CHAPTER TWO
ORCHARD DEVELOPMENT

There are around 12,747 hectares of kiwifruit vines that have been established in New Zealand over the last 100 years. The development of kiwifruit orchards has significantly advanced over this time, particularly in the last 10 years. This chapter identifies important aspects of orchard development.

THE SECTION IS DIVIDED AS FOLLOWS

2.1 GREENFIELD CONVERSION

A greenfield conversion is when land used for farming or another use is converted to a kiwifruit orchard. Prior to any land purchase, consideration must be given to water consent requirements in the area.

The conversion process involves initial capital cost of:

- Site preparation (with possible contouring)
- Establishment of shelter
- Establishment of water supply and reticulation
- Planting of rootstock and grafting kiwifruit or planting pre-grafted kiwifruit plants
- Support structures, initially post and wire then pergola (usually steel agbeam)
- In some orchards, frost protection (via water or windmill) and overhead hail protection may be included

Once the initial capital work has been completed, vine and orchard maintenance is required to establish the orchard to the producing stage in around three years. Consideration needs to be given to lack of return for a period of 3-5 years before orchards reach maturity and are covering their annual growing costs.

2.2 SUPPORT STRUCTURES

Kiwifruit vines need to be trained onto a support structure for commercial cultivation. The most commonly used support structure is the pergola system. Historically, vines have been grown on a T-Bar system which was cheaper to construct and easier to maintain. However, greater yields are achieved on pergola structures and most orchards are now grown using the pergola system.

Right:
A young kiwifruit vine growing on a pergola system
(Shane Max, Zespri OPC)

Right:
Grafted kiwifruit stumps with pergola structures and wires in place ready for training
(Shane Max, Zespri OPC)

Far right:
Kiwifruit growing on a pergola system

Right:
T-Bar grown kiwifruit vines

Far right:
T-Bar to pergola conversion kiwifruit vines
(Shane Max, Zespri OPC)

2.3 SHELTER

It is important to have shelter established before kiwifruit vines are planted. Kiwifruit vines do not tolerate wind well. Good shelter should reduce wind speeds in the orchard which will also increase the temperature providing a warmer, protected environment for plants. Without shelter young vines will be stressed and slower to develop. Cooler temperatures can cause decreased growth and smaller leaves while a windy environment will lead to increased physical damage on young plants. In an established orchard reduction in wind speed will raise orchard productivity through improved growth and reduced damage. Shelter decreases the number of fruit rejects due to wind rub, especially on skin sensitive Gold varieties. Additionally, shelter offers protection to new growth in spring preventing blowouts of shoots and physical damage on canes that can be entry points for Psa infection. Increased temperatures during flowering can also encouraging bee activity, and promote normal flower and fruit development. During summer when vines typically require more water, reducing wind speeds reduces evapotranspiration, decreasing how much water the vines require in windier seasons.

Types of Shelter

Natural shelter (e.g. tree shelterbelts) is used extensively in New Zealand. Natural shelter is low cost but takes time to establish. Kiwifruit vines need the most protection when the vines are developing and if natural shelter is being grown at the same time as young kiwifruit vines, it will not provide adequate protection. Natural shelter comes with regular maintenance costs, including trimming, mulching and spraying for pests. It also takes up productive land area and can compete with vines for nutrients, sunlight and water.

Artificial windbreaks can be used to increase shelter while not limiting light and still maximising productive land area. Artificial shelter is more expensive to install than natural shelter, but gives an immediate solution, rather than waiting for natural shelter to establish. While the annual maintenance costs are lower compared with natural shelter, the shelter cloth usually has a ten-year warranty, so the maintenance costs beyond ten years may be much greater than natural shelter. Overhead shelters cover kiwifruit vines typically with hail netting on the roof and wind break cloth on the sides. Overhead shelters have an expensive outlay cost, but the financial rewards can be significant. The benefits include:

- eliminating the impact of a hail event provided the cloth is in good condition;
- a significant reduction in wind speed;
- elimination of wind turbulence;
- reducing leaf wetness and vine damage minimising the spread of Psa and risk of Psa infection;
- and improved pest control.

Right:
Trees planted for natural shelter
(Shane Max, Zespri OPC)

Far right:
Internal shelter helps to keep temperatures up reduce wind and improve the growth of developing vines
(Shane Max, Zespri OPC)

Growers have reported improved pest control with the elimination of susceptible shelter species that can harbour pests such as leafroller, scale and passion vine hopper. There are also reports of improved cicada control in using overhead shelter as emerging adults do not like the enclosed canopy and immediately fly to one end and attempt to exit. Overhead shelter has been associated with greater bee mortality and decreased pollination with traditional pollination systems. Ongoing research is revealing new strategies for improving pollination while maintaining hive health.

Right:
The erection of hail netting over an orchard. In this instance the structure also has enclosed sides

" It is important to have shelter established before kiwifruit vines are planted. Good shelter raises orchard yields through improved growth. "

Right:
Perimeter artificial shelter
(Shane Max, Zespri OPC)

Far right:
Internal artificial wind breaks have removed the need for natural shelter and so increasing the productive area
(Shane Max, Zespri OPC)

2.4 IRRIGATION

Young developing vines require constant watering to help develop healthy leaf growth and root systems. Irrigation requirements are variable throughout New Zealand. Soil type is a significant factor in determining how much and how often a block of kiwifruit is watered. Variation of soil types within an orchard requires some precision irrigation so that water is not wasted and vines are not stressed. Soils with a high proportion of pumice will drain more quickly than soils with a high proportion of clay and will require more frequent watering. Kiwifruit vines that run short of water, especially during phases of rapid growth, will wilt and the leaves will quickly go brown. Kiwifruit vines suffering from drought will produce smaller fruit and excessive drought can reduce the following seasons yield.

Excessive irrigation, particularly in clay soils, can also be detrimental to the productivity of kiwifruit vines. Kiwifruit roots are sensitive to a lack of air and if the roots remain under water for 24-48 hours it will result in root death from which the vine is slow to recover. Irrigation can also be used as tool to increase fruit size prior to harvest. This is managed with caution by growers because although water increases the fruit size it also reduces the fruits dry matter. Growers are paid using both measures. Irrigation can also be used for frost protection.

Right:
Sprinkler used for irrigation (*Shane Max, Zespri OPC*)

2.5 FROST PROTECTION

Nearly all the horticulturally significant frosts in New Zealand are of the radiation type. Radiation frosts occur on nights with clear skies and little or no wind. As heat is radiated away from the surface of vegetation (or other objects) the surface cools and draws heat from the plant material and the surrounding air. If suitable conditions persist, the temperature of the plant material falls to a point where irreversible damage occurs to the plant tissue.

Frost damaged fruit are not edible or saleable and frost damage to vines can negatively impact productivity of kiwifruit vines the following season.

Right:
Severely frost damaged kiwifruit leaves
(*Shane Max, Zespri OPC)*

Far right:
Ice on kiwifruit
(*Shane Max, Zespri OPC)*

2.5.1 Methods of Frost Protection

A wide range of methods are presently used to protect horticultural crops against frost damage and can be loosely grouped into four main classes; directly heating the vines, mixing the air to disturb the temperature inversion, employing a radiation barrier and using cold air drainage.

Heating

Actively heating the area may employ specially designed burners known as 'frost pots'. Frost pots are fuelled by oil, natural gas, LPG or by special solid fuel blocks or candles made from wax, compressed wood waste or other similar materials.

Sprinkler-based frost protection systems are most common and use the heat released when water changes state from a liquid to a solid. Spraying water at an appropriate rate onto a crop under frost conditions causes a layer of ice to slowly develop over the vines. Provided the surface of this ice layer is kept wet, the temperature of the enclosed plant tissue will not drop below about minus half a degree, even though the surrounding air may be at a much lower temperature.

Right:
"Frost pot" burner used to heat orchard area

Far right:
Sprinklers used for frost protection
(*Shane Max, Zespri OPC)*

Mixing

A wind machine is essentially a large fan (with a horizontal axis) which rotates around the top of a 10 or so metre tower, located in the centre of the area to be protected. The 'jet' of air produced by the fan draws the warm air from above the orchard and mixes it into the colder air closer to the ground.

Flying a heavily laden helicopter at relatively slow speed across the orchard area can also effectively mix the air and provide frost protection but has the advantage over wind machines of being able to concentrate on selected areas if required, and to fly at greater elevations to provide added mixing capability.

Right:
Windmill used for frost protection
(*Shane Max, Zespri OPC)*

Far right:
Helicopters used for frost protection

Radiation Barriers

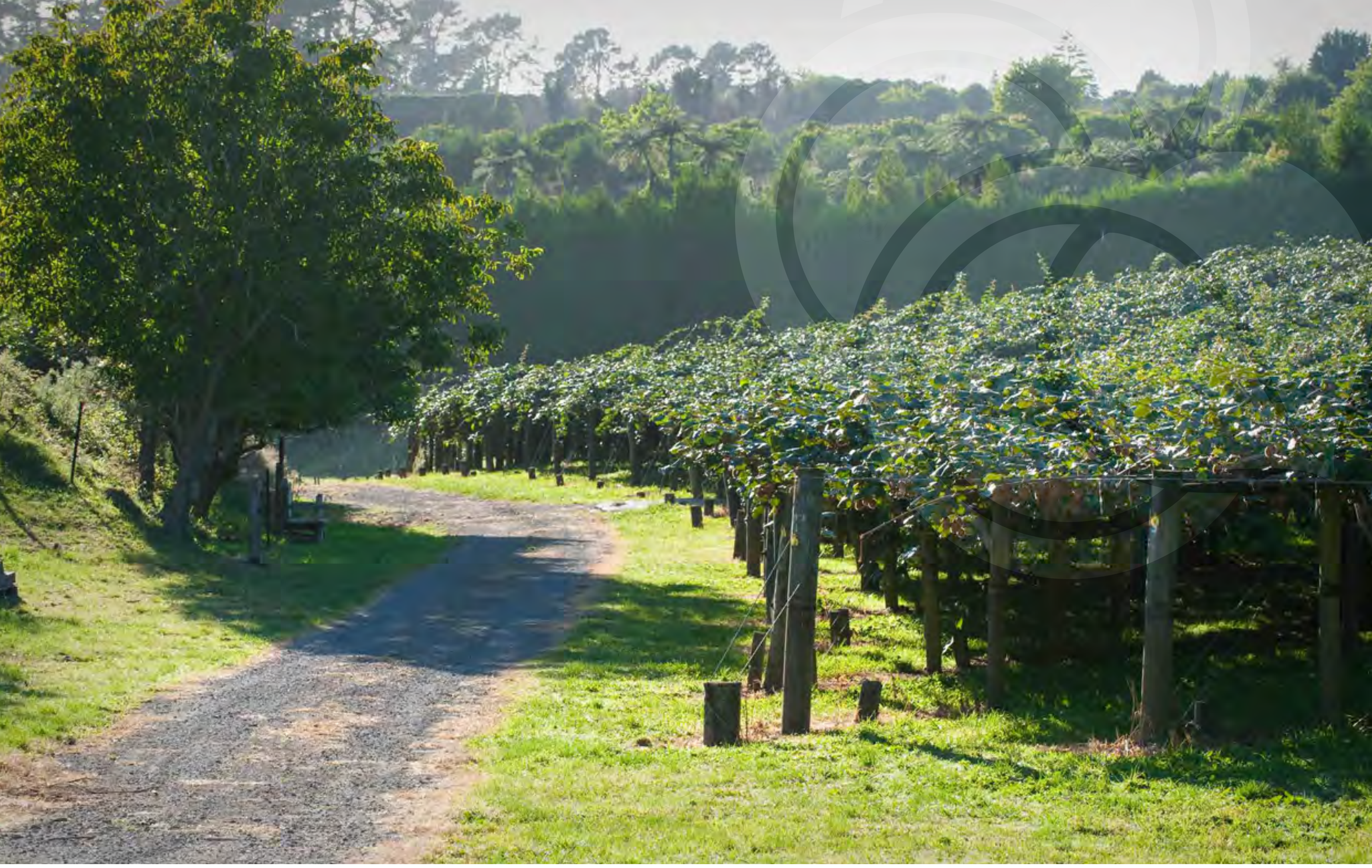
The principle of a radiation barrier is to reduce the heat radiated from the vines and soil surface, and hence increase the vine temperatures. This is achieved by intercepting the outgoing radiation by means of frost cloth, fog or some other radiation barrier.

Right:
Overhead shelter
(*Shane Max, Zespri OPC)*

Cold Air Drainage

Since cold has a greater density than warmer air, it settles at the lowest point that it can easily flow to. In an open environment, the lowest point is often at lakes, ponds or river beds. However, in kiwifruit orchards, natural or artificial shelter can trap cold air so that it pools in kiwifruit blocks where it can lead to frost damage.

Maintaining cold air drainage involves modifying downhill shelter so that cold air can freely drain out of the orchard. This can include removing the lowest metre of foliage from natural shelters so that cold air can flow under the shelterbelt, or repositioning shelter to allow for cold air to escape.



2.6 ROOTSTOCKS AND GRAFTING

Grafting is the joining of two plants to create desirable characterises expressed in one plant. Female kiwifruit vines are generally grafted on top of another type of female kiwifruit cultivar. The plant on the top is called a scion and the plant on the bottom is called a rootstock. The scion is chosen for the fruit it produces (e.g. Gold, Gold3, Green14, Green). The rootstock is chosen for desirable characteristics such as tolerance to heavy, wet soils. The rootstock can also impart its characteristics on to the scion. An example of this is low vigour in vegetative growth.

Historically, there were a number of rootstocks used for kiwifruit. The most common is 'Bruno'. Bruno has been used for many years due to its strong vigour and Psa tolerance. Less common rootstocks include: Hayward; Kaimai; Hort16A; and Bounty. Hayward is less vigorous and can produce fruit that is more variable than Bruno when it is used as a rootstock. Both Kaimai and Hort16A are highly susceptible to Psa. Bounty, a more recently bred rootstock, has Psa tolerance and appears to tolerate dry conditions as well as wet feet (when roots remain wet for prolonged periods of time usually due to poor draining soils).

Bounty is referred to as a clonal rootstock; with clonal rootstocks, every individual plant is genetically identical, therefore every Bounty rootstock on an orchard will deliver exactly the same attributes to the scion. The other rootstocks, including the common Bruno, were grown from seedlings. This means that every Bruno rootstock is genetically different, so there is potential for the different Bruno genotypes within an orchard to create variation in vine growth and fruit quality.

The choice of rootstock can also impact on the timing of the vines development throughout the season (phenology). Gold3 budbreak and flowering can happen a week earlier when grafted onto Bounty compared to Bruno. This has financial implications for those growers whose fruit is early enough to make the first shipment of fruit to market. Bounty is less vigorous than Bruno and requires higher planting densities to speed up full-canopy establishment.

Right:
Looking down on a kiwifruit stump where the canopy has been cut off and two short pieces of budwood (scion) cleft grafted on

There has been extensive re-grafting in the kiwifruit industry post Psa to remove the most susceptible cultivars and replace them with the most tolerant ones. There are a number of places on the vine that can be grafted, they include: notch grafting (side graft); stump grafting; and sucker/rootstock grafting. When the grower has decided where to graft, the type of graft is chosen. These include: kerf (chainsaw) grafting; cleft grafting; and whip and tongue grafting.

Mid-winter is the best time to begin grafting and should be completed by late winter. The grafting success rate declines once sap flow starts (sap flow can also be termed bleeding where there is exudation from cuts. Bleeding is less likely when plants are dormant). The timing of sap flow depends upon several factors including weather conditions, soil moisture and the chosen rootstock. Sap flow normally lasts six to eight weeks.

Summer grafting is possible, but sap flow must be carefully managed. Summer grafting is generally not as successful as winter grafting and is usually only used when abnormal conditions exist. For example, if there was a high rate of grafting failure in winter, or high levels of Psa infection in the grafts. The earlier summer grafting is undertaken (November) the better the subsequent growth.

Post grafting care and graft hygiene are of the utmost importance when it comes to insuring graft success. New shoot growth is vulnerable to damage from birds, leafrollers, bronze beetle, slugs and snails, as well as diseases such as Psa. It is important to keep the base of stump free of weeds and use slug pellets around the base and on top of the stump. When using insecticides, wet-able powder sprays are least likely to damage new shoots and emulsifiable concentrate formulations are the most likely to cause damage. Grafting wounds can be sealed with a wound protectant to prevent water from entering the graft union and will protect the graft against infection. The links below are two videos showing the grafting methods outlined above.

READ MORE HERE:

www.youtube.com/watch?v=4Ikpc7pv41g
www.youtube.com/watch?v=QV4AICjPUIE

2.7 STRINGING

Many orchardists, during the conversion or establishment stages of orchard development employ a management practice called stringing. This is when new leaders and canes are grown up strings. This causes lots of rapid vegetative growth that fills the canopy area and allows growers to move into production sooner. Once the canopy has developed, some growers choose to train their vines to a low vigour system, while other growers will continue to grow canes up strings every season, effectively refreshing their canopy each year. Canes growing up strings receive far less spray coverage than those trained along the pergola wires, as the canopy acts as a barrier to spray reaching those canes.

Right:
Pergola kiwifruit block set up for growing up strings
(*Shane Max, Zespri OPC*)

Right:
Kiwifruit vines growing up strings

Far right:
Kiwifruit block set up for growing up strings
(*Shane Max, Zespri OPC*)

“Once the canopy has developed, some growers choose to train their vines to a low vigour system, while other growers will continue to grow canes up strings every season.”

NOTES