiwifruit roots are very sensitive to a lack of air. If soils remain waterlogged beyond 48 hours root death can occur. Equally, the water-holding capacity of the soil in summer also impacts on soil health. Avoiding compaction of soil by heavy machinery is imperative. Wet soils are particularly at risk of compaction, so activities such as fertiliser spreading and spraying need to be carefully timed.

Soil ripping is a tool for helping to improve soil structure and drainage in heavier soils. The objective is to shatter the soil, hastening water drainage and allowing more oxygen into the soil which then encourages more root activity. Various implements are used for ripping, but timing is key. It is usually carried out in late summer when the soil conditions are drier for best effect.

Root pruning, although similar to soil ripping, serves a different function. By cutting off roots and reducing the size of the root system of the vine, the carbohydrate demands of the root system is reduced making more available for fruit growth and dry mater accumulation. The prune is completed via a large tractor-drawn pruning blade that cuts through the roots (approx. 40cm deep) on both sides of the vine. For best results root pruning is used alongside trunk girdling and is usually applied in January. Research is still ongoing, with the technique showing variable efficacy in terms of improving dry matter with soil type, root distribution, and vine age and health.

Right:
Root pruning is done with a large blade attached to the back of a tractor that drives slowly down the rows and cuts down into the soil

Far right:
Ripper attached to the back of a tractor, used to help improve soil drainage (*Shane Max, Zespri OPC)*

3.8 FERTILISER

As in any biological system where organic matter is removed (in the form of fruit), nutrients need to be returned. Nutrient management is important not only crop production but also for soil health and protection of waterways. Nitrogen (N) runoff is a key pollutant to freshwater in New Zealand, with fertilisers and drainage (from rainfall or irrigation) potential sources of N leaching that need to be managed on orchards.

Smart fertiliser use considers the "4Rs":

1. At the **right rate**
2. Of the **right type**
3. Delivered to the **right place**
4. At the **right time**

A soil test is usually taken after harvest (early winter) when the soil is cooler and the vines are dormant. Soil testing determines the levels of the key nutrients present in the soil - phosphorus (P), potassium (K), Calcium (Ca), Magnesium (Mg) and nitrogen (N). Testing also indicates how readily soils can absorb nutrients and make them available to plants (based on pH and Cation Exchange Capacity results). This information, along with the previous season's yield and growth response can form the basis for a fertiliser recommendation (**right rate**).

Fertilisers come in different forms and methods of application (**right type**)

- Ground applied solid fertilisers - Calcium Ammonium Nitrate (CAN) is the most common form of Nitrogen based fertiliser used, along with Sulphur of Potash (SOP), the most common form of potassium fertiliser. Orchardists usually attempt to time fertiliser spreading before a light rain event to help integrate it into the soil (but not heavy rain events that would cause run-off). Little and often is most effective for fertiliser application.
- Foliar fertilisers – soluble fertilisers spayed on to foliage, most commonly Urea. Applied preharvest, foliars support early season growth, support the vines through periods of stress (e.g. cold snaps), can correct nutrient deficiencies, and improve fruit quality, and/or to increase fruit size. Foliars may also be applied postharvest to accelerate leaf drop or to build plant reserves for the following spring. They are used in addition to solid fertilisers.
- Fertigation – soluble fertiliser applied to vines via an irrigation system. This provides greater ability to apply smaller amounts of nutrients often, targeted at the root zone (**right place**) resulting in improved nutrient use efficiency and reduced nutrient losses. Fertigation is a relatively new method of fertilisation and research is still ongoing. It is promising for light soils with low nutrient holding capacity and organic matter, and for heavy soils where root growth is constrained near the surface. The biggest constrain for growers is access to water.

Spring is the best time for plants to take up nutrients (**right time**). For best uptake and to limit leaching, fertiliser application should be avoided ahead of or during heavy rain, or when soils are clogged, overly wet or waterlogged.

Read more about sustainable nutrient management in Ch 4.4.3.

Right:
Fertiliser spreading

3.9 CROP PROTECTION

The Zespri Crop Protection Standard advises growers which agrichemical compounds may be applied to fruit that will be marketed by Zespri. There are different standards for conventional and organic production systems. These standards ensure fruit meets the legal requirements in each country where Zespri fruit is sold and that customers and consumers requirements for safe fruit, produced in an environmentally responsible manner, are also met.

Integrated Pest Management

Kiwifruit are susceptible to a range of pests and diseases which can affect vine health, fruit quality, or restrict access to important export markets. The best method for crop protection is an integrated pest management approach that includes:

- Monitoring for pests and diseases.
- Applying appropriate agrichemicals at the right time and at the correct concentration.
- Using cultural controls to further minimise pests and diseases.
- Implementing orchard hygiene measures to prevent the spread of pest and diseases.

Agrichemical Controls

Pest and disease control using agrichemicals is an essential part of modern orchard management. Pests such as scale and leafroller, and diseases such as Psa and Sclerotinia, often require agrichemicals to control their numbers. Agrichemicals should only be applied if they are required, therefore monitoring for pests is essential for growers to determine what agrichemicals they should be using.

Agrichemicals for pest and disease control can be grouped into three categories: systemic, contact and preventative. Systemic agrichemicals travel through the plant after they enter through healthy leaves, where they can poison or disrupt the lifecycle of pests and diseases. Contact agrichemicals rely on excellent spray coverage, as they depend on touching the pest or disease that they target. Preventative agrichemicals tend to make the plant unappealing to a particular pest or disease, by methods such as altering the taste of the plant or changing the pH of the leaf surface.

Right:
Sprayer applying an agrichemical to dormant vines in winter

Cultural Controls

Cultural controls are often simple non-chemical methods which result in more effective control of pests and diseases. Examples include:

- Ensuring plant species used for shelter are not those favoured by pests e.g., poplar and willow can be hosts for scale insects.
- Removal of host plants from the orchard surrounds e.g., Passionvine hopper (PVH) readily lay eggs on blackberry, bracken, and mahoe.
- removing overly large crowns from vines during winter pruning to reduce the number of crevices where scale insects can hide.
- mulching the grass sward under the vines immediately prior to flowering to reduce the ability of Sclerotinia spores to drift from the ground up to the canopy.

Orchard Hygiene

Keeping tools and equipment clean and sanitised is a key strategy for minimising the spread of pests and diseases. Virulent diseases such as Psa can spread from vine to vine on pruning tools and can move between regions through new plants or budwood; soil-borne diseases can be transported onto an orchard in mud on boots or tractor tyres; and pests can be transported in machinery imported from other countries.

Sterilising pruning and girdling tools between every vine, using foot baths when entering an orchard, and thoroughly cleaning machinery can all help to prevent or slow down the spread of pests and diseases.

3.10 ORCHARD RISK MANAGEMENT

It is important the growers plan risk into their business model to ensure sustainable profitability. The following diagram illustrates some of the immediate risks growers should take into consideration. Please note that there are wider risks which also impact upon grower profitability such as market access or geopolitical changes. Below is a diagram outlining the various risks that growers could encounter throughout their orchardist careers.

Immediate risks to growers