TO: Waikato Regional Council

DATE: 29 July 2022

SUBMISSION ON: Freshwater Policy Review

FROM: New Zealand Kiwifruit Growers Incorporated (NZKGI)
Kathy Mason
Senior Policy Advisor
kathy.mason@nzkgi.org.nz
Phone: 021 056 4778

1 Introduction

1.1 New Zealand Kiwifruit Growers Inc (NZKGI) is a grower advocacy body for New Zealand Kiwifruit Growers. The kiwifruit industry is New Zealand's largest horticultural earner. Kiwifruit exports were worth $3.6 billion in the financial year 2020/2021[1] and sales are expected to grow to $4.5 billion by 2025. By 2030 Māori grower revenue is estimated to grow from $271m to $638m per year.

1.2 Kiwifruit provides the highest per hectare return in New Zealand's primary sector – $76,722 per hectare for Green and $177,846 per hectare for SunGold in 2020/21. Just 5% of all producing orchards are greater than 10 ha, with the median orchard being approximately 3 ha in size.

1.3 The kiwifruit industry is a major contributor to regional New Zealand returning $2.25 billion directly to rural communities in 2020/21. There are approximately 2800 growers, 14,000 ha of orchards, 9,250 permanent employees and up to 24,000 jobs during the peak season.

2 Kiwifruit Production in the Waikato Region

2.1 The regional contribution and producing areas for New Zealand kiwifruit are summarised in Figure 1. Kiwifruit is grown in eight regions however much of New Zealand's kiwifruit (80%) is grown in the Bay of Plenty region where the soils are generally deep and free draining.

[1] Global net kiwifruit sales increased to $4.03 BN in 2021/22, up 12% from 2020/21.

Figure 1: Regional Contribution and Producing Area[2]

2.2 Figure 1 illustrates that there is 551 ha of kiwifruit in the Waikato region, generating a regional economic contribution of $67 million. The kiwifruit industry provides valuable job opportunities for locals in orchards and packhouses. There are currently approximately 200 permanent employees (refer Table 1), and up to 566 seasonal workers per month are required and this number is expected to grow in conjunction with the growth of the industry.

Table 1: Kiwifruit Estimated Season Labour Needs in the Waikato Region (2020/2021 season)

Time of Year	**Activity**	**Seasonal Labour Need (Peak Number of Employees Required Per Week)**
January	Summer pruning, girdling	167
February	Girdling	12
March	Picking, packing, girdling	566
April	Picking, packing	553
May	Picking, packing	553
June	Picking, packing	553
July	Winter pruning*	242
August	Winter pruning*	242
September	Winter pruning*	242
October	Bud thinning, girdling*	402
November	Summer/male pruning, girdling, bud/fruit thinning	561
December	Summer pruning, girdling, fruit thinning	411

*CA and repacking not included, labour requirements will be underestimated for these months.

2.3 Figure 2 shows the general location of the kiwifruit orchards in the Waikato Region.

[2] NZKGI (2021) The Voice of New Zealand's Kiwifruit Growers. New Zealand Kiwifruit Growers Incorporated.

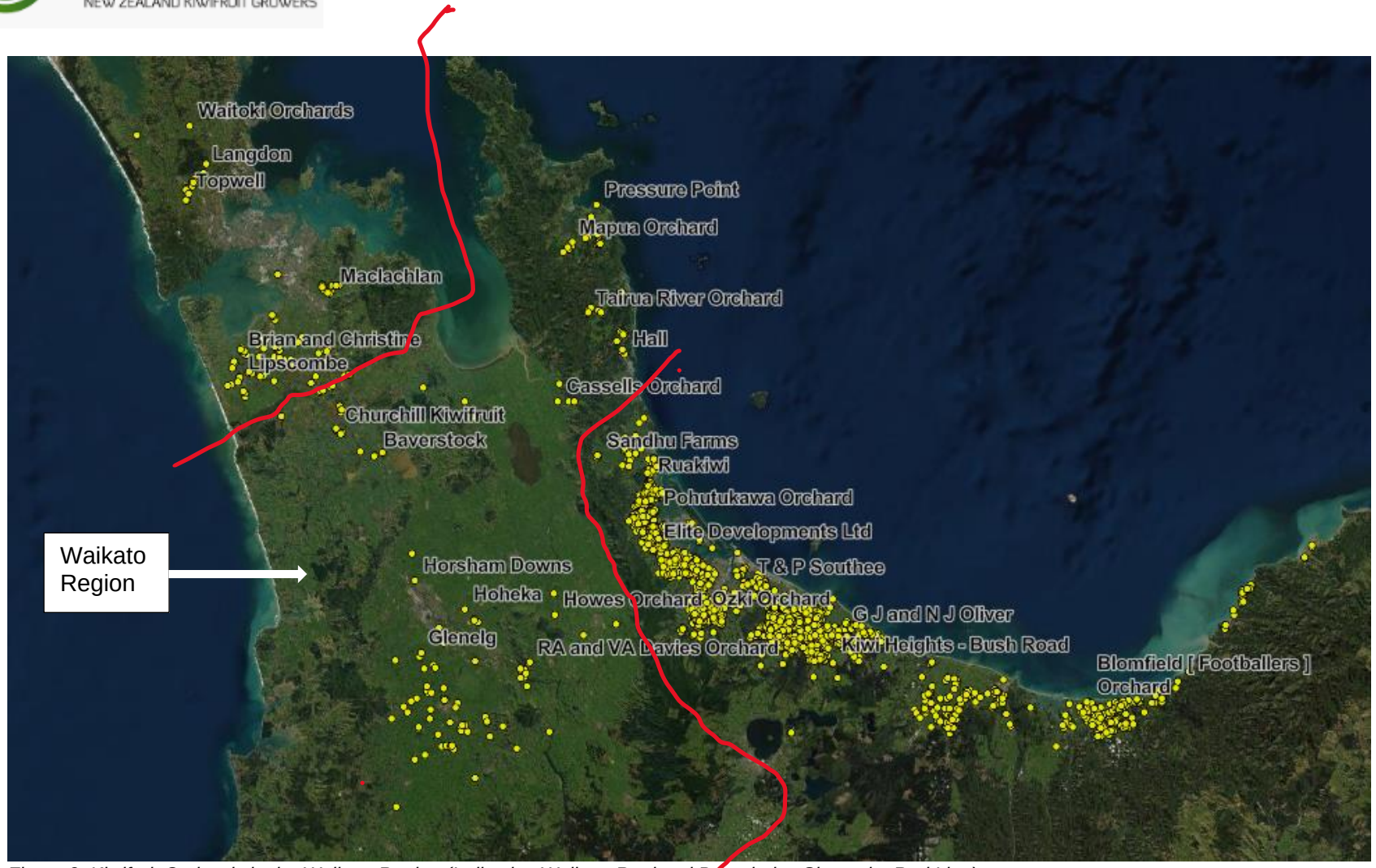


Figure 2: Kiwifruit Orchards in the Waikato Region (Indicative Waikato Regional Boundaries Shown by Red Line)

2.4 Within the Waikato Region, kiwifruit are grown on the Coromandel Peninsula, with some orchards located south of Pukekohe, near to and south of Hamilton and towards Te Kuiti. Kiwifruit orchards therefore provide important seasonal employment opportunities in rural areas across the region.

3 State of the Environment

3.1 The webinar of 25th July 2022 included a presentation on the state of the environment. The slides provided a snapshot of the following:

- River water quality – bacteria in steams and rivers, nitrogen and phosphorus, water allocation, climate change,
- Stream ecosystems – invertebrates,
- Lakes – algal blooms, nitrogen and phosphorus,
- Groundwater – groundwater nitrate,
- Land management – erosion, planting and fencing of streams.

3.2 While bacteria is not expected to be an issue for kiwifruit growers, NZKGI has a particular interest in water allocation, nitrogen levels in surface water and groundwater, phosphorus and turbidity in surface water (albeit to a lesser extent than nitrogen). The industry also has a particular interest in the implications of climate change for the industry.

3.3 NZKGI would like to better understand the effects of the kiwifruit industry on the region's freshwater, including if, how and where it is contributing to overallocation and increasing nitrogen levels on a catchment basis, and how it can work with the council to be part of a solution.

3.4 As discussed later in this submission, an understanding of the importance of responsible freshwater management led the industry to commence work on a water strategy that has the following vision:

"To collectively protect and enhance our water resources for our people, our environment, and our communities, while enabling kiwifruit industry growth.'"

4 Freshwater Policy Review

4.1 NZKGI understands that Waikato Regional Council (WRC) is reviewing its freshwater policy and over the next two years will be making changes to the Waikato Regional Policy Statement (RPS) and the Waikato Regional Plan (WRP) to bring them into line with the national direction arising from the government's Essential Freshwater package. HortNZ has prepared a submission entitled "Submission on Waikato Freshwater Engagement NPSFM 2024", and NZKGI generally supports HortNZ's submission.

4.2 NZKGI notes that WRC is currently seeking input from the public to help identify and understand the issues, values and aspirations for fresh water in the Waikato, and that this feedback will help to inform changes to the RPS and the development of a new regional plan. These revisions will likely affect how activities are carried out in the region.

4.3 WRC seeks that feedback is provided via a feedback form, and by pinning locations of interest onto an interactive map along with an explanation of why they are important, under the following categories:

- Activities in the water: Mahinga kai/hauanga kai, fishing, swimming and other contact recreation (describe the sort of activity),
- Activities beside the water: Mahinga kai/hauanga kai, fishing, swimming and other contact recreation (describe the sort of activity),
- Activities on the water: boating, waka, kayaking, rafting, (describe the sort of activity),
- Plants and animals that live in or near water, including threatened species (describe what these species are),
- Habitat and ecosystems (describe what should be protected, maintained or improved),
- Natural character (describe what's unique about this area0,
- Special sites and features (describe freshwater sites and features that are special to you and why),
- Water quality (describe what needs to be protected, maintained or improved),
- Water take/use, (describe what is important to you about water take and use)
- Something else (describe anything else that's important to you about freshwater).

4.4 We provide answers to the feedback from questions below. We note that public feedback via the interactive map will be used to help WRC develop a plan for maintaining or improving the states of fresh water at an appropriate local scale. NZKGI wishes to ensure that where relevant, the voice of kiwifruit growers is heard through this process.

4.5 As previously described, NZKGI is a grower advocacy body for New Zealand Kiwifruit Growers. The growers rely on NZKGI to represent their interests regarding policy. It is unlikely therefore that individual growers will register their interest regarding individual water bodies on the interactive map.

4.6 Individual growers all have interests in the waterways surrounding their orchards, particularly but not exclusively in relation to the category of "water take and use". Growers are concerned about the changing policy and how that might affect their ability to operate. NZKGI wishes to record their interest through this submission to ensure that the voice of kiwifruit growers is not underrepresented through this process.

4.7 We note that it is unlikely that seasonal workers who rely on employment from kiwifruit orchards will pin their interest in the waterways in terms of "water take and use" on the interactive map, but they too could be affected by changes in policy that may adversely impact the industry.

4.8 In addition, in relation to pinning our interest to the waterways of interest, we make the two following points:

- with the increasing population both nationally and globally, it is important to plan for growth in terms of food production and kiwifruit is no exception,
- climate change may affect where kiwifruit (and other crops) can be grown in the future.

4.9 For these reasons, it is difficult as an industry to highlight all of the waterways that NZKGI and individual growers may have interests in both now and in the future.

4.10 Instead, at this stage we wish to register our interest in the region's waterways more generally. We would like to become more involved regarding individual waterways and catchments that are of interest to the kiwifruit industry as the policy develops.

4.11 NZKGI notes that there is allocation pressure on some waterways and that there are freshwater quality issues in the region that need to be addressed. From the industry's perspective, the issues of most importance are overallocation and nitrogen concentration in surface water and groundwater. As described below, Zespri and NZKGI are undertaking a number of initiatives in that regard. Our desire is to work proactively with WRC on solutions that will benefit both the industry and the environment.

5 Feedback Form

5.1 The following summarises the questions from the feedback form with NZKGI's responses.

1. What are the freshwater challenges or issues facing your sector or industry?

   In our view the main issues are as follows:

   - Having reliable access to water primarily for the purposes of irrigation but also for frost protection and spraying,
   - Having the ability to apply sufficient fertiliser (particularly N) to kiwifruit orchards to provide for healthy growth and acceptable yield/quality,
   - Understanding how N application may be affected by the new policy on orchards that are located in areas where the trends in surface water and/or groundwater are worsening due to cumulative effects,
   - How the council will address the competing values of, and demands for freshwater,
   - Whether emerging policy will acknowledge and provide for those industries and resource users who have voluntarily made improvements with respect to freshwater management to date,
   - The need to grow the industry and the potential implications regarding freshwater,
   - The uncertainties around what climate change means for the industry in terms of freshwater, and,

- The need for, and timeframes required for science to identify how the industry can improve in terms of its effects on freshwater.

2. What are your sector or industry priorities for freshwater management?

3. What is your sector or industry already doing to halt degradation and improve freshwater in the Waikato?

We provide answers to both of these questions together.

In 2019, NZGKI, Māori Kiwifruit Growers Forum, Zespri, HortNZ and industry partners and growers launched the kiwifruit industry's strategy on water. The aim of the strategy is to provide strong leadership and a clear vision and governance to the kiwifruit industry. The vision is as follows:

"To collectively protect and enhance our water resources for our people, our environment, our communities while enabling kiwifruit industry growth."

Attachment 1 contains the five-year plan to reach the Kiwifruit Industry's water goals. As an industry, it is agreed that there are three outcomes that we want to achieve for growers by 2025:

1. Demonstrate alignment of nutrient inputs and losses to good practice limits,
2. Use monitoring technology to actively manage and demonstrate efficient use of water
3. Access tools and knowledge to protect and foster healthy, fertile soils.

In relation to question 2, the priorities of the industry for freshwater management are listed on page 8 of Attachment 1.

Regarding question 3, the industry is undertaking actions to halt degradation and improve freshwater in the Waikato through the results of scientific trials on N leaching, and the provision of advice to growers.

Considerable research, monitoring and modelling has been undertaken by the kiwifruit sector in recent years to understand the nutrient balances in kiwifruit orchards of all New Zealand growing regions including the Waikato. The research also seeks to generate knowledge to increase nutrient use efficiency through good management practice.

This work is achieving good outcomes. Data from the 2022 fertiliser diaries, indicates that the national average applied nitrogen fertiliser rates were similar for Gold3 and Hayward at approximately 105 kg/ha; a 15 and 11 percent drop respectively over the 2020/21 season. This includes nitrogen associated with synthetic soil and foliar fertilisers as well as compost applications. Analysis of users of the Fertiliser Diary indicates that these results are representative of the industry's synthetic fertiliser use while capturing just 20 percent of KPINs.

In conjunction with BOPRC, several case studies are underway with growers to understand the impact of irrigation on yield, fruit quality and orchard gate returns. This work is due to be presented to council in September.

A three-year study to understand the water requirements for Sungold kiwifruit is also in progress. Year one has been completed however results are not expected to be published until after year two (July 2023). The study is being expanded into other regions where Sungold is grown on different soils to

provide more in-depth insights. Year three will provide repetition and will cement results.

In addition, Zespri runs workshops and produces information for growers regarding effective nutrient and irrigation management. Examples of some key resources for growers are provided in Attachment 2.

Last year, several sets of grower workshops on irrigation and nutrient management were held. Waikato growers are encouraged to attend the South Auckland or Bay of Plenty events when Waikato specific events are not scheduled, or the dates/times are not suitable for them. The following summarises recent events held:

Nutrient Know-How Workshops (Booklet provided in Attachment 2)

Thirteen workshops were held, attended by a total of 206 growers across New Zealand's growing regions in May/June 2021. This included a workshop held in Waikato on 3rd June, attended by fifteen growers. The workshops focussed on:

- Elevating basic nutrient management knowledge so that growers are better equipped to sense check and ask informed questions about their fertiliser recommendation,
- Supporting growers in implementing nutrient management plans that optimise nutrients for production, while minimising losses to the environment, and,
- Helping growers identify nutrient loss risks on their orchard, and identify strategies to manage those risks.

94% of attendees said they learned something new and 94% indicated that they would implement actions on their orchard because of what they had learned.

Irrigation Workshops

Ten workshops were held, attended by a total of 367 growers across New Zealand's growing regions in January 2021. The workshops focussed on bucket testing (Gisborne, Hawkes Bay) and irrigation scheduling (BOP, Northland, South Auckland) with the aims of:

- Raising awareness of the kiwifruit industry's water goals and benefits of efficient irrigation, and,
- Promoting good irrigation practices, providing practical advice that growers can take away and implement straight away.

99% of attendees indicated they learned something new and 91% indicated that they would implement actions on their orchard because of what they learned. A further six workshops were held in October/November 2021, attended by more than 130 growers. These delivered the content not covered in January to each region i.e., bucket testing (BOP, Northland, Nelson) and irrigation scheduling (Gisborne, Hawkes Bay, Nelson). Waikato and Auckland workshops had to be cancelled due to Covid restrictions.

We also note that Zespri introduced their industry assurance programme, Zespri GAP in 2003. The GLOBALG.A.P. standard is the base for setting requirements but the focus is on having a programme that delivers the outcomes desired for the industry. As an early adopter of GAP the kiwifruit industry is well placed to respond quickly to new challenges and shifts in customer and regulatory needs.

There are several modules within the Zespri GAP programme that address freshwater either directly or indirectly including:

1. Water management,
2. Soil and Nutrient Management,
3. Environment and Conservation,
4. Site Management,
5. Agrichemical Management.

The kiwifruit industry is currently in the process of preparing for GLOBALG.A.P Version 6 which will be mandatory from October 2023. There are significant changes to this version of the standard, especially in the environmental areas of the requirements. Version 6 includes a transition from a prescriptive to an outcome-oriented approach and the introduction of a continuous improvement plan for producers.

4. What else should be done?

From an NZKGI perspective, the next step is to consider the locations of the kiwifruit orchards within the region in relation to the results of the state of the environment reporting, to identify the effects that the industry is having on waterways and where it needs to focus its efforts. NZKGI would like to work with WRC to properly understand the issues for the industry and the region, and how both parties can work together to address the issues as the policy develops.

5. What suggestions does your sector or industry have about how the council should manage freshwater in its planning documents to give effect to the NPSFM 2020?

Our view is that it is important for the council to:

- adopt a catchment specific approach within the planning documents, that focusses on priority catchments, rather than applying blunt instruments across the region,
- work with industry regarding opportunities for improvement as the policy develops,
- acknowledge and/or provide incentives to those industries and landowners who are making real efforts to improve their management of freshwater, ‘
- make provision for crop survival water during dry conditions for the sole purpose of avoiding plant death or plants sustaining damage to the degree that they require removal,
- provide the right mix of “carrot” and “stick”,

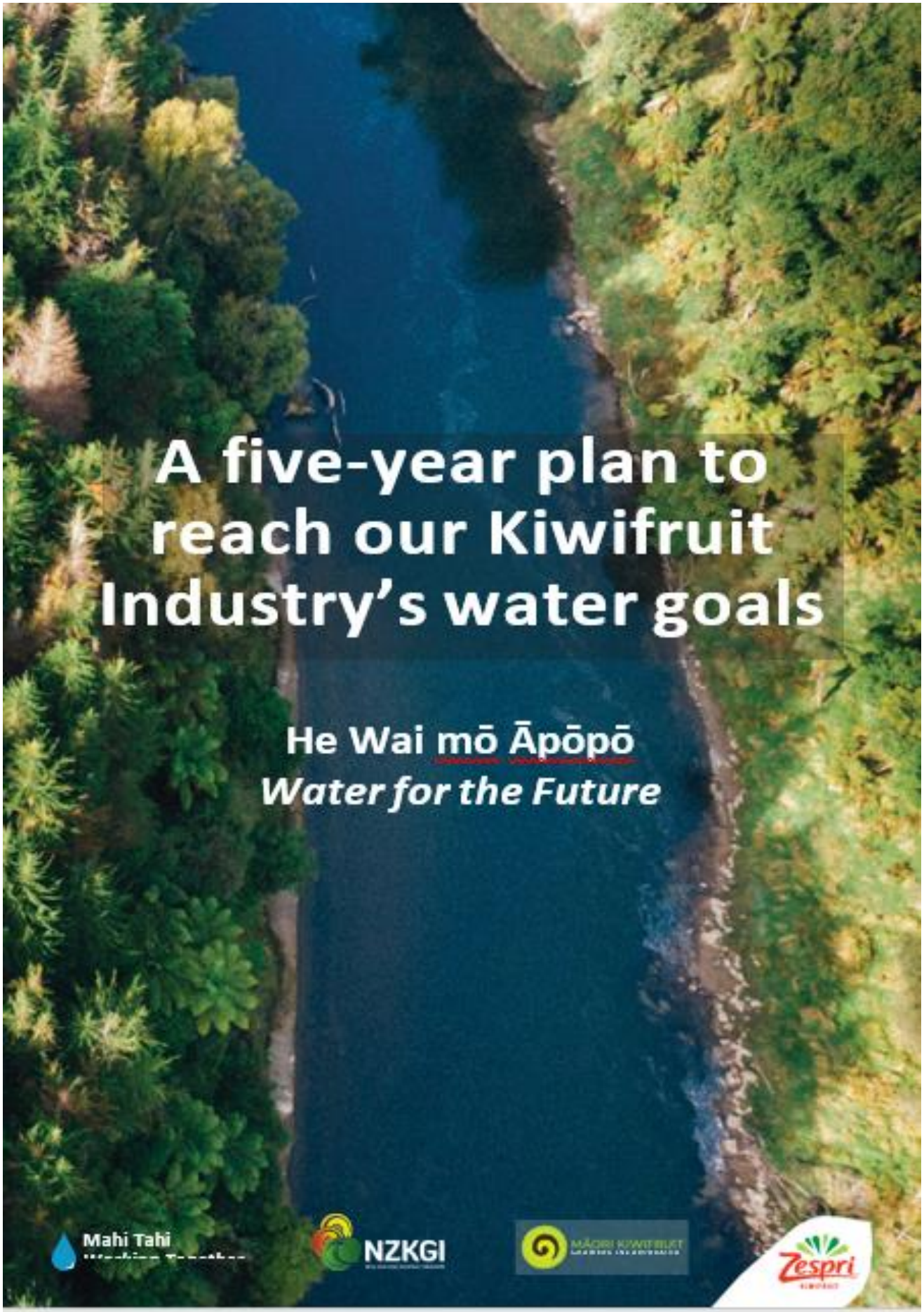
- work collaboratively to identify opportunities for improvement through industry assurance programmes such as Zespri GAP,
- where improvements to freshwater quality are required, provide realistic timeframes to achieve goals, and,
- work with industry to identify science needs and the timeframes necessary to complete research.

5.2 We finish by stressing the importance of getting the balance and timing right within the policy documents. The kiwifruit industry wants to be able to continue to grow and contribute positively to the region. At the same time, the industry understands the importance of collectively protecting and enhancing water resources for people, the environment, and our communities while enabling kiwifruit growth.

5.3 The industry has invested in the water strategy to achieve this vision, and it is achieving good results, but good science takes time and there is more work to be done. This should be considered in terms of the timeframes necessary to achieve the maintenance and improvement of surface water and groundwater across the region.

5.4 Thank you for considering this submission.

Attachment 1: A five-year plan to reach our Kiwifruit Industry's water goals


A five-year plan to reach our Kiwifruit Industry's water goals
He Wai mō Āpōpō
Water for the Future
Mahi Tahi
NZKGI
Zespri

CONTENTS

FOR ALL NEW ZEALANDERS, WATER IS AN INTEGRAL PART OF OUR LIVES, OUR COMMUNITIES, AND OUR ENVIRONMENT.

INTRODUCTION

In Te Ao Māori (the Māori world view), the principle of kaitiakitanga (guardianship) instills in us the responsibility that all people work together as guardians of land and water.

This practice means the sharing of mātauranga Māori (Māori knowledge) and all people gaining a better understanding of land and water science.

Water is a key component of our living environment, which encompasses wetlands, drainage systems, waterways, lakes and estuaries. It is critical we consider the factors that impact on good water quality and thriving aquatic life, as key indicators of healthy water and ecosystems.

The New Zealand kiwifruit industry is committed to protecting and enhancing water resources for our people, our environment and our communities while enabling the industry to grow.

In 2019, New Zealand Kiwifruit Growers Incorporated (NZKGI), Māori Kiwifruit Growers Incorporated (MKGI), Zespri, industry partners and growers, launched the kiwifruit industry's strategy on water. The aim of the strategy is to provide strong leadership and a clear vision and governance to the kiwifruit industry. It focuses on the sustainable management of water resources that protects our environment and enables industry growth objectives, while ensuring the industry can grow and thrive.

PURPOSE OF THIS DOCUMENT

This document provides an update on our progress. It outlines the key projects we have underway and how we plan to deliver the goals set in the 2019 Water Strategy.

In doing so, it provides growers, stakeholders and regulators an idea of what to expect in the coming years.

By working together across the industry, and in collaboration with other industries and local communities, we will continue to make progress in managing and protecting our water resources for today, and for future generations.

Our plan will help ensure we meet the expectations of our communities, build the trust of our consumers, strengthen our brand, enable the continued growth of our industry, and build the resilience of our orchards.

OUR PRINCIPLES

At the heart of our work are five key principles. These provide a framework for our decision-making as partners, as we work towards doing what we say we will do.

He taonga te wai
Water is a treasure

- Water is precious and valuable
- Water has spiritual, environmental, physical and economic value
- Water is a resource to use, preserve and replenish
- Water is life.

Ko tātou katoa ngā kaitiaki
We are all guardians and caretakers

- We take collective and personal responsibility to care for water resources
- We are accountable to future generations so they benefit from water resources like we do
- We will lift our knowledge of caring for and using water better.

Titiro ki te paetawhiti
Look to the horizon and beyond

- We seek solutions for now and into the future
- We look beyond our own backyard to find solutions and problems that may impact on our water usage
- We will find solutions based on evidence and research for better water quality and efficiency.

Oranga nuku, Oranga rangi
Prosperity from the earth and sky

- We gain prosperity, well-being and health from the earth and sky
- Water is a resource to grow food and for all people to benefit from
- We are stakeholders, investors and beneficiaries of the kiwifruit industry for today and in the future.

Te amokura rangatira
The mark of leadership

- We are taking a leadership position together
- We will act proactively with our people and groups we interact with
- We are calling people to take a lead in their communities.

OUR GOALS

The 2019 Water Strategy outlined our objectives under five areas: Leadership, Policy, Growing our People (extension), Research and Information, and Communications.

As an industry, we have agreed on the outcomes we want to achieve for our growers by 2025:

1. *Demonstrate alignment of nutrient inputs and losses to **good practice limits***
2. *Use monitoring technology to actively manage and demonstrate **efficient use of water***
3. *Access tools and knowledge to protect and foster **healthy, fertile soils.***

To be successful, there are a wide range of actions we could take, and a need to do some before others.

We have worked with grower representatives, stakeholders, scientists, grower advisors and others in the industry, to agree on the impact we want to have. We have developed **10 indicators of success** so our growers and stakeholders can track our progress over time.

OUR WORK PROGRAMME

Our work programme has been developed based on the success indicators set out in this document. It is a five-year programme of interlinked objectives which represent a significant investment of time and resources for, and by, the industry.

OUR KEY DELIVERABLES

For each indicator of success, we have a number of actions. The most important priorities are outlined overleaf.

In the **first two years**, these projects focus on improving the scientific knowledge about managing water quality and use, transferring this knowledge to the industry through extension, and ensuring our growers are equipped to meet policy requirements arising from the government's freshwater reforms announced in September 2020.

Together, we are taking care to streamline processes for growers as we move forward with this work.

We already have a good foundation to build upon with Zespri GAP to manage, measure and demonstrate improvements – not all requirements will be new to growers.

As these projects progress, details of on-orchard requirements and options for implementing them will be provided to growers. We will communicate with, and support growers, throughout this journey.

PRIORITIES: 2020-2025

VISION: To collectively protect and enhance our water resources for our people, our environment, and our communities, while enabling kiwifruit industry growth.

INDICATORS OF SUCCESS

2020-21	• Definitions for water and soil quality and measurement confirmed
2021-23	• Orchard nutrient use and loss quantified • Soil health indicators identified • Practices for efficient water use and access validated
2023-24	• Benefits and risks of nutrient use practices assessed • Good practices for soil health identified
2021-24	• Grower decision-making tools for water use and quality on orchard in place • Annual water GAP extension and engagement plans developed and delivered • Growers proactively involved in shaping water policy
By 2025	• All orchards have a plan in place to meet environmental standards by 31 December 2025

OUTCOMES

By 2023	• Reliable scientific data to support the strategy
	• Clear understanding of current state and intended future state for kiwifruit industry water use
	• Good practice is understood across the kiwifruit industry
	• Engaged community through information, communication and participation
	• Mindset shift to a proactive collaborative industry-wide approach

IMPACT FOR OUR GROWERS

By 2025	• Growers are protecting the quality of water by aligning nutrient inputs and losses to good practice limits
	• Growers use monitoring technology to actively manage and efficiently use our precious water resources
	• Growers have access to tools and knowledge to protect and foster healthy, fertile soil

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HIGH-LEVEL 5-YEAR PLAN

	INDICATORS OF SUCCESS	2020	2021	2022	2023	2024	2025
1	Definitions for water and soil quality and measurement confirmed		Definitions agreed				
2	Orchard nutrient use and loss quantified	Baseline nutrient modeling complete			Ongoing research		
3	Soil health indicators identified		Soil quality measured		GIS storage system for soil health		
4	Practices for efficient water use and access validated		Water needs measured				
				Drought impacts understood			
5	Benefits and risks nutrient use practices assessed			Advice on optimising fertiliser application			
				Complete assessment and provide advice to growers on benefits and risk of different practices			
6	Good practices for soil health indentified			Guide for measuring soil health developed		Tools available to support practices that protect and foster healthy, fertile soils	
			Guidance on measuring soil health developed and shared with growers				
7	Grower decision-making tool for water use and quality on orchard in place		Develop and deliver interim tool				
				Develop, pilot and roll-out decision-making tool			
8	Annual Water GAP extension and engagement plans developed and delivered	Establish connections and understand current practice, motivators and barriers to inform extension plans					
			Build and deliver annual extension plan				
9	Growers proactively involved in shaping water policy			Use research, experts and grower advice to develop our positions on water policy			
10	All orchards have a plan in place to meet environmental standards by Dec 31 2025		Develop system and roll out training that meets requirements	Supporting growers to meet requirements			

Timeframes will be refined as projects progress.

HOW WE WILL DELIVER OUR WORK PROGRAMME

LEADERSHIP

We have adopted an industry-wide ***leadership*** approach to managing water and nutrients. We have engaged experts and stakeholders from all areas of the industry to help develop our priorities and support the implementation of our programme.

This collaboration will position us to deliver a cohesive water programme for the kiwifruit industry. It includes providing opportunities for Māori growers to engage on these issues via Māori Kiwifruit Growers Incorporated, as members in the working groups and Leadership team, as well as kanohi ki te kanohi (face-to-face) with our team on the ground.

RESEARCH AND INFORMATION

Our investment in ***research and information*** will provide insights that will help our industry focus on the actions that will make the biggest difference in protecting water.

We have engaged independent experts across this work, and together the insights learnt are helping us measure baselines so growers can understand their nutrient use and risks. It will also inform our understanding of policy implications for our growers (environmental and financial), and gives us the opportunity to in turn, inform policy makers of the impact of growing kiwifruit on water resources. We have developed a multi-year, multi-million dollar research programme focused on three key areas: nutrient-use and loss; efficient water use; and soil health.

It is the outputs of this research which will provide knowledge and content for extension.

GROWING OUR PEOPLE (EXTENSION)

Extension is at the heart of our water strategy. Making meaningful changes to on-orchard practice over time is vital for protecting our environment and the ongoing prosperity of the industry.

We will provide New Zealand growers and industry partners with information, decision support tools and develop extension services to aid and inspire continuous improvements. Zespri GAP also has a role to play here as we build on existing processes to identify risks, demonstrate progress, measure improvements and improve reporting. Growers will be able to take action confidently, knowing the changes they make will protect our precious water resources, while remaining productive and profitable. We are committed to developing efficient systems and tools to support change — so growers can focus on their orchard, not their paper trail.

POLICY

Sensible **policy** is critical to the ongoing environmental and financial sustainability of the kiwifruit industry.

We will give growers a voice as we develop our positions on water and ensure they have the tools and knowledge to meet the water rules. We will advocate for policies that make sense for New Zealand growers, and which integrate with our own industry systems, such as ZespriGAP.

COMMUNICATIONS

Our **communications** to growers and the wider kiwifruit community will ensure they know what they need to do and why.

We will be proactive, open and clear as we engage with our key stakeholders, such as those in-market, government and environmental organisations. We will share our challenges and our successes.

MAHI TAHI — WORKING TOGETHER FOR OUR GROWERS

To achieve our goals, the Water Strategy partners are focused on working in partnership with each other, with growers, and the wider kiwifruit industry, both at a leadership level and grass roots level.

NZKGI

MĀORI KIWIFRUIT

Zespri

Our goal is to provide leadership and encourage active engagement from growers and stakeholders across the industry to develop, promote and implement the kiwifruit industry Water Strategy.

LEADERSHIP

Our Leadership Group includes diverse representation from NZKGI, Māori Kiwifruit Growers Inc and Zespri.

Together, we have already achieved many of the leadership-focused objectives from the 2019 Water Strategy. These continue to be a focus as we deliver the Strategy:

- We have identified and addressed the resource needs to deliver the Water Strategy.
- We have identified industry roles and responsibilities in relation to the Water Strategy.
- We have developed governance and oversight to the working groups to ensure continuous progress and accountability.
- Industry leaders are taking shared ownership of the Water Strategy.
- We have strong grower representation and Māori partnership on the leadership group.
- We are actively engaged with local and central government to ensure the industry is represented on matters relating to freshwater.

What we will do:

- Shift the mindset so we have a proactive, collaborative, industry-wide approach to water. This means engaging with stakeholders across our industry, including contractors and orchard managers; researchers, and subject matter experts, as we move forward on this journey together.
- Provide opportunities for all our growers to contribute to the Water Strategy.
- Understand the values and perspectives of other water users and community groups.
- Work together with local and national government and environmental stakeholders.
- Influence water users to comply with the use and protection of freshwater.

Our goal is to quantify the relationship between kiwifruit vines and their need for water and nutrients to minimise impacts on water resources, while ensuring productivity.

RESEARCH AND INFORMATION

We've invested in a multi-year research programme which is informed by focus areas outlined in our Water Strategy in 2019. It focuses on nutrient use and loss, efficient water use, and soil health.

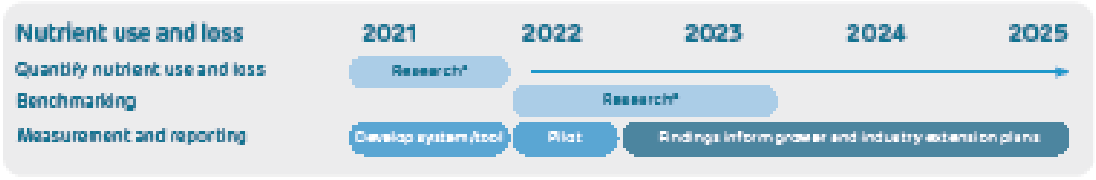
What we will do

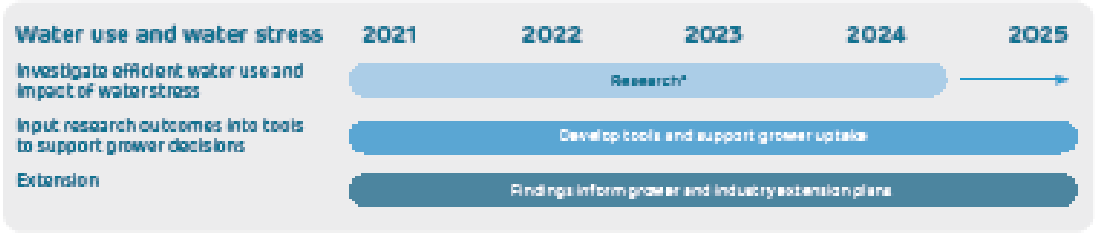
- Develop reliable scientific data to support the water strategy and enable tool development to support on orchard decision making
- Encourage effective practice across the kiwifruit industry
- Establish a common benchmark to compare orchard management practices and outcomes and track continuous improvement
- provide valuable insights for grower tools and extension.

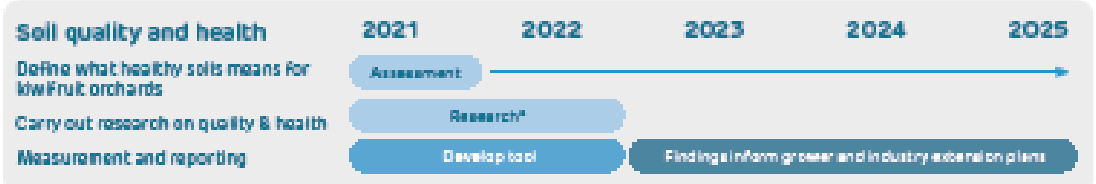
The timeframes for these differ, as the evidence base is more developed for some areas (e.g., nutrient use and loss) than others (e.g., soil health). Research in some areas takes longer than others — water use in particular, is a multi-year discipline.

Ultimately, the tools and extension programmes, informed by science and data, we develop will enable all orchards to have effective farm environment practices in place.

The tables below illustrate the timeframes for the areas of research and development Zespri is investing in and demonstrate how our research will flow through to providing practical, on-the-ground support for our growers so they can optimise the way they grow kiwifruit. The research findings will also be useful for policy makers in understanding the impacts of growing kiwifruit, and the opportunities for improvement.







*These timeframes are approximate and indicate the research underway to develop our data and insights. The arrows demonstrate our commitment to ongoing research in these areas.

13

Our goal is to support and encourage growers in the sustainable management of water and nutrients on-orchard. We will build knowledge and capability so growers can make continuous improvements to their on-orchard practices, with confidence.

GROWING OUR PEOPLE (EXTENSION)

As in other areas, we have already made progress towards meeting the objectives from the Water Strategy set in 2019:

- We developed and delivered the annual extension plan for growers with an approach we can roll out over time.
- We are building a foundation of knowledge for on-orchard practices related to water and nutrient use.
- We are influencing growers on efficient water use and irrigation.

Our growers will need to learn new skills to implement new practices, monitor and report on their management of water and nutrients on orchard. Our aim is to introduce these learnings, data gathering, record-keeping and decision support tools, and on-orchard changes over time, while supporting growers every step of the way.

At the same time, we can build on what growers are already doing through existing risk assessment tools and soil and water management plans.

What we will do:

- Develop a culture of continuous improvement in orchard management practices
- Implement annual extension programmes that incorporate new knowledge as it becomes available and support continuous improvement
- Provide a grower-friendly data reporting and management decision system to enable informed decision-making for each unique orchard, and track progress, to be built with knowledge and understanding of what the requirements are within Zespri GAP
- Influence grower behaviours through targeted information and extension services
- Work together with community catchment groups, prioritising at-risk catchments
- Support growers to implement Farm Plans
- Develop industry extension capability in sustainable orchard management.

DEVELOPMENT OF OUR ANNUAL EXTENSION PLAN FOR GROWERS

Resource development

- Research reports, consumer and market requirements, government regulations, input from growers, expertise from industry and consultants
- Publications, content creation, apps, websites.

Extension delivery

Events, targeted programmes, industry event support, measurement and evaluation.

Trials and data analysis

- Trials to demonstrate on orchard impacts.
- Interpreting industry data in a way that resonates with growers.

Influencing policy that has implications for growers is vital to get the best outcomes for growers, which protects their right to grow.

POLICY

What we will do:

- Develop a consistent approach to responding to regional and national policies
- Enable growers and the wider kiwifruit community to contribute to our policy processes
- Understand the role of Zespri GAP in supporting the water strategy, including linking with Farm Plans and setting industry standards.

The government is continuing to develop its approach to farm planning through the Freshwater Module of Farm Environment Plans. At the same time, GLOBALG.A.P, which sets our market expectations across a range of areas, including environmental standards, is being updated.

Zespri GAP is benchmarked to GLOBALG.A.P and combines market access requirements with our customers' requirements. We are working with the government to confirm Zespri GAP as the reporting and monitoring tool for the delivery of Farm Plans.

Aligning these reporting and quality assurance systems would provide efficiencies for growers and the industry (time, energy and cost). It would also help growers prioritise their actions, supported by advice from industry representatives and orchard advisors.

Growers will be represented in these developments and can contribute to policy positions in the following ways:

- The Policy Working Group (which has grower representation) leads the development of the industry's response to water policies
- Through NZKGI and NZKGI Forum representatives.

Our goal is to have an engaged community through information, communication and participation.

COMMUNICATIONS

To date, we have developed a comprehensive set of key messages and a stakeholder management plan to make sure we talk with the right people at the right time.

What we will do:

- Deliver the information and tools that mean growers can protect the environment, remain profitable, and meet customer and government expectations
- Engage with environmental stakeholders, to bring them on our journey
- Develop clear external messaging on the opportunities and implications of policies on growers and the industry.

Grower communications

We know there are a lot of changes happening for our growers. Increasing expectations for reporting and compliance affecting the way orchards operate on many fronts.

We want to bring those changes together for our industry. We will keep growers updated with changes to requirements. We will work across water and nutrient-related issues, bringing together systems and evolving decision support tools for water, climate change, and soil quality from within Zespri GAP to meet requirements and demonstrate improvements.

At a practical level, NZKGI and Maori Kiwifruit Growers Inc. will continue to provide information to growers about changes to local and national policies as they relate to the kiwifruit industry.

We will continue to test our communications approach with environmental stakeholders as our thinking develops and our work takes shape.

The government also has significant policy work underway which will have implications for our growers and the industry. We'll make sure we connect with the right people at the right time across this complex and interconnected work.

BY WORKING TOGETHER, WE CAN CREATE A LEGACY FOR NEW ZEALAND AND OUR FUTURE GENERATIONS.

MEASURING OUR PROGRESS: WHERE TO FROM HERE?

It is important that we hold ourselves to account and remain committed to our five-year plan. The Water Leadership Group receives updates on progress from each working group every time they meet.

As we improve our scientific knowledge and get the tools in place to measure our impacts, we will start to report on these in more detail to our stakeholders.

Māhi Tāhi / Working Together

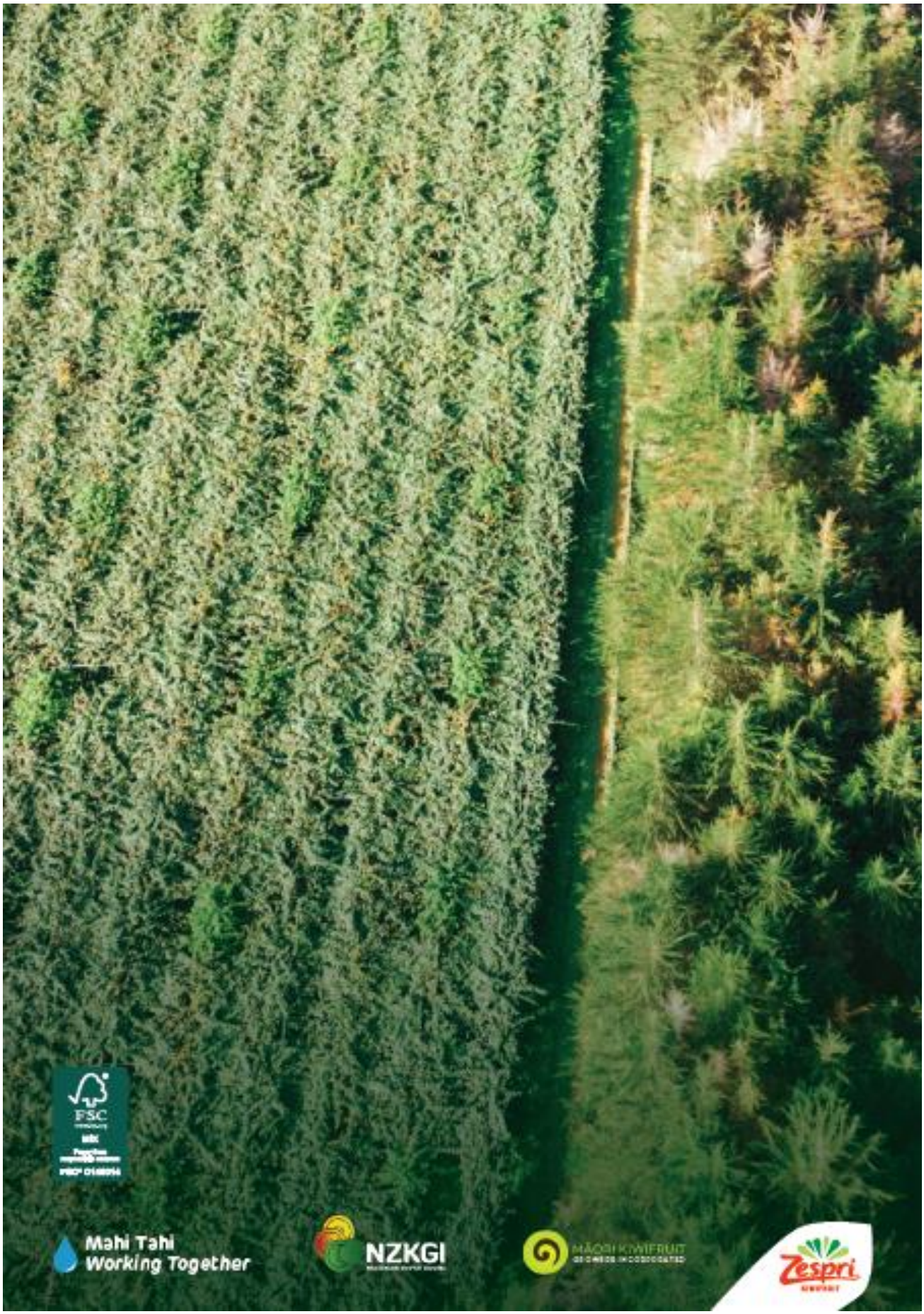
Our actions are guided by our values and the principles we set out.

We know how to work together, proactively, and through shared leadership and commitment.

We will adopt insight from science, along with the learned experiences of growers, to continuously improve our management of water and nutrients.

We know we need to be agile with our actions as we learn from our research and as the environment changes around us.

We are committed to achieving this together, so that our future generations can benefit from water resources like we do.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Mahi Tahi
Working Together
NZKGI
MĀORI KIWIFRUIT
Zespri

Attachment 2 – Examples of Resources for Growers

NUTRIENT KNOW-HOW

WORKSHOP BOOKLET

ZESPRI GLOBAL EXTENSION TEAM

May/June 2021

Mahi Tahi
Working Together

NZKGI

MĀORI KIWIFRUIT

Zespri KIWIFRUIT

A Water Strategy for the kiwifruit industry was developed in 2019 by NZKGI, Zespri, Māori Kiwifruit Growers Incorporated (MKGI), and growers. Together, we are committed to working collaboratively with the entire kiwifruit industry to protect water quality, use water efficiently, and build soil health on orchards.

AGENDA

INDUSTRY WATER GOALS

Kiwifruit growing is more than a job or an income for most growers; it's a way of life that many are born or drawn into. It naturally includes a strong affinity and sense of responsibility for the local land and waterways that support our lives and livelihoods.

As a grower, it makes good business sense to optimise fertiliser and water use for maximum productivity and fruit size, without waste or loss from the orchard system. Being thoughtful about how much, when and where nutrients are applied is also an important step towards:

Through strong leadership, governance, vision and participation across the kiwifruit industry we can contribute to the sustainable management of water resources that protects our environment, while ensuring the industry can grow and thrive.

- meeting customer expectations
- maintaining a good reputation in the communities where we grow
- taking leadership to moderate or avoid regulatory push.

Through He Wai mō Āpōpō — Water for the Future (the industry-wide water strategy), NZ Kiwifruit Growers Incorporated, Maori Kiwifruit Growers and Zespri have committed to working towards a shared goal of demonstrating alignment of nutrient inputs and losses to good practice limits by 2025.

To help achieve this, there are a number of research and trial projects underway to develop and share practical ways to improve nitrogen uptake and reduce nutrient losses. This includes research into seasonal kiwifruit water and nutrition requirements, nitrogen release rates from compost, nutrient loss risk factors, and working with growers to explore whether productivity can be maintained with reduced nitrogen fertiliser inputs.

WHY THE FOCUS ON NITROGEN?

Nitrogen (N) is a naturally occurring substance and its use in fertiliser form is a key tool in driving kiwifruit productivity.

Nitrogen fertiliser is not a problem when contained within a kiwifruit orchard and within the root-zone.

However, as the nitrogen in fertiliser breaks down into the soluble form (NO_3^- or nitrate), any excess not taken up by plants can be carried below the root zone via water and gravity (as leaching), and lost to the environment.

By using nitrogen efficiently (applying only the amount your plants need, when they need it) and reducing these losses, growers can help to care for local waterways.

Nitrate-nitrogen levels are increasing in 39 percent of monitored groundwater sites in New Zealand.

Excess nitrogen in waterways:

- makes water toxic for people and livestock to drink
- promotes excess growth of weed and algae
- degrades swimming and fishing areas, as well as wildlife habitat.

The Ministry for the Environment has reported that nitrate-nitrogen concentrations are above natural levels in 44 percent of New Zealand's monitored groundwater sites[1], and this trend is worsening at 39 percent of sites. Nitrogen levels are increasing at more than 30 percent of monitored river sites in pastoral areas, posing a risk to water quality and wildlife[2].

Nitrogen is one of the most common contaminants of rivers, streams and groundwater in rural and urban areas. The biggest source of nitrogen in New Zealand's waterways is urine from farm animals[3]. However other key contributors of nitrate (the soluble form of nitrogen) in waterways include:

- excessive application of inorganic fertilisers
- animal waste
- human waste, such as from sewerage system seepages and overflows.

Excessive amounts of nitrate in waterways can make the water toxic so that it becomes unsafe for people and livestock to drink, and unsuitable for fish and other wildlife to live in.

Excess nitrogen in waterways also promotes weed and algae growth which can:

- clog waterways (and water intakes),
- reduce water oxygen levels, and
- increase water temperatures,

so that swimming spots, and fish and bird habitats become degraded.

[1] p.39 https://environment.govt.nz/assets/Publications/Files/our-freshwater-report-2020.pdf
[2] P. 37 https://environment.govt.nz/assets/Publications/Files/our-freshwater-report-2020.pdf
[3] https://www.pce.parliament.nz/explore/water-quality/nutrient-pollution

NUTRIENT BASICS

KEY NUTRIENTS AND PLANT REQUIREMENTS

Kiwifruit vines require 16 key elements for growth and fruit production. These include carbon, hydrogen, oxygen, small quantities of micronutrients (iron, zinc, manganese, copper, boron, molybdenum and chloride) and larger quantities of macronutrients, including:

- **Nitrogen (N):** this is a key element in plant growth. It is found in all plant cells, in plant proteins and hormones, and in chlorophyll. High nitrogen levels can cause excess vigour and if late in the season, lead to fruit softening and spoil in storage.
- **Phosphorus (P):** helps transfer energy from sunlight to plants, stimulates early root and plant growth, and hastens maturity.
- **Potassium (K):** Potassium increases vigour and disease resistance of plants, helps form and move starches, sugars and oils in plants. A potassium deficiency can affect fruit number and size, but not quality.
- **Calcium (Ca):** Calcium is essential for root health, growth of new roots and root hairs, and the development of leaves. It is also important for cell wall development and fruit storage.
- **Magnesium (Mg):** Magnesium is a key component of chlorophyll, the green colouring material of plants, and is vital for photosynthesis (the conversion of the sun's energy to food for the plant). A magnesium deficiency can affect fruit number and size, but not quality.
- **Sulphur (S):** is essential for forming proteins, enzymes, vitamins, and chlorophyll in plants. Sulphur is also important in photosynthesis.

NUTRIENT BALANCES, INTERACTIONS AND AVAILABILITY

In the soil, nutrients interact with one another leading to changes in availability to plants. If there is an imbalance with too much or too little of a particular nutrient present in the soil, it can reduce or increase the availability or ability of a plant to access other nutrients.

Importantly, plant growth is dictated by the scarcest resource (limiting factor). This means that even if all the other elements are present at adequate levels, a deficiency in one may limit overall productivity. This is called the law of the minimum and could potentially explain any observed lack of response to adding fertilisers.

pH (discussed on page 9) also alters the availability of nutrients by changing the chemical form of those nutrients.

WHEN MORE BECOMES LESS

There is a point at which no more yield can be gained from additional application of nutrients.

Ulrich first established a now longstanding principle of plant nutrition (noted by Smith et al[4]) that identifies a 'luxury-range' for plant nutrient concentrations, between the points of maximum yield and nutrient toxicity (see Figure 1 below).

If vines can already access enough nutrients to achieve maximum yield, the application of additional nutrients could be considered an unnecessary luxury that will achieve no further production benefit.

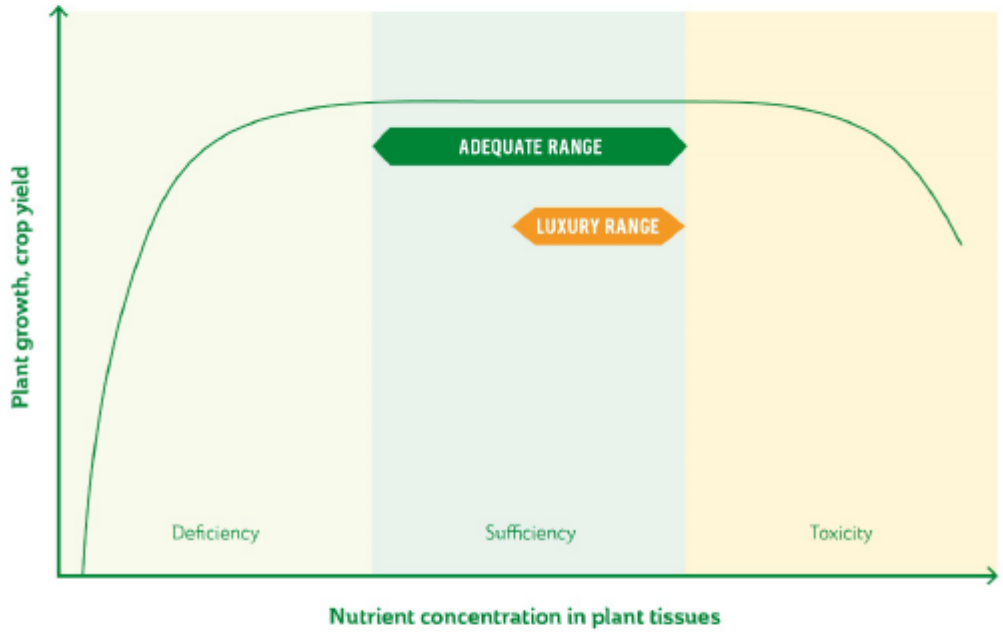


Figure 1. A graphical representation of the principle that nutrient concentrations in plant tissue may continue to increase (in the luxury range) even when a plant has reached maximum yield.

[4] Smith G.S., Asher C.J., Clark C.J., 1987, Kiwifruit nutrition: diagnosis of nutritional disorders, page 55.

WHAT AFFECTS NUTRIENT UPTAKE?

There are many factors that can influence what level of nutrients are available in the soil for kiwifruit vines to use and how much of each nutrient the vine is able to absorb and make use of at any given time. Key factors are shown in Figure 2 below and brief explanations are provided on the following pages.

Detailed discussion of each is beyond the scope of this workshop. However references for further reading are available on page 42.

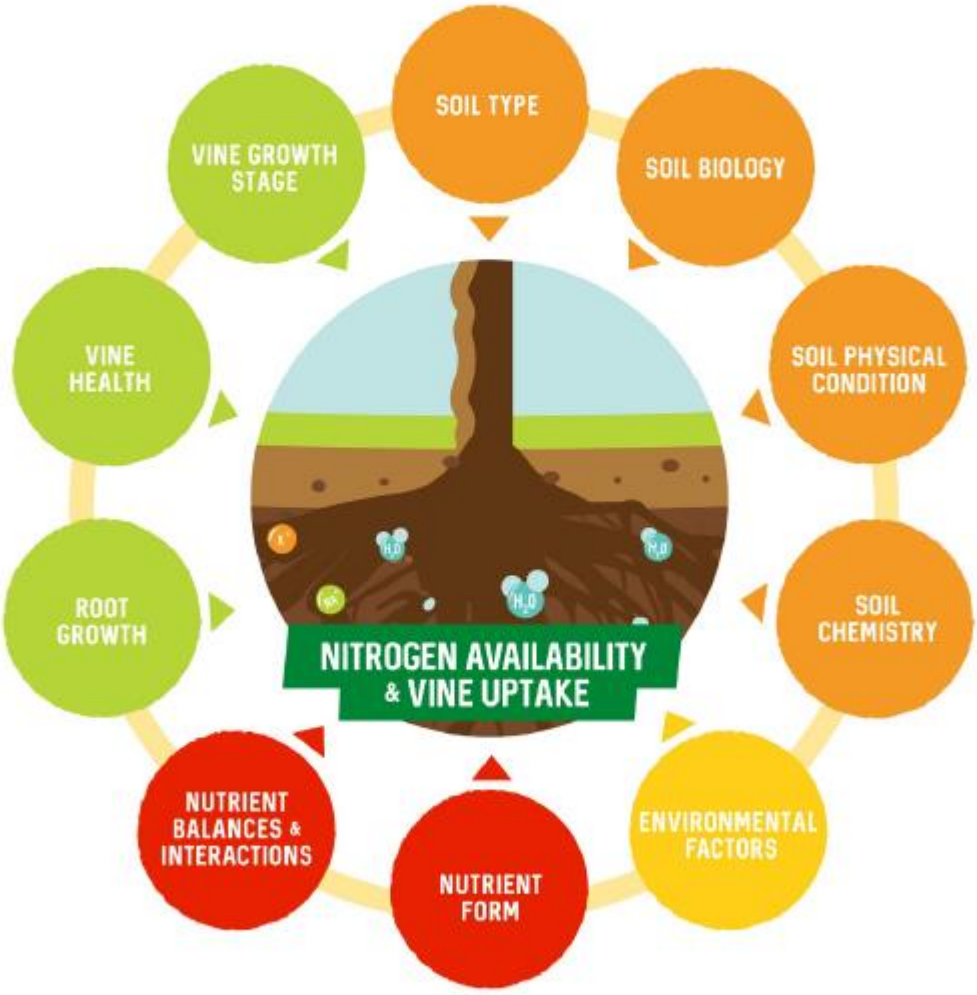


Figure 2. Some of the key factors that can affect nitrogen availability and plant uptake

SOIL CHEMISTRY

Cation exchange capacity (CEC)

Plant nutrients exist as molecules floating around in the water content of your soil. Some of these molecules are positively charged (cations), while others are negatively charged (anions).

For example:

- calcium is a cation that exists in your soil as Ca^{2+}; a calcium molecule with two positive charges on it
- magnesium (Mg^{2+}), potassium (K^{+}), ammonium (NH_4^{+}) and sodium (Na^{+}) are also cations.

In the world of molecules, opposites attract – so positive cations such as those in a calcium molecule will bind to the negative charges of a soil particle. Cations bind weakly to the soil so plant roots can still access them, and they are less likely to filter down and be lost from the root zone when bonded.

The amount of negative sites in a soil and therefore the ability of the soil to hold onto cations, is measured as the **cation exchange capacity**, or CEC, of a soil. Most basic soil test packages include a CEC measurement.

Check your CEC and organic matter test results

- Medium CEC for kiwifruit is 12-25.
- Medium organic matter (OM) for kiwifruit is 7-17%

Results below medium indicate your soil has low nutrient retention rates.

Manage low nutrient retention with a 'little & often' approach to nutrient application and by building soil organic matter.

The texture of your soil is a big part of determining its CEC:

- Soils with lots of clay, or with high levels of organic matter typically have a higher CEC and are 'sticky'. They have lots of places for the cations to stick to....this is like being in a theatre with lots and lots of seats for our cations to sit in.
- Sand and silt however typically have a lower CEC and are more 'gritty', because they have fewer places for the cations to stick. This is more like your lounge at home, with only a few seats available for cations to hang out in.
- Soils that have low levels of organic matter often also have low CEC.

Important soil anions are nitrate (NO_3^{-}) and phosphate (PO_4^{-}). Nitrogen is often taken up by plants in the form of nitrate, but this is susceptible to leaching. Phosphate is highly reactive and forms bonds with other elements in the soil, so leaches less.

If you have a low CEC soil

When lots of nutrients are added all at once to a soil with low CEC, they are much more likely to be lost before plants can use them. In this case, applying smaller but more frequent amounts of nutrient is important for improving plant uptake and production benefit.

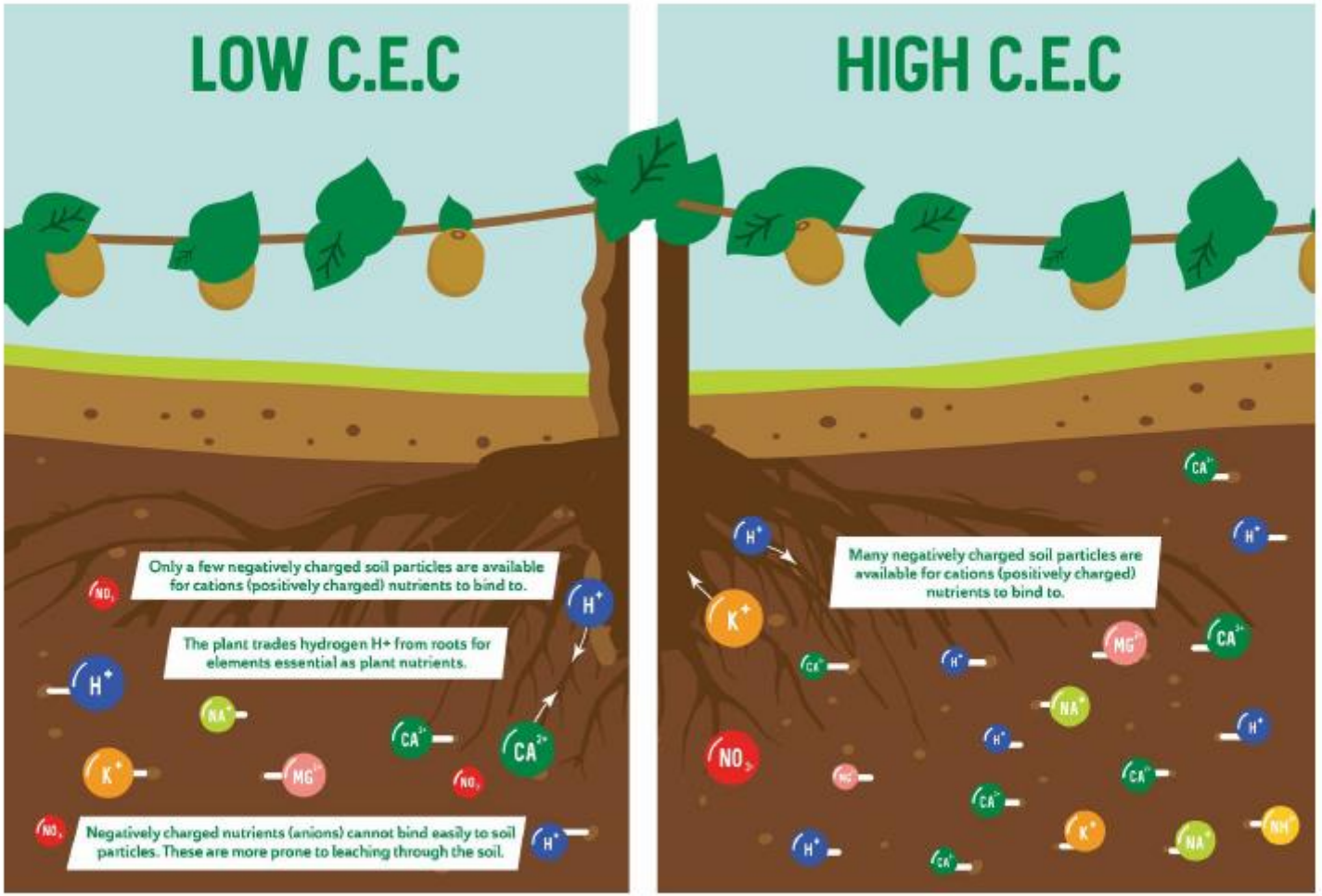


Figure 3. Soils with higher CEC levels have more negatively charged soil particles that can help to keep positively charged nutrients such as ammonium, calcium, magnesium and potassium in the root zone, compared to those with low CEC.

Acidity – pH

The soil pH is a measure of the acidity or alkalinity of the sample. It is important because of how it influences the chemical and physiological processes in the soil, and the availability of plant nutrients. Most basic soil test packages include a pH measurement. Kiwifruit naturally prefers slightly acid soils, so the target pH level is approximately 5.8-6.5.

Figure 4 below shows how pH can affect the availability of nutrients. Some nutrients become more or less available with changes in pH as shown by the band width and colouring in the chart, so it's important to balance pH at a level where enough is available of each of the key macro and micronutrients need for growth.

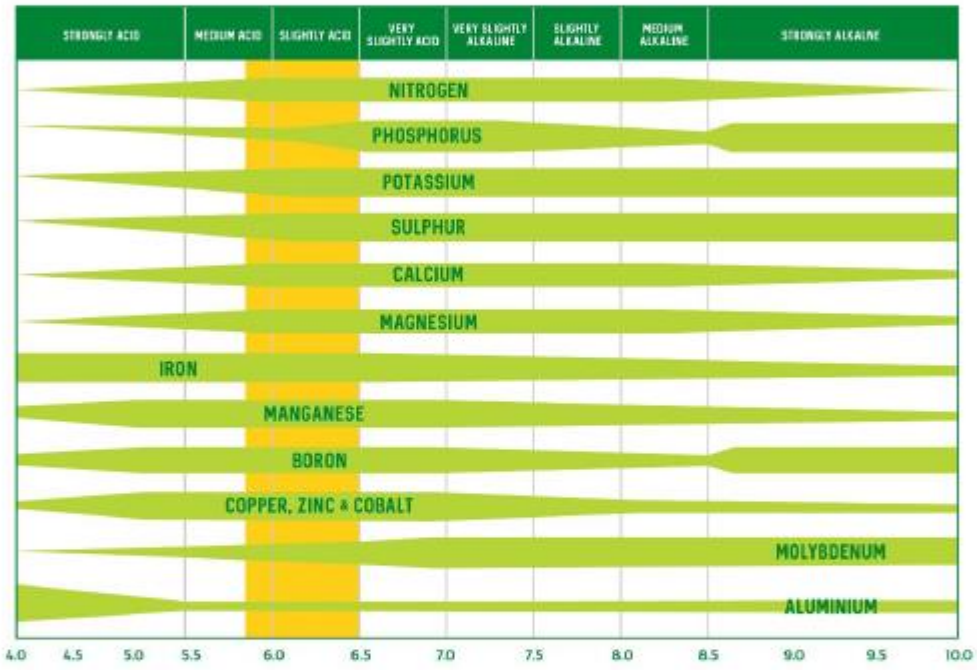


Figure 4. pH effects on plant availability of nutrients[5]. Yellow band shows the optimum pH range of kiwifruit. Content derived from resources by Hills Laboratories and www.superior.net.

[5] From Truog, 1948

ROOT GROWTH & DISTRIBUTION

Mature Hayward kiwifruit roots have been found to explore depths of four metres or more in the Bay of Plenty, but the effective rooting depth (i.e., the zone which most water and nutrients are taken up from) is usually within one to 1.5 metres of the soil surface.

Soil type can have a significant influence on root growth. Impediments, such as a clay pan may limit deep growth, while light, free-draining soils that dry out quickly may encourage deeper exploration by roots in search of water.

Little research is available on rootstocks. However, typical root growth patterns for mature Bruno rootstocks with Hayward grafts are that:

- the highest density of fibrous 'feeder' roots is in the top 30–70 cm of the soil, with more than 50 percent of total root length found within 0.3 to 0.5m of the soil surface[6]
- more than 90 percent of total root length is found within the top one metre of soil.
- the rate of new white root growth increases from spring, peaks in summer and then declines during autumn and winter when soils are cooler. A second peak in root growth can occur in autumn
- roots hunt for water, so irrigation practices can influence their distribution for example, root density will increase in the area under a dripper. Dry conditions may encourage roots downward
- root density declines with depth
- roots of mature vines, unlimited by moisture and nutrients will spread across a row.

Consider where your roots are when applying fertiliser.

For mature vines, the main root zone is typically within the upper one to 1.5 metres of the soil profile.

Most of the feeder roots are in the top 30 - 70 cm of soil.

For younger vines, root density falls with both depth and distance away from the crown.

Due to the root behaviours noted above, nutrient uptake will be greatest from the top one metre, and in particular the upper 30-70 cm, of a kiwifruit orchard's soils. If nutrients filter down below this zone, they are more likely to be lost from the orchard system and be at risk of leaching into waterways.

Tactics for optimising fertiliser application in response to root distribution include:

- use of broadcast fertiliser applications for mature vines
- use of banded fertiliser applications for young vines.

[6] *Buwalda, J. G., & Smith, G. S. (1990). Acquisition and Utilization of Carbon, Mineral Nutrients, and Water by the Kiwifruit Vine. In* Horticultural Reviews *(pp. 307–347).*

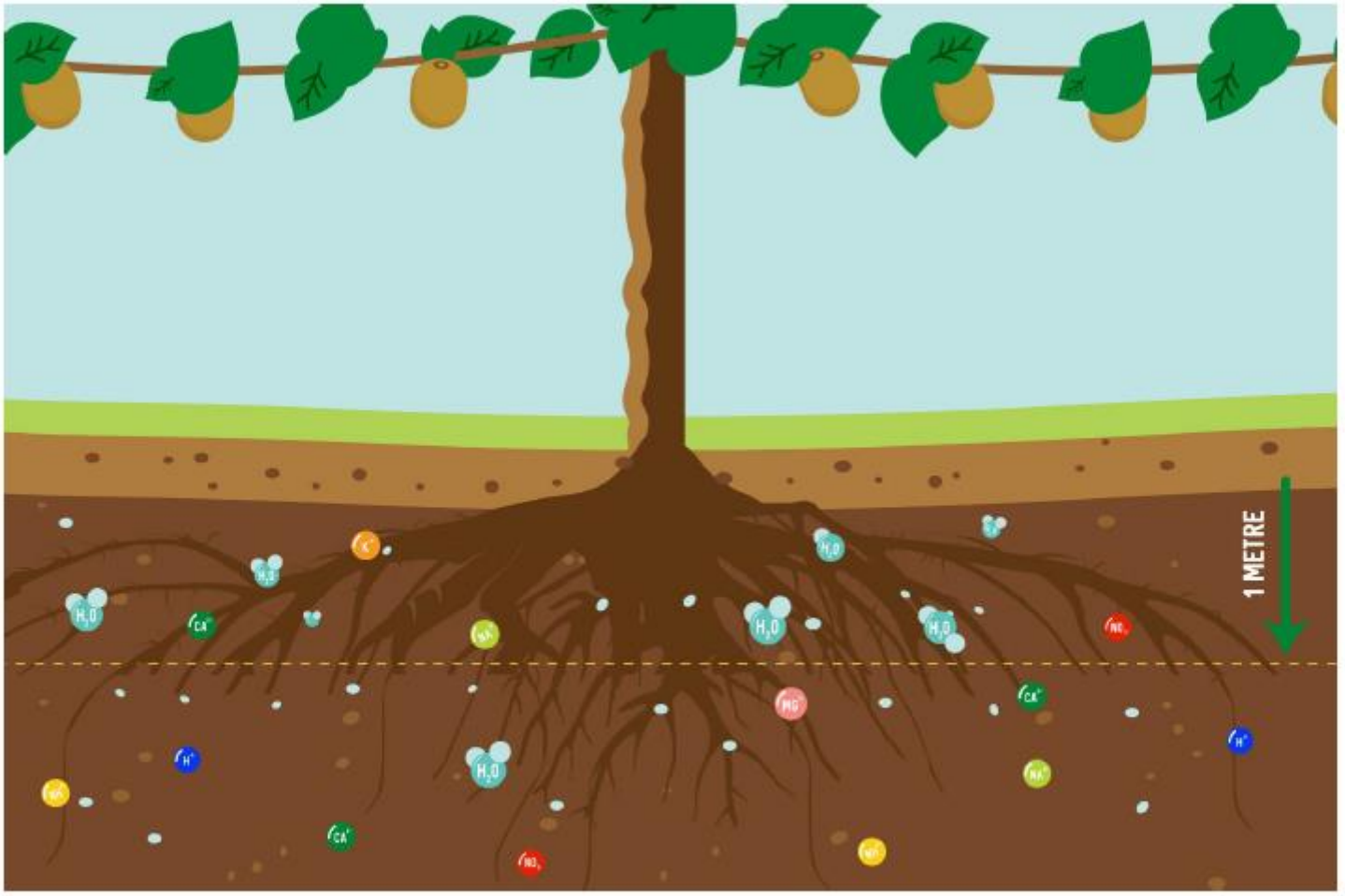


Figure 5. Roots can only access the nutrients within reach. For mature vines, this will typically be within the upper 1 to 1.5 metres of the soil profile (especially the upper 30cm).

ENVIRONMENTAL FACTORS

SOIL MOISTURE

The main pathway for kiwifruit vines to access nutrients from the soil is through the drawing up of water (soil moisture) and the dissolved nutrients within it by the roots. Roots are porous and require just the right balance of oxygen and water in the soil to function well.

Field capacity (also known as water holding capacity) is the amount of water that remains in a soil after it has been thoroughly saturated and allowed to drain freely (usually for one to two days). This varies by soil type.

Roots can make best use of soil nutrients when:

- Soil moisture is close to (but not above) field capacity.
- Soil temperature is 10-20°C

When soil moisture exceeds field capacity, kiwifruit roots become deprived of oxygen and unable to take up all the water and nutrients they need.

As soil moisture decreases, the hydraulic conductivity of the soil slows down, so the roots can no longer take up water and nutrients as quickly as optimal plant growth might demand.

When managing soil moisture, it's important to keep an eye on the weather outlook and leave enough room in the soil profile to accommodate rainfall, while keeping soils damp enough to support nutrient uptake by the plants. If a soil is already at field capacity, it will quickly become saturated and over-wet during a rain event, smothering root function, and leading to nutrient loss through run-off and leaching.

SOIL TEMPERATURE

Experiments in New Zealand have shown that kiwifruit vine growth:

- ceases when the temperature of the root environment is less than 10°C, and
- increases as the soil temperatures increase to 20°C, then declines at higher temperatures[7].

While roots can take up some nitrogen in winter, uptake levels are low as growth activity is minimal at this time and nutrients don't move into other parts of the plants until soil temperatures warm enough to re-start plant growth at budbreak time.

AIR TEMPERATURE, WIND AND HUMIDITY

A range of other climatic conditions can affect plant stress levels and transpiration rates. Lower transpiration rates - such as when humidity is high, air temperatures are cool, or winds are light - will reduce the amount of water (and nutrients) that a vine will take up from the soil.

[7] Buwalda, J. G., & Smith, G. S. (1990). Acquisition and Utilization of Carbon, Mineral Nutrients, and Water by the Kiwifruit Vine. In Horticultural Reviews (pp. 307–347).

SOIL TYPE AND RAINFALL

Timely and moderate rainfall or irrigation can be beneficial to dissolve dry fertiliser, move nutrients into the soil rooting zone, and create ideal soil moisture conditions (as discussed on page 12).

However, excessive rainfall or irrigation can promote run-off and leaching which carries soluble nutrients such as nitrate and phosphorous away from the root zone, making it unavailable for plant uptake.

Nutrients are most quickly lost from the root zone when:

- Soils are light (such as pumice)
- Rainfall is high (such as in winter and early spring).

Plant water and nutrient availability is also impacted by soil texture. Coarser textured soils, such as those with high sand or pumice content, usually have less water and nutrient-holding capacity than finer soils such as silt loams. Coarse soils tend to lose water faster and have a higher risk of leaching, so a 'less, more often' approach to fertiliser application can be useful for managing nutrient supply in these soils. Figure 6 below gives an overview of water-holding capacity across different soil types.

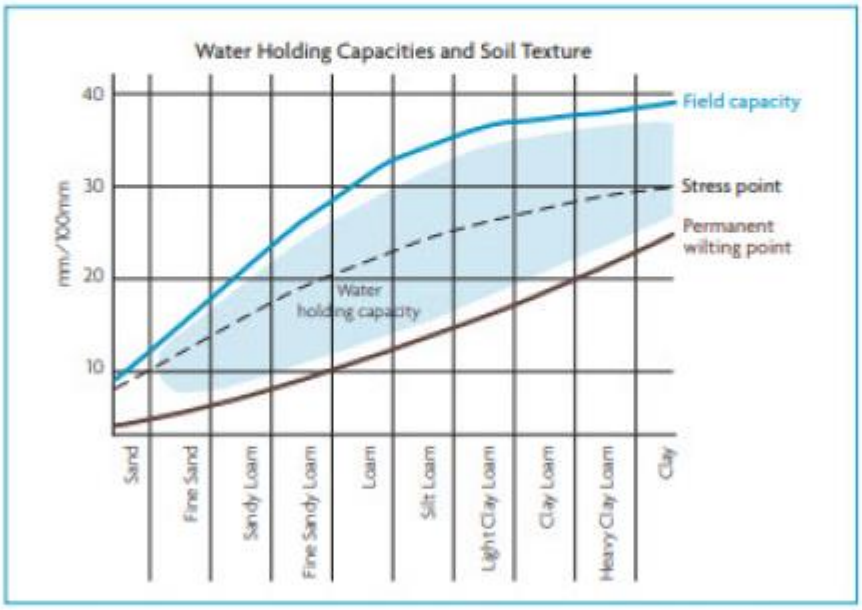


Figure 6. Water holding capacity is largely dependent on soil textures. Image credit Irrigation NZ.

One of the main ways of minimising the risk of nitrate losses through leaching is to align the timing of nitrogen fertiliser application, with the time that the risk of drainage is lowest and greatest plant nitrogen uptake occurs.

The time of year that drainage is most likely to occur will vary between seasons, but is usually highest in winter and early spring when large rainfall events, or sequences of rainfall events, are most common.

ANNUAL NUTRIENT REQUIREMENTS

Once vines are established, only the deciduous (leaves, fruit, fibrous roots) and transient (shoots) components will need nutrients to be supplied each year. The figure below gives an indication of the amount of nitrogen in mature vines.

During the growing season, on average, leaves need about 60 to 70 kg of nitrogen, the shoots about 30, and the fruit about 50 to 90 kg (depending on yield). That nitrogen can come from plant and soil reserves, or applied sources.

Vines take up more than 65 percent of the nutrients they need in the 10 weeks after bud break.

Fruit growth is fuelled by nutrients from plant and soil reserves, as well as compost and applied fertilisers.

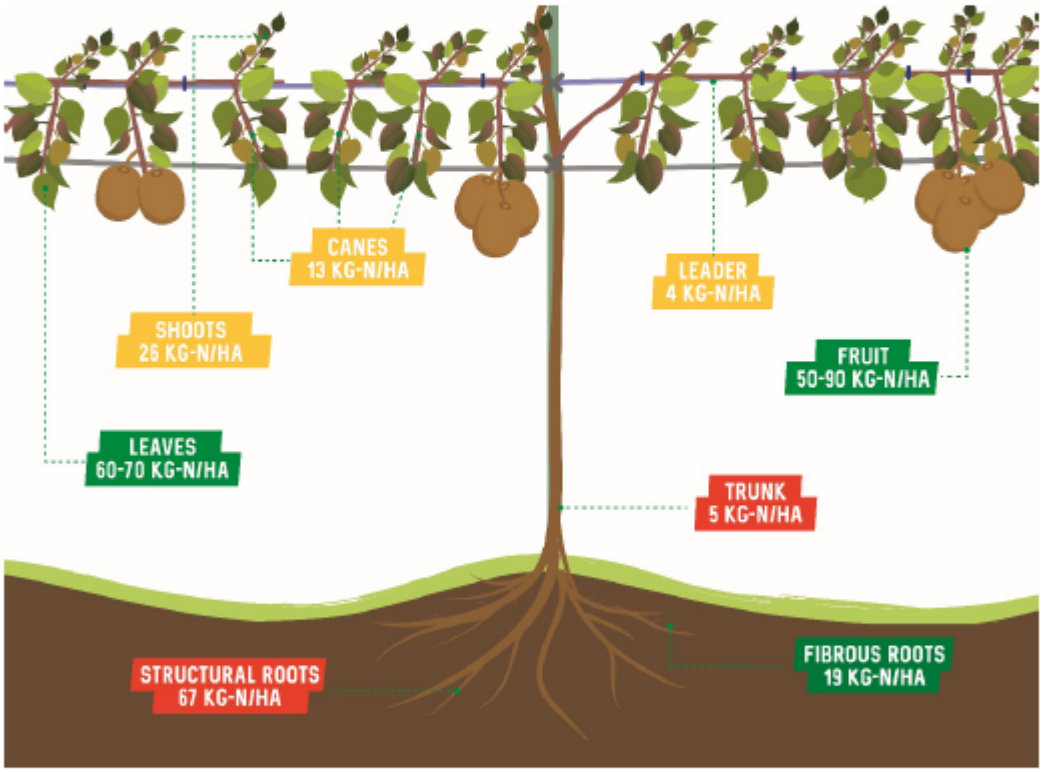


Figure 7. Typical quantities (kgs per hectare) of nutrients within different components of a vine. The fruit and leaf values come from recent research. The other values come from historical research on Hayward[8]. Previous research on Hort16a found about 100 kgs of nitrogen per hectare in the leaves and shoot, which is similar to what is shown here[9].

[8] *Smith, G. S., Buwalda, J. G., & Clark, C. J. (1998). Nutrient dynamics of a kiwifruit ecosystem. Scientia Horticulturae, 37(1–2), 87–109.*

[9] *Boyd, L., Barnett, A., Civolani, C., & Fini, E. (2010). Whole plant excavations to determine nutritional requirements in "Hort16A" kiwifruit vines. Acta Horticulturae, 868, 171–176.*

SEASONAL UPTAKE

Growth rates of different plant components vary throughout the year as shown in Figure 8 below. This means that a vine's nutritional requirements and rate of uptake varies throughout the season. Seasonal patterns of uptake also vary for different nutrients. However research has shown that more than 65 percent of the annual uptake by vines, of most nutrients, occurs during the first 10 weeks after bud break.

In addition to taking up nutrients from the soil or through the leaves, kiwifruit vines can also shift (remobilise) some nutrients around different parts of the plant as needed.

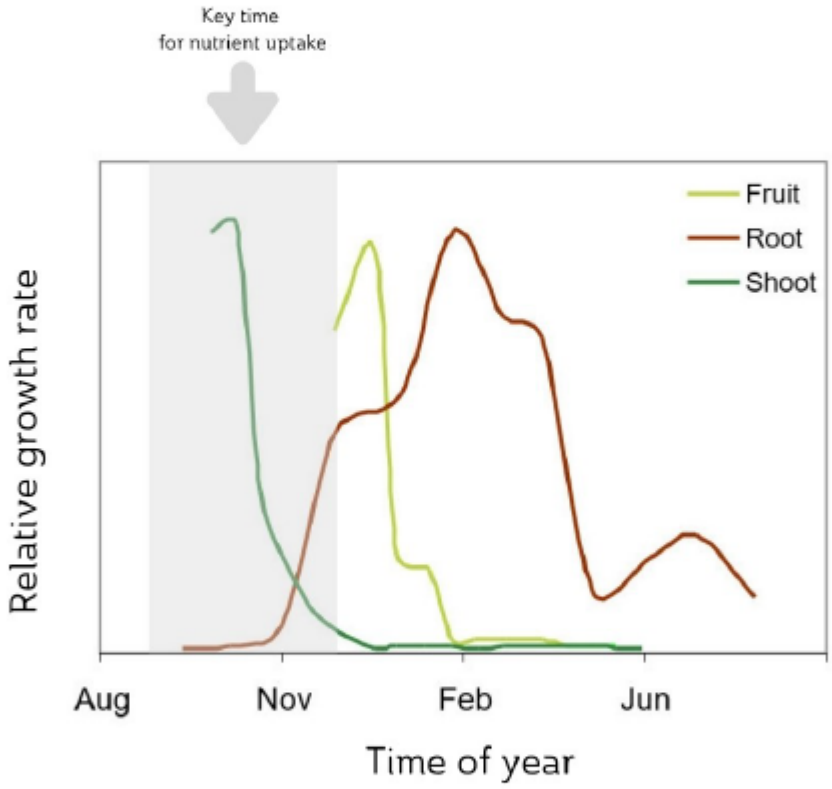


Figure 8. Seasonal changes in the relative growth rates of 'Hayward' kiwifruit fruit, roots, and shoots[10].

[10] KiwiTech Bulletin No. N51: Hayward Kiwifruit – Phenology and Nutrient Uptake
https://canopy.zespri.com/EN/industry/pubs/kiwitech/Documents/N51.pdf

FOCUS ON NITROGEN

NITROGEN CYCLE

Nitrogen is a naturally occurring chemical element, with the symbol N. In its gas form (N_2), nitrogen makes up about 80 percent of the Earth's atmosphere. In other forms, it is one of the most important nutrients for plant growth.

In the soil, nitrogen occurs in two main plant-available forms; nitrate (NO_3-) and ammonium (NH_4^+).

- Ammonium is positively charged, so it binds to negatively charged soil particles more strongly than nitrate. As discussed on page 7, soils with high CEC (i.e., those with higher clay/organic matter) can hold onto more ammonium than low CEC soils (i.e., sandier soils).
- Nitrates are negatively charged so they are less likely to bind to negatively charged soil particles. This makes nitrates easier for plants to absorb, but also more likely to pass through the soil and into waterways (mainly via leaching).

Natural bacterial and microbial processes are always at work to convert ammonium in the soil into nitrate. Soil temperature, texture and moisture content will influence the rate of these natural soil processes. Plant-available nitrogen enters and exits orchard soils in several ways:

Entry

- **Rainfall and plant fixation:** Nitrogen can be 'fixed' from the atmosphere by plants (legumes) such as clover, and added by rainfall. Current assumptions for kiwifruit orchards are that the relative contribution of these sources is small.
- **Mineralisation:** As organic matter (including compost, prunings and leaf fall) decomposes, it is converted into ammonium, and then nitrate, by soil microbes (such as bacteria, fungi and earthworms). A balanced carbon to nitrogen (C:N) ratio in the soil promotes mineralisation.
- **Fertiliser application:** soil-applied solid fertilisers are dissolved by rain or irrigation water that allows the nitrate or ammonium they contain to soak into the soil. Nitrogen may also be applied in liquid form as foliar applications, or through irrigation (i.e., fertigation).

Losses

- **Immobilisation:** This is the opposite of mineralisation. A high carbon: nitrogen (C:N) ratio in the soil promotes immobilisation by slowing down the decomposition process.
- **Plant uptake:** the plant converts nitrogen into fruit components and this is removed from the orchard system in the harvested fruit.
- **Leaching:** nitrate that is not taken up by the vines is at risk of moving down out of the root zone by water and gravity. This is discussed in more detail on page 18.
- **Volatilisation:** this is a chemical process where (ammonium NH_4^+) from fertilisers, such as from urea and some composts, naturally converts to ammonia gas (NH_3) that is released into the atmosphere. In general, higher pH, warmer temperatures, and greater soil moisture content increase the potential for volatilisation, while soil incorporation of fertiliser via rainfall, irrigation, or tillage after application decreases volatilisation potential. Soils with a higher CEC, buffering capacity, and cool environmental conditions during fertiliser application have a reduced potential for NH_3 volatilisation.

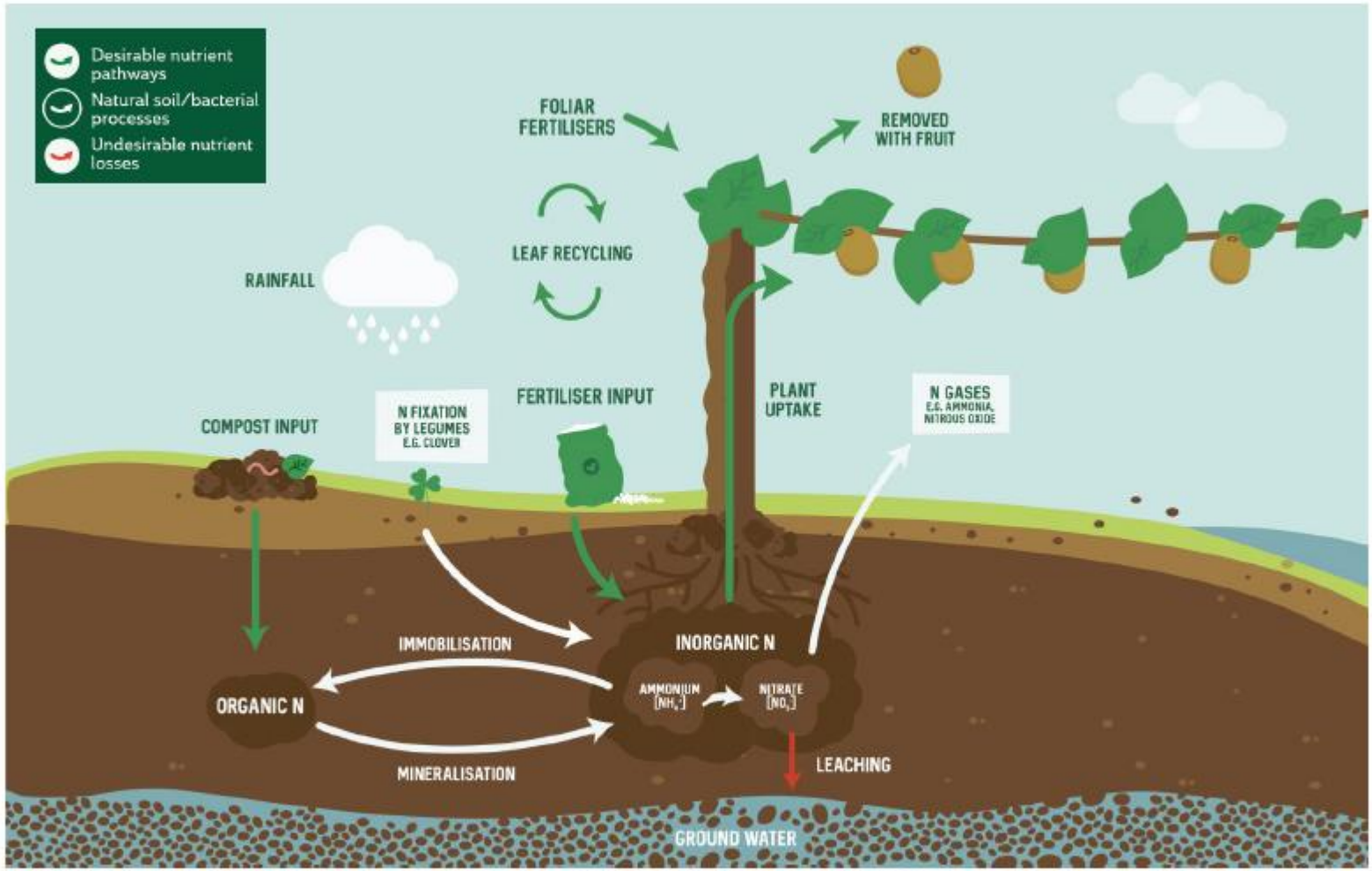


Figure 9. Overview of nitrogen flows in a kiwifruit orchard.

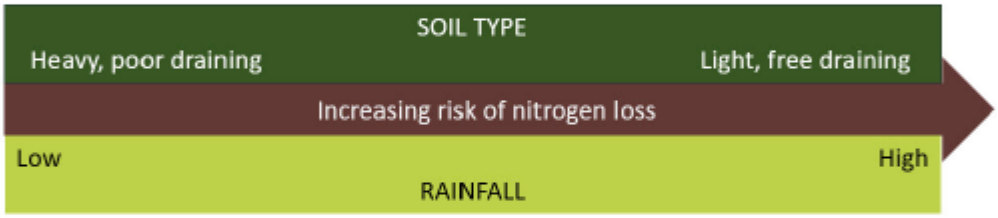
NITROGEN LOSSES

Nitrogen is most easily lost below the root zone as nitrate, which moves readily down through the soil carried by gravity and water from rainfall or irrigation. Too much nitrogen in a waterway can be harmful to wildlife, promote unwanted algae growth, and can make water unsafe for people and animals to drink.

Soil type and rainfall have the greatest impact on nitrogen loss risk.

The amount of nitrate that is lost through the soil profile is influenced mainly by:

1. The amount of soluble **nitrogen available in the soil**: this is affected by the amount of fertiliser applied, how much is taken up by plants, and the rate that natural soil processes (such as mineralisation, immobilisation and denitrification) convert nitrogen into soluble, insoluble or gaseous forms.
2. The amount of **water draining from the soil**: this affected by soil type, slope, rainfall or irrigation rate and volume, and evapotranspiration rates.



Based on an average fertiliser application rate of 120 kg-N/ha/yr, the national weighted average for nitrogen leaching from kiwifruit orchards has been modelled at 27 kg-N/ha/yr. Actual rates will vary between orchards and regions depending on factors such as soil type, climate and management. Work to refine these results is ongoing through a Zespri-funded Plant & Food Research programme that seeks to better understand nutrient balances and losses in New Zealand kiwifruit orchards.

Measurements collected so far are showing that nitrogen loss rates are highest on light soils (such as pumice), in wet years, and especially in winter when soil is close to field capacity and rainfall is high.

NOTES

NITROGEN INPUTS AND OUTPUTS

FINDING THE BALANCE

A range of inputs and outputs should be considered when considering the overall nitrogen balance of a kiwifruit orchard, as shown in Figure 10 below.

As noted on page 14, leaves need about 60 to 70 kgs of nitrogen, shoots about 30, and the fruit about 50 to 90 (depending on yield). These numbers are averages and there will be variation between orchards.

Growers should aim to match the supply of nitrogen, mineralised from soil, organic matter and/or from fertiliser, with the amount removed in harvested crop.

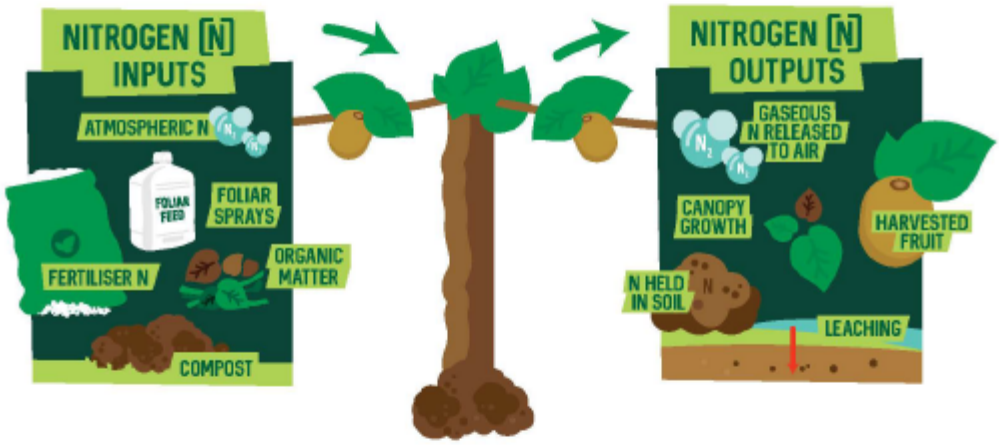


Figure 10. Key nitrogen inputs and outputs that should be considered when setting nitrogen fertiliser application rates for a kiwifruit orchard.

NITROGEN BALANCE SHEET WORKED EXAMPLE

Nitrogen inputs		
Nitrogen sources	**Info source**	**kg-N/ha**
Ground-based fertiliser	Fertiliser Diary or own fertiliser records.	110
Foliar fertilisers	Spray Diary or own fertiliser records.	10
Compost	Fertiliser Diary or own order records.	75
Organic matter – leaves, shoots, canes & roots	Previous research.	100
	Total nitrogen added (I)	295

Nitrogen removals		
Nitrogen removals	**Info source**	**kg-N/ha**
Fruit	Based on yield of 12,000 from Table 1, p.23.	69
Leaves, shoots, canes & roots	Previous research.	100
	Total nitrogen removed (R)	169

Surplus (+) or deficit (-) N = I – R	**126 kg-N/ha**
Surplus/deficit is the difference between nitrogen applied to and removed by the plants. Where there is a surplus, some of that could be lost via leaching and the rest incorporated into the organic nitrogen pool.	

SOIL AND PLANT NITROGEN SOURCES

Plant reserves
In addition to taking up nutrients from the soil or through the leaves, kiwifruit vines can also shift (remobilise) significant amount of nutrients around different parts of the plant as needed. Past research on Hayward showed that kiwifruit canes (laterals) can supply enough nutrient for remobilisation to support early growth after budbreak i.e., enough to support 20-40 percent of the leaves[11].

Soil reserves
Plant-available nitrogen enters orchard soils from a number of key sources as discussed on page 16. These include:

- **Organic matter including insects, prunings and leaf fall**
  Good organic matter levels, with the right C:N ratio (i.e. not too high) and warm moist conditions, will favour decomposition and promote nitrogen release from organic matter.

  As indicated earlier (page 14), leaves have been found to contain 60-70 kg of nitrogen per hectare which is returned to the soil following harvest.

- **Atmospheric nitrogen fixation from the grass sward**: Previously clover has been estimated to approximately 28 kg of nitrogen per hectare to the soil by November each year[12]. However this was for a T-bar system and the amount thought to be fixed in a pergola system is likely to be much less.

Fruit
By harvesting fruit, you also remove nutrients from your orchard that will need to be replaced. The exact amount will vary between orchards and seasons but Table 1 (over page) below gives an indication of the amount of each nutrient that may have left your orchard with your harvested fruit.

[11] Smith, G. S., Buwalda, J. G., & Clark, C. J. (1998). Nutrient dynamics of a kiwifruit ecosystem. Scientia Horticulturae, 37 (1–2).
[12] Sale, P.R., (1990). Kiwifruit growing, p.41

The amount of nutrients removed in harvested fruit varies with yield.

The average amounts for Hayward and Gold3 are shown in Table 1 below will give you a 'ball-park' estimate on the nutrients removed with your fruit.

To get a more precise value for nutrient removals from harvested fruit for your particular orchard:

1. Send a sample of your fruit to a laboratory services provider to have its nutrient contents tested
2. Determine the total yield (kilograms) of fruit removed from your orchard (available on most pack-out reports)
3. Use the laboratory test results to calculate the nutrients removed with fruit, per hectare.

What's your number?

N in harvested fruit kg/ha/yr

LOSS

To be most helpful, complete this process over a number of years to build a picture of nutrient removals on your orchard.

Export yield (trays/ha)	Harvest yield incl. rejects	Export yield (tonnes/ha)	Kg/ha nutrients removed in harvested kiwifruit (HW & G3)						
			N	P	K	S	Ca	Mg	Na
6,000	6,600	21	35	10	79	5	6	7	1
8,000	8,800	28	46	13	106	7	8	10	2
10,000	11,000	35	58	16	132	9	10	12	2
12,000	13,200	42	69	19	159	10	12	14	2
14,000	15,400	49	81	22	185	12	14	17	3
16,000	17,600	56	92	26	212	14	17	19	3
18,000	19,800	63	104	29	238	16	19	22	4
20,000	22,000	70	116	32	265	17	21	24	4
22,000	24,200	77	127	35	291	19	23	26	4

Table 1. Fruit nutrient removal from mature vines. Hayward and Gold3 approximate average industry yields for 2020 are highlighted in green and yellow respectively. NB: indicative values only, refer footnote[13] for details.

[13] The information shown in Table 1 is indicative only and based on assumptions as follows:

- N values based on N content value of 1.55 kg-N per tonne (average from previous studies), other nutrient values based on OVERSEER content values.
- Same nutrient % value assumed for both green and gold fruit.
- Calculations based on a 3.5 kg of fruit per tray and assume that nutrient % per fruit remains constant across different yields.
- Based on reject rate of 10% (i.e. nutrient removals based on export yields specified plus 10%).

NITROGEN FERTILISERS

GROUND-BASED FERTILISERS

Table 2 below, lists the most commonly applied nitrogen fertilisers based on current Zespri Fertiliser Diary records. The nutrient content values have been gathered from multiple sources.

CAN is the most used in conventional orchards because it provides nitrogen in both ammonium and nitrate form, and has the added bonus of calcium. Also, CAN doesn't lose as much nitrogen through volatilisation, or acidify the soil like urea does.

DAP is used by some growers to provide phosphate where needed.

Organic orchards commonly use compost as a their primary source of nitrogen 'fertiliser' see more on this in the compost section on page 28. It is recommended that growers test their compost to check its quality and nutrient status.

	Percent of nutrient in product				
	N	*nitrate : ammonium ratio*	P	K	S
CAN *calcium ammonium nitrate*	27%	*50 : 50*	0%	0%	0%
YaraMila Complex	12%	*40 : 60*	5%	15%	8%
DAP *diammonium phosphate*	18%	*0 : 100*	20%	0%	1%
Nitrabor *calcium nitrate plus boron*	16%	*100 : 0*	0%	0%	0%
Ammonium sulphate	20%	*0 : 100*	0%	0%	23%
SustaiN	46%	0 : 0 (100% urea)	0%	0%	0%
Nitrophoska® Extra *ammonium nitrate*	12%	*50 : 50*	5%	14%	8%
Fishmeal	10%	*Organic N*	4%	0.6%	1.2%
Protamin N 13	13%	*Organic N*			

Table 2. Nutrient content of commonly used ground-based fertilisers on kiwifruit orchards.

What's your number?

Ground-applied fertiliser N kg/ha/yr

INPUT

Calculate your total fertiliser nitrogen inputs per year using the table below and enter the total in the green box on the top right of this page.

Fertiliser nitrogen calculation sheet

Fertiliser application	Type	A: Total product applied per hectare (kg)	B: Nitrogen % of product *eg. 1% = 0.01*	Total applied N per hectare (kg) *(A x B) = N*
EXAMPLE: *Base dressing*	*CAN*	*250kg*	*0.27*	*(250 x 0.27) = 67.5*
BASE DRESSING				
SIDE DRESSING 1				
SIDE DRESSING 2				
TOTAL APPLIED FERTILISER NITROGEN (kg/ha)				

FOLIAR FERTILISERS

What's your number?

Foliar N kg/ha/yr

INPUT

Foliar applications of nitrogen may be a useful option for reducing nitrogen losses, especially in higher rainfall areas on light free-draining soils where leaching risk is greatest, and when cooler soil temperatures inhibit plant uptake from soil.

As you'd expect, increases in fruit growth or yield appear through fertiliser use are dependent on the timing of applications relative to growth stage and the formulation used.

Trial work (mainly on Hayward) has found foliar nitrogen to be most effective when applied 15 - 50 days after full bloom (DAFB):

- Early season foliar applications of nitrogen (0.75 to 1%) to Hayward kiwifruit have been shown to increase fruit growth without a strong vigour response, and no negative impact on dry matter.
- Fresh weight increases of six to eight percent have been achieved on Hayward crops from the use of three successive foliar urea sprays (1 percent w/v) from 15 DAFB at seven to ten day intervals.

Fewer foliar nitrogen studies have been conducted on Gold varieties, however, some of these[14] have indicated similar fruit benefits.

Post-harvest foliar fertiliser application trials to date have shown little or no production benefit in subsequent years – further trials are planned.

Product	Nitrogen %
Megafol	3%
Tech / low biuret urea	46%
Acadian seaweed	0.8 – 1.8%
Croplift K	5%
Kiwifruit Complex	6%

Table 3. Some commonly used nitrogen-containing foliar fertilisers on kiwifruit orchards.

Table 3 (above right) shows the nitrogen content of some of the most commonly used nitrogen-containing foliar fertilisers on kiwifruit orchards. Check the label of foliar spray products to determine nitrogen content and only use products in accordance with the Zespri Crop Protection Standards, some may be listed in the 'Allowed Other Compounds' list.

Use the calculation sheet below to work out your total foliar nitrogen inputs and enter that in the green box (top right of page).

Foliar nitrogen calculation sheet

Foliar application	Type	A: Total product applied (L or kg per hectare)	B: Nitrogen % of product *eg. 1% = 0.01*	Total applied N (kg per hectare) *(A x B) =N*
EXAMPLE: *Post flowering*	*Low biuret urea*	*10 kg*	*.46*	*(10 x .46) = 4.6*
TOTAL APPLIED FOLIAR NITROGEN (kg/ha)				

[14] https://canopy.zespri.com/EN/grow/GET/grower-trials/Documents/Grower-Trial-G3-Urea-and-Benefit.pdf

NOTES

COMPOST

Compost is commonly used on organic orchards and is increasingly being used on conventional orchards, but its nutrient content is variable.

The nitrogen content and release rates of compost varies based on the make-up of the compost mix, including the C:N ratio, and environmental conditions such as temperature and biological activity in the soil.

Typically, green-waste compost has one to two percent nitrogen. This is on a dry-weight basis so the amount of moisture in the compost will influence the amount of nitrogen provided. Compost and manure blends will provide more nitrogen.

It is recommended that growers test their compost to check its quality and nutrient status. An indicative figure is one to two percent nitrogen per kg of dry matter (two to three percent for chicken manure blends). For example:

- 10 tonnes per hectare of compost with 50 percent dry matter = 5,000 kg dry matter/ha
- 1.5 percent nitrogen x 5,000 kg dry matter = 75 kg nitrogen per hectare from compost.

Carbon : nitrogen ratio

As discussed on pages 16 and 22, if the carbon to nitrogen (C:N) ratio of a compost is too high (e.g., lots of saw dust and straw) then this can inhibit and slow the release of plant-available nitrogen into the soil from compost and other organic matter.

A C:N ratio of about 30:1 is considered nitrogen neutral - lower ratios will release nitrogen and act as nitrogen fertilisers while higher ratios will immobilise (lock up) nitrogen. The following table from Hills Laboratories[15] provides 'typical' C:N ratios for common compost materials.

Material type	Typical C:N ratio
Poultry manure	7:1 (indicative of a fast rate of decomposition)
Bio-solids	8:1
Poultry litter	10:1
Cow manure	12:1
Green waste	20:1
Corn stalks	33:1
Dead leaves	60:1
Straw	100:1
Bark	500:1
Sawdust	550:1 (indicative of a low rate of decomposition)

Table 4. Typical C:N ratios for common compost materials[15].

Zespri now has compost trials underway to estimate nitrogen release volume and rate from a selection of compost mixes commonly used on kiwifruit orchards.

[15] https://www.hill-laboratories.com/assets/Documents/Technical-Notes/Agriculture/GUIDELINES-FOR-INTERPRETING-YOUR-COMPOST.pdf

What's your number?

Compost N kg/ha/yr

INPUT

Calculate your total fertiliser nitrogen inputs per year using the table below and enter the total in the green box (top right of this page).

Compost nitrogen calculation sheet

Compost type	**A: Total product (kg) applied per hectare** *1T = 1000 kg*	**B: Dry matter %*** *eg. 1% = 0.01*	**C: Nitrogen % of product**** *eg. 1% = 0.01*	**Total applied N (kg per hectare)** *(A x B) x C*
Standard compost	*7,000 kg*	*0.5*	*0.015*	*(7,000 x 0.5) x 0.015 = 52.5*
TOTAL APPLIED COMPOST NITROGEN (kg/ha)				

Calculation/estimation notes:

- To convert from cubic metres (m^3) to tonnes per hectare, multiply by the bulk density of the compost (this will vary). For the example above we've used a bulk density of 700 kg per m^3 (wet weight) for 10m^3 of compost per hectare i.e. *10m^3 x 700 kg/m^3 = 7,000 kg compost per hectare (wet weight).*

- *Compost is 40-70% dry matter – *in the absence of product-specific analysis, use a mid-range estimate for dry matter of 50%.*

- **Standard compost** contributes 1 - 3 % nitrogen per kg of dry matter – *in the absence of product-specific analysis, use 1.5%*
  Compost/manure blends contribute 2 – 3 % nitrogen per kg - *in the absence of product-specific analysis, use 2.5%*

YOUR NITROGEN BALANCE SHEET

How do your nitrogen inputs compare to what is needed?

This worksheet aims to help you understand the sources of nitrogen in your orchard relative to the amount required. Use specific values for your orchard if known, otherwise use the indicative average values provided in the worked example on page 21. The following excludes minor sources of nitrogen like fixation and rainfall, as well as atmospheric losses. Soil organic matter (including applied compost) may be a significant source of nitrogen, however the amount that is released during the season will vary.

Nitrogen inputs		
Nitrogen sources	**Info source**	**kg-N/ha**
Ground-based fertiliser	p.25. Fertiliser Diary or own fertiliser records.	
Foliar fertilisers	p.26. Spray Diary or own fertiliser records.	
Compost	p.29. Fertiliser Diary or own order records.	
Organic matter – leaves, shoots, canes & roots	Previous research.	100
Total nitrogen added (I)		

Nitrogen removals		
Nitrogen removals	**Info source**	**kg-N/ha**
Fruit	p.23. Table 1 N value for yield.	
Leaves, shoots, canes & roots	Previous research.	100
Total nitrogen removed (R)		

Surplus (+) or deficit (-) N = I – R	**kg-N/ha**
Surplus/deficit is the difference between nitrogen applied to and removed by the plants. Where there is a surplus, some of that could be lost via leaching and the rest incorporated into the organic nitrogen pool.	

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GROUND TRUTHING WITH VINE SIGNALS

The nitrogen balance sheet (page 30) has been created using a number of assumptions. It's important to ground-truth your results before you decide on any course of action.

A simple and effective way to do this is to consider signals from the vines in your orchard. Run through the questions below to build a picture of what your vines are saying:

Did you achieve your production goals last season?

- For yield?
- For size?

Was your canopy vigorous?

- If yes, was vigour a bit more than you'd like, especially when considering pruning requirements?

Were your vines healthy?

Was your leaf colour good?

Was your leaf condition good?

If you've answered 'yes' to all of the questions above, you could consider applying less nitrogen fertiliser this spring.

- Have a discussion with your fertiliser advisor about whether you could reduce your nitrogen applications.
- Try testing a reduced nitrogen fertiliser approach on a portion of your orchard. Get started by checking out our *Need to know #51 How to test a low nitrogen approach* on Canopy.

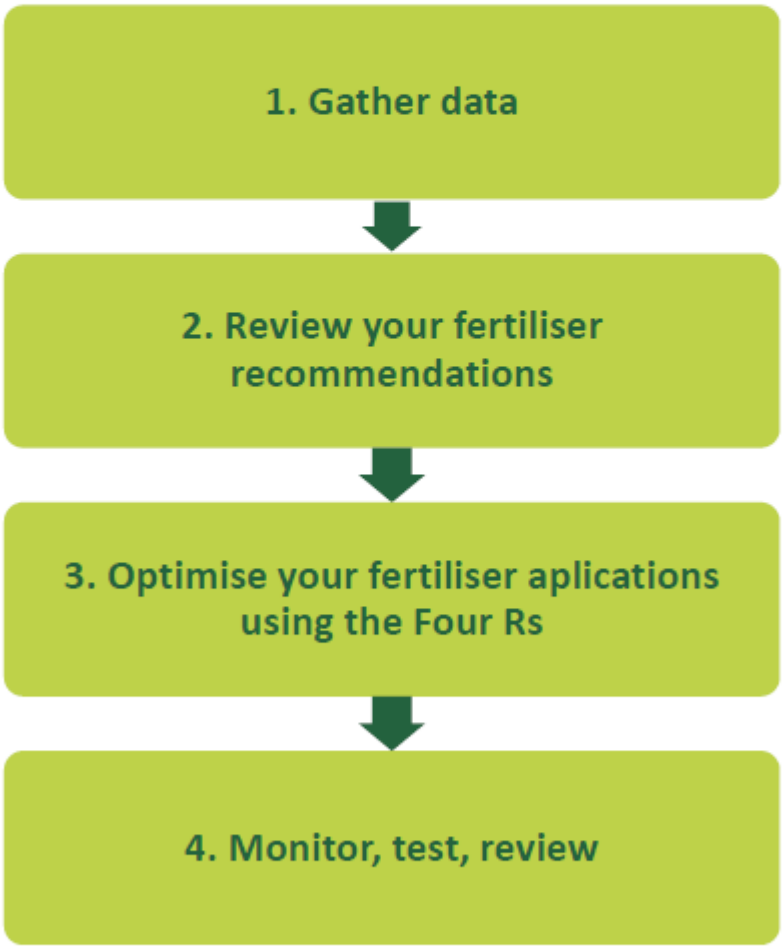
FOUR STEPS TO A SMART NUTRIENT PLAN

Getting a nutrient plan in place for the upcoming season means you can target nutrients to be applied to your vines when they need them most, using information gathered from your soil tests, fertiliser recommendations, and records from previous years.

The starting point for determining how much nutrient is going to be needed is to reflect on your orchard's performance last season (vine and fruit) and what your production goals are for the coming season.

Soil testing can be used to gauge how much nutrient your soil can provide and hold onto, and inform your fertiliser recommendations.

A nutrient budget acts as a 'check and balance' to guide your application decisions throughout the season.



NOTES

1. GATHER DATA

SOIL TESTS

Soil testing can give an indication of the nutrient content of your soil, and indicate how readily your soils can absorb nutrients and make them available to your plants (based on pH and Cation Exchange Capacity results).

Use **Available N** and **Organic Matter** soil test results for annual comparison to determine trends over time in soil reserves.

Consider using a **Mineral N** soil test on just prior to fertiliser application to see how much nitrogen is readily available in the soil.

Use **leaf tests** to make adjustments to side-dressings and foliar applications.

What tests to order with your annual soil sample

A basic soil test is a great starting point, as this provide measures of soil pH, Olsen P, CEC, cations and base saturation. Many orchards will have a history of basic soil test values, so maintaining this testing enables growers to continue to monitor trends. If there are concerns around micro-nutrients (also called trace elements), then additional tests like Mehlich3 are available to monitor these. We recommend discussing these options with your advisor.

There's a few extra soil tests we also recommended you request from your annual soil samples, to inform your nitrogen management decisions:

- **Available nitrogen (AN):** this quantifies how much nitrogen is present in your soil in a form that could readily be mineralised from soil organic matter if soil temperature, moisture and other conditions were ideal. This test can also be called Potentially Available Nitrogen, or Anaerobically Mineralizable Nitrogen (AMN).
- **Organic matter (OM):** OM is a source of plant nutrients, particularly nitrogen. Nutrients are released through the process of mineralisation which is dependent on soil carbon to nitrogen ratios, moisture content and temperature. So, the amount of nitrogen released will vary between sites and seasons.

When you order your soil test, **be sure to identify your crop as 'kiwifruit' on the test order form,** otherwise your results won't make sense! This is because the benchmark values (e.g., medium values presented by Hills Laboratories) may differ between crops.

To minimise variability in soil test results, soil samples should be collected at the same time of year, from the same location, and in similar weather conditions, each year. Consider differences across your orchard and collect (and clearly label/order) separate sample batches eg., for each variety, soil type or maturity area. The standard horticulture and kiwifruit sample depth is 15 cm.

If you want to do your own sampling and testing, corers are available to be purchased from most rural supply stores or testing laboratories. You can order a self-sampling kit (incl. bags, labels etc.) from laboratory services providers to collect and send your samples back for analysis.

Interpreting your Available N soil test results

Optimum soil test nitrogen values for kiwifruit have not yet been established. Given this, Available N soil testing is best used as a tool to compare your own orchard's performance year-on-year and monitor for change over time so you can identify and correct any upward or downward trends in nitrogen levels.

For example, if soil test shows that soil nitrogen levels are decreasing and there has been no corresponding decrease in production, you may not need as much nitrogen fertiliser next season.

Note: care is needed when using the benchmarks (e.g. medium ranges) presented on kiwifruit soil test results. These are generally not crop specific – they are typical levels for a range of New Zealand soils.

NUTRIENT USE REPORTING TOOL

As an industry, we are committed to protecting and enhancing water resources for our people, our environment, and our communities. With this in mind, we are investing in understanding applications of major nutrients applied in our orchards, particularly nitrogen.

In the future, Zespri will be introducing our new **Nutrient Use Reporting Tool**. This will be available via the Industry Portal on the Zespri Canopy website.

This tool will collate and display benchmarked nutrient use data by KPIN, provided via Spray Diary, Fertiliser Diary, and other key sources. The data will include nitrogen and phosphorus initially, with plans to add more nutrients over time.

Help us to help you

This year, we are asking growers to please pay careful attention to three things, when it comes to your nutrient use on-orchard:

1. Be mindful that all nutrients count – compost contains nitrogen too!
2. Enter all fertiliser data accurately, completely and promptly — strong value and insight will come from good data.
3. Share your results with your fertiliser consultant, so that together you can make good decisions on future nutrient use.

This will mean that when the tool is delivered, you will have greater understanding of your current use of nutrients on orchard and can analyse your data in relation to that of other growers in your supply area, region and nationally.

By working together and leveraging common sense, good practice and quality data, we can all make a real difference for our customers and communities.

2. REVIEW YOUR FERTILISER RECOMMENDATIONS

In deciding what fertilisers to use and how much, review your year-on-year soil test results and production results, along with your nutrient inputs and outputs balance. Use this to develop a list of questions to ask your fertiliser advisor. Some suggestions are below:

Questions to ask your fertiliser advisor

- I have soil test measurements that are outside of medium. Is action required?
- When I compare my soil tests year-on-year, I can see a measurement trending up or down. Is that a concern?
- Should I be leaf testing to determine if my nutrients are being taken up by the plants as expected?
- The nutrients in my fertiliser recommendation are outside of what my nutrient budget indicates. What are the reasons for that?
- Are there alternative fertiliser forms (eg. with different nitrate : ammonium ratios), products or technologies (such as slow release fertilisers) that I should/could consider? Could these improve the proportion of nitrogen taken up by my vines and reduce leaching risk?

To reduce nitrogen loss risk

CONSIDER:

- Splitting nitrogen fertiliser into multiple applications, particularly on soils with low CEC (e.g., gritty)
- Rainfall and soil drainage specifics for your orchard and adjust fertiliser tactics in response
- Using less nitrogen fertiliser:
    - consult with your advisor and pull back in an amount you are comfortable with
    - or try lower nitrogen rates in a test block, to see if yield can be maintained.

AVOID:

- Applying nitrogen fertiliser too early. If you can, avoid the worst of the winter rainfall and take advantage of increased plant uptake activity by holding off on application until a few weeks before budbreak.
- Applying fertiliser to soil that is too wet or when heavy rain is expected.
- Using extra fertiliser 'just in case' or for convenience.

3. OPTIMISE FERTILISER APPLICATION

It is important to discuss your nutrient application timing with the consultant who designed your programme.

Roots can take up some nitrogen in winter, however this does not move into the aerial parts of the vine until four to six weeks prior to budbreak i.e. when the vines start to bleed if pruned[16]; there is no production benefit in applying fertiliser any earlier than this. If nitrogen fertilisers are applied too early, much of the applied nitrogen will be carried down the soil profile by rainfall and drainage water. It can be lost below the root zone before the vines have had a chance to use it. To minimise this loss, split your nitrogen applications i.e.

- Apply an initial amount of nitrogen fertiliser (30 to 60 percent) no more than two weeks before bud break.
- The remainder can be applied in in one or more applications leading up to fruit set (November/December).
- We recommend discussing the best way to split your applications with your advisor, as factors such as soil and fertiliser type can affect this.

To optimise plant uptake from ground-based nitrogen fertiliser

Apply:

- your initial application of fertiliser as close to budbreak as possible.
- the remainder just prior to fruit set.

If possible, delay your fertiliser application until afterwards if >20mm of rain is forecast.

By fruit set, most of the previously applied nitrogen (80 percent) would have already been taken up by the leaves. Fruit pulls mobile nutrients like potassium and nitrogen from the leaves, so to avoid deficiencies it is important to apply nutrients prior to fruit-set. Nitrogen applications after fruit set may be detrimental to fruit quality[17].

It's also important to consider the weather forecast and/or make careful use of irrigation when scheduling your fertiliser application. A little water helps uptake, too much raises loss and leaching risk. If possible, delay application until afterwards if a significant amount (>20mm) of rainfall is forecast. Avoid over-irrigating if fertilisers have been applied; this will not only waste water but will lead to drainage and leaching of nutrients.

'Four Rs' of fertiliser use

Growers can also optimise orchard inputs, vine and fruit outcomes, and help care for soil health and local waterways by considering the 'Four Rs' when making decisions about fertiliser use i.e., using fertiliser only:

- at the **right rate**
- of the **right type**
- delivered to the **right place**
- at the **right time**, this includes **with the right amount of water:** consider soil moisture but avoid over-irrigation or application ahead of heavy rain.

[16] C.J. Clark and S.F. Ledgard. 1993. Uptake of 15N by kiwifruit vines from applications of nitrogen fertilizer prior to budbreak.
[17] Turner and Marsh, 1988

5. MONITOR, TEST, REVIEW

MONITOR VINES THROUGHOUT THE SEASON

By observing and recording the behaviour of your vines, you can gain other useful insights to inform your nutrient management approach. This can include:

- Budbreak timing compared to previous seasons
- Leaf condition including size and colour
- Shoot and cane growth
- Signs of plant stress such as leaf drop.

EARLY-SEASON LEAF TESTING

Leaf tests can be used to assess uptake of micronutrients and diagnose early issues so that adjustments can be made as needed to side dressing (pre-flowering) and/or foliar fertilisers applications.

There are generally three broad testing periods for leaves, which vary slightly according to variety, as shown in Figure 11 below.

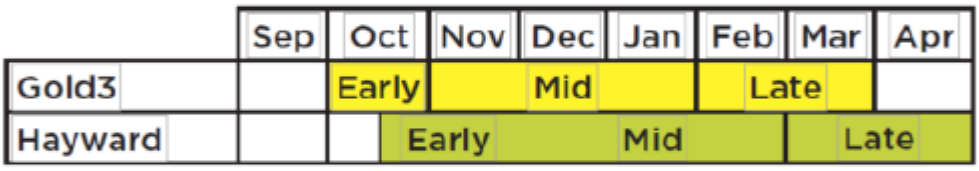


Figure 11. Recommended leaf testing periods for Gold3 and Hayward.

Early in the season, prior to flowering, is the most useful time for leaf testing to inform future ground-based nitrogen application decisions (i.e., side dressings). Consider early season leaf test results in the context of any recent fertiliser applications and where vines are at in their growth cycle and demand for nutrients. For example, high nitrogen or potassium may be due to recent budbreak fertiliser applications and because a large 'draw-down' of nutrients by developing fruit has not yet taken place.

Mid-season tests are useful for identifying any deficiencies which could be rectified using foliar fertilisers.

Which leaf tests to order

Generally, a 'basic plant' test as well as chloride is recommended; a deficiency in chloride will reduce the plants response to potassium. The basic plant test includes measurement of the levels of all the major nutrients (nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, sodium), as well as trace elements (iron, manganese, zinc, copper boron).

Charting your results over time can help you understand if your nutrient levels are stable, or trending up or down for a particular nutrient.

REVIEW AND ADJUST YOUR PLAN

Consider the 'Four Rs' of fertiliser use (page 37) and adjust your nitrogen applications where practical throughout the season in response to leaf and soil test results, vine observations, and weather conditions throughout the season.

Your standard fertiliser programme may be producing consistently good production results, but it may not be the best option for the long-term health of your soil, business, and local waterways.

Discuss your findings and performance from the previous season, and any adjustments you'd like to make as a result, with your fertiliser advisor when setting plans for the next season.

SUMMARY OF KEY POINTS

- A broad range of factors affect nutrient availability and vine uptake. These vary between each orchard and each season. They include (but aren't limited to):
    - soil type
    - soil chemistry such as pH and CEC levels
    - soil physical condition including compaction and organic matter levels
    - vine growth stage
    - environmental conditions at time of application such as soil and air temperature, rainfall.

- Nitrogen is a key tool for driving kiwifruit productivity, however, to achieve production goals while avoiding unnecessary costs and environmental risks, it's important to apply only what is needed by the vines, when they can use it.

- Fruit growth is fuelled by nutrients from plant and soil reserves as well as applied fertilisers. More than 65 percent of the annual uptake by vines of most nutrients occurs during the first 10 weeks after budbreak.

- When working out a nutrient budget, take all sources of nitrogen into account. This includes:
    - ground based fertilisers
    - foliar fertilisers
    - compost
    - organic matter such as from mulched prunings and leaf fall
    - plant reserves.

- Pair your nitrogen balance results, with vine signals to inform your decision making on the right amount of Nitrogen to apply. If you have a surplus from your balance, and your vine signals are all good:
    - talk to your fertiliser advisor about applying less nitrogen or,
    - test a lower nitrogen approach on a portion of your orchard.

- Your risk of nitrogen loss is impacted by three key factors:

Nitrogen loss risk factor	Manage by
1. Light, free-draining soils	• using a little and often approach • paying careful attention to timing of your fertiliser applications. Apply nitrogen fertiliser as close to budbreak as possible.
2. Water logged soils and/or heavy rainfall	• not applying fertiliser if a large rainfall event is in the forecast • not creating drainage events with irrigation practices
3. High levels of nitrate remaining in soil after harvest	• applying the right amount of nitrogen at the right time • avoiding excess nitrogen use

- Use leaf tests and visual observations to inform and adjust your nutrient management approach throughout each season.

NOTES

FIND OUT MORE

Canopy > Growing Kiwifruit > Orchard Management > Nutrition, Soil & Water > **Plant Nutrition & Nitrogen**

- Including:
  - Need to know 43: Four steps to smart fertiliser use
  - Need to know 51: Testing a low nitrogen approach
  - Soil testing video series
  - Spotlight on nutrient management – 2020 Spring Field Days booklet, especially:
    - Calibrating your fertiliser spreader (p.8)
    - Leaf testing (p.9)
    - Foliar N information sheet (p.11)
    - Nitrogen rate trials summary (p.13)
  - Kiwitech Bulletin N51: Hayward kiwifruit phenology and nutrient uptake

- *NZ Kiwifruit Journal* articles
  - Soil testing: In search of what's under your feet - Apr May 2020 (p.16-20)
  - Nitrogen in kiwifruit orchards - Oct/Nov 2019 (p.54-57)
  - The low-down on nitrogen - Jun/Jul 2020 (p.14-19)
  - Leafing no stone unturned – Aug/Sept 2020 (p.38-41)

YOUR ACTION PLAN

What is one thing you'll do next season to optimise nitrogen on your orchard?

KIWIFLIER SPOTLIGHT ON:

OCTOBER 2021 | ISSUE #23

EFFICIENT IRRIGATION

Water is a precious resource that we all have a responsibility to care for and use wisely.

Irrigation can be a useful tool for achieving kiwifruit production goals, especially in dry areas or seasons.

However, irrigation is only useful if it is well managed.

Inefficient irrigation can result in production loss, water-logging, water waste, unnecessary pumping costs, and an increased risk of nutrient loss through leaching.

Why irrigate?

Kiwifruit vines are sensitive to water – both too much and too little:

- Too little water can restrict growth and impact fruit size.
- Too much water can deprive kiwifruit roots of oxygen and prevent them from taking up the water they need. This also restricts growth and, if roots remain saturated for more than three to four days, can result in vine die-back.

When vines don't get enough water, either early or late in the growing season, there is an immediate and irreversible effect on fruit growth which results in smaller fruit at harvest, as shown in Figure 1.

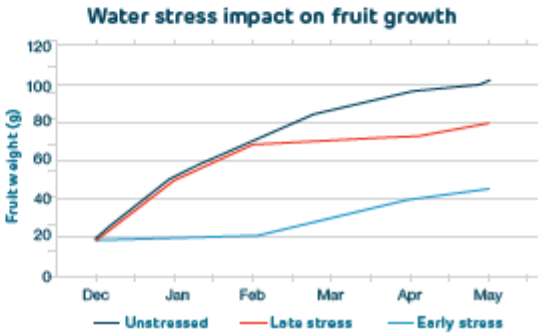


Figure 1. The navy blue line on this graph shows a typical fruit growth curve for Hayward. The pale blue and red lines illustrate the impact of early and late season water stress (respectively) on fruit size. If the plant experiences water stress during the growth period it will never make up the difference. Source: Trevor Lupton/Murray Judd.

When to irrigate

Start early if dry

The most critical time to avoid moisture stress is from flowering, until around six weeks after flowering. Moisture stress in this period will have the greatest impact on fruit size at harvest (shown by the pale blue line in Figure 1). Moisture stress later in the season will also impact on fruit size at harvest, but this will be less significant (see red line in Figure 1).

Soil moisture tells the story

Fruit growth can be affected up to 11 days before kiwifruit leaves show any visible signs of water stress (e.g., drooping, edges curling or discolouration). So, if a decision to irrigate is based only on canopy observation, water application is likely to be too late and fruit size at harvest may have already been compromised.

TOP TIPS FOR EFFICIENT IRRIGATION

- Use regular system checks and maintenance to ensure accuracy and avoid water waste.
- Match water use to vine needs.
- Monitor soil moisture to inform irrigation decisions.
- Keep good records of rainfall, ET and water use. Reconcile them regularly to help inform orchard decisions, demonstrate use efficiency, and meet GAP and compliance requirements.
- Make sure your water use is metered and within permitted activity or consent limits.

Mahi Tahi *Working Together*

NZKGI

MĀORI KIWIFRUIT GROWERS INCORPORATED

Zespri

A Water Strategy for the kiwifruit industry was developed in 2019 by NZKGI, Zespri, Māori Kiwifruit Growers Incorporated (MKGI), and growers. Together, we are committed to working collaboratively with the entire kiwifruit industry to protect water quality, use water efficiently, and build soil health on orchards.

Soil moisture monitoring offers an earlier indicator of water stress risk than canopy symptoms. A range of soil moisture sensor options are available, or at a minimum, dig a hole to have a look and feel the soil.

Soil type informs trigger point

The trigger point for turning on irrigation is usually based on soil moisture levels relevant to your soil type, along with consideration of rainfall received or forecast, and vine growth stage.

The type and texture of your soil affects how much water it can hold (full point), how quickly water drains through the soil profile, and how tightly water is held by soil particles (affecting stress point). See comparison in Figure 3.

An irrigation consultant can advise on soil moisture targets for your specific orchard. A rule of thumb is to keep soil moisture level above stress point and below full point (field capacity) i.e., within the irrigation target zone shown in Figures 2 and 3. This is the soil moisture range where kiwifruit roots can easily take up as much water as they need, and some room is left in the soil for rainfall absorption.

STRESS POINT is when soil becomes too dry for vines to be able to extract as much water as they need.

FULL POINT (field capacity) is the soil moisture level that remains after excess water (such as from significant rainfall) has drained away and the drainage rate has slowed - usually two to three days after a significant rain event.

WILTING POINT is the soil moisture level at which roots can no longer extract water, plant growth stops and die-back begins.

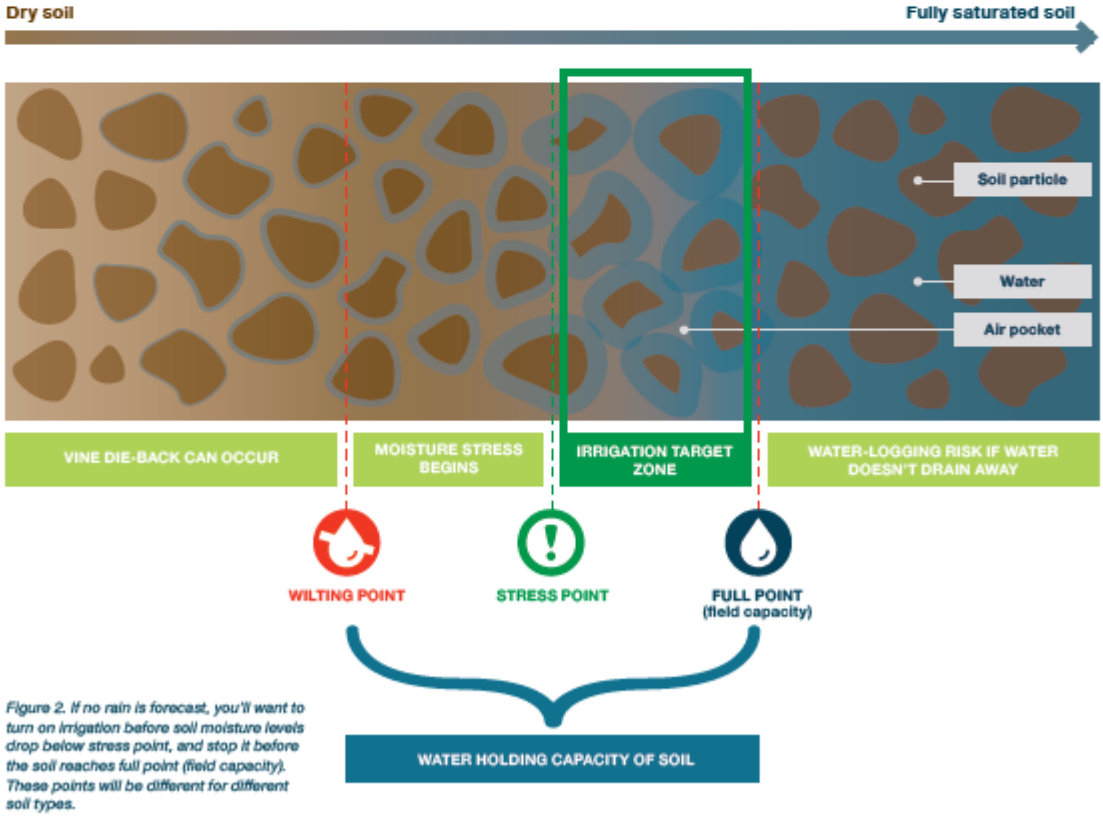


Figure 2. If no rain is forecast, you'll want to turn on irrigation before soil moisture levels drop below stress point, and stop it before the soil reaches full point (field capacity). These points will be different for different soil types.

START WITH SYSTEM CHECKS
Complete pre-season maintenance checks and a bucket test before you start irrigating, to make sure your system is performing well. Use regular visual checks throughout the season too.

How much water to apply

The actual amount of water (and associated system run-time) needed to keep soil moisture levels within your irrigation target zone will depend on your daily vine water use, rainfall received, and system set-up (emitter output rate and quantity).

Calculate daily water needs

Irrigation trials to date have found that the best vine growth and production results are achieved for mature Hayward vines when water is supplied based on the evapotranspiration (ET) rate. For best results, the canopy area should also be considered.

For mature vines, daily water requirements can be estimated by calculating:

Effective canopy area (m²/bay) x ET* (mm) = daily water requirement (L/bay)

**Evapotranspiration (ET) is the opposite of rainfall, it's the amount of water lost through evaporation and plant use (transpiration). ET rates can be sourced from a local weather station or a climate data service. These vary daily, so a seven-day average ET value should be used.*

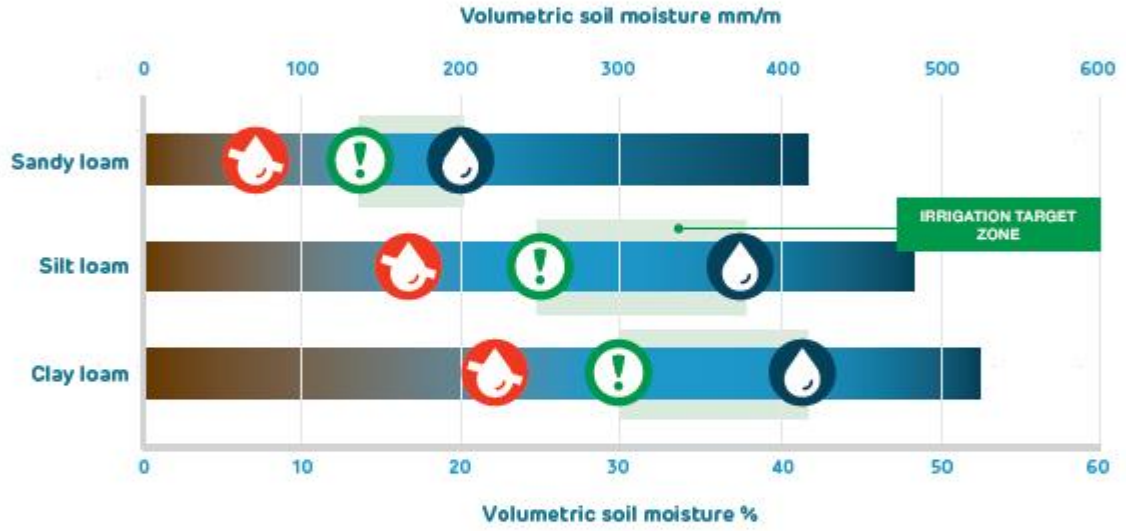


Figure 3. Different soil types reach stress point and full point at different soil moisture levels. The graph above shows examples of these levels for three different soil types.

Young vines require more water than the canopy and ET calculation would estimate.

Determine target depth

Aim to irrigate for as long as it takes for water to reach ½ to ⅔ of the way down your critical root depth. This is the area where approximately 70 percent of your vine roots, including most of the white or fine feeder roots, are (see Figure 4). For kiwifruit, this is usually within the top 30-70 cm of soil.

Water will continue to drain down the soil profile after irrigation is turned off, wetting the remainder of the critical root depth. Dig a hole and take a look to see how deep your irrigation water is going. Soil moisture sensors can also help you to see if the water you apply is reaching this zone (ideal) or draining below it (excess).

KEEP REGULAR RECORDS FOR BEST RESULTS

Keeping records of rainfall, water use, ET rates and soil moisture (if measuring), is a helpful way to see if your vines are at risk of moisture stress or if you have faults in the system that could be wasting water. It can be useful for meeting GAP and compliance requirements, and for future planning too.

Figure 4. Critical root depth. The top half of total root depth is where approximately 70 percent of root mass is. Monitor and maintain soil moisture within this critical root depth.

FIND OUT MORE

Visit the 'Water Management' page of the Zespri Canopy website for more information and tools for improving your production and water use efficiency. This includes a handy calculator that can help you work out the daily water requirements of your vines and track your water use.

If you would like more information or have questions relating to this insert, please contact Zespri's Global Extension team on extension@zespri.com or 07 572 7600.
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P.O. BOX 4043, MOUNT MAUNGANUI. TEL. 07-572 7600, FAX 07-572 7646. www.zespri.com canopy.zespri.com EMAIL: contact.canopy@zespri.com