

Annual Review of Psa in the New Zealand Kiwifruit industry 2015- 2016

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Contents

Objective	2
Executive Summary	2
1.0 The production season and impacts of Psa	3
Introduction and summary	3
1.1. Industry production.	3
1.2 Psa overview	6
1.3 Regional overview	8
2.0 Reviews of four regions: Northland, Waikato/Auckland, Western Bay of Plenty, and Eastern Bay of Plenty.	14
Introduction and summary	14
2.1 Northland	15
2.2 Waikato and Auckland	19
2.3 Western Bay of Plenty	23
2.4 Eastern Bay of Plenty	27
2.5 Comparison of weather	30
3.0 Crop Protection	31
Introduction and summary	31
3.1 Crop Protection Standard- Major changes in Psa controls	31
3.2 Key changes during 2015-16 season: Bactericide review	32
3.3 Management using agrichemicals	36
4.0 Industry activities and communication plans	39
Introduction and summary	39
4.1 Zespri lead Psa-V activities	39
4.2 KVH lead activities and communications	40
4.3 Zespri Communications	40
4.4 Review of grower attitudes, knowledge and practices from all regions	48
5.0 Innovation and Development	50
Introduction and summary	50
5.1 Development of Integrated Fruit Production System	50
5.2 Psa research	51

Annual Review of Psa in the New Zealand Kiwifruit industry

2015- 2016

Objective

To review the 2015/16 season in terms of factors influencing the impact of Psa-V, industry activities in Psa management, and messages to industry from Zespri and Kiwifruit Vine Health.

Executive summary

Information on weather, kiwifruit production and impacts of Psa-V on kiwifruit crops in the main growing regions was compiled; this compilation, with summaries of information provided by Zespri on industry activities and communications, formed the basis of this review of Psa-V in the kiwifruit industry for the 2015-2016 season.

The weather over the season was generally favourable for kiwifruit crops resulting in high yields. Mild conditions over most of the winter period resulted in late budbreak and slightly later flowering period than average. Spring and summer conditions were generally warm and dry and favoured good fruit development.

A cold, wet period in June 2015 may have increased the risk of Psa infection and increased exudates in spring. The number of hectares of orchards affected by Psa increased over the year by around 260ha, mostly identified between October and December 2015. However a grower survey showed that the overall severity of impact of Psa has declined to 21% severe in 2015-16 season from 29% in 2014-5 season.

Hayward leaf spotting and bud rot were reported to be less than in previous years; this was attributed to more growers applying a pre-flowering trunk girdle. There were increasing reports of Gold3 showing signs of cane die back.

A survey of growers across all growing regions found that the orchard issues that are relevant to Psa impact vary in importance with region. Analysis of this survey showed that Eastern Bay of Plenty, Waikato and Waihi areas have the highest percent of orchards severely impacted by Psa. According to a Kiwifruit Vine Health (KVH) review of regions, cold, damp sites within these areas may contribute to this result. The grower survey showed that the main issue identified as contributing to Psa impact was the orchard being prone to frost. Most growers are managing this issue by providing frost protection or improving cold air drainage. The main issues identified in Northland were inadequate shelter and shading in cold areas; in Waikato/Auckland and Hawke's Bay vine stress was a major issue, whilst in Western and Eastern Bay of Plenty orchard sites being prone to frost was an important issue. Hawke's Bay and Poverty Bay growers reported that heavy soils and root diseases were the main issues impacting Psa severity on their orchards.

Changes in crop protection strategy, especially for Psa management, occurred during the 2015-16 season. Worldwide concerns over the use of antibiotics or bactericides in agriculture, and the identification of Psa-V strains with streptomycin resistance and tolerance to copper, resulted in an industry review of bactericide use and initiated the development of an Integrated Fruit Production system for kiwifruit. A recommendation was made to and accepted by the Zespri Board to reduce the use of bactericides for Psa control.

Growers received advice on Psa management throughout the period according to the season. Advice was given by Zespri and KVH through orchard visits, field days, crop protection forums and grower workshops, and via Zespri and KVH bulletins, websites and publications such as Zespri Kiwiflier and NZ Kiwifruit Journal. KVH also developed a Psa-V Seasonal Management Wall Chart.

Key messages to growers included: best practice to limit potential for resistance to Psa control products including the ongoing need for good hygiene practices, regular cut out of Psa symptoms, and use of products at label rates. Other messages were for growers to maintain vigilance for Psa throughout the year, to maintain protective sprays and develop healthy canopies in winter, being aware of pruning only in dry weather. In spring growers were given a strong message to reduce reliance on agrichemicals, especially bactericides. Messages also focused on good management practices pre- and post-flowering, and on managing male vines. In summer, a key message was the importance of spring trunk girdles on Hayward vines. Autumn messages focused on the need to protect scars after harvest and to manage the orchard environment to reduce cold areas.

Most growers were managing the key issues they identified as contributing to the severity of Psa on their orchard. However, of those reporting issues with poor shelter or heavy soils less than 50% were taking steps to manage these. Spring girdling is a practice that is adopted by less than 50% of growers who reported the practice as being relevant to their orchard.

A decision was made to develop an Integrated Fruit Production (IFP) system and to revise and re-launch the Kiwigreen programme. Further reviews identified that more research into Psa biology, epidemiology and effective management are required to support the development of an IFP programme and that research projects need to move from a short term, broad focus approach to a focus on fewer, multiyear projects. Four multiyear programmes of research were recommended covering topics of Psa epidemiology and population dynamics, the kiwifruit microbiome, and growing Gold3 economically in a Psa environment.

1.0 The production season and impacts of Psa

Introduction and summary

The kiwifruit season was shaped by weather patterns influenced by strong El Niño conditions. Generally mild conditions over the winter period (2015) for most regions resulted in later budbreak and slightly later flowering. However, a cold, wet period in June 2015 may have increased risk Psa infection and increased exudates in spring. The weather over spring and summer was generally warm with adequate but not too much rainfall resulting in high yields of kiwifruit, especially Hayward, and reduced pressure from Psa-V.

The number of hectares of orchards affected by Psa increased over the year by around 260ha, mostly between October and December 2015; but a grower survey suggests that overall severity of impact of Psa is declining. Hayward leaf spotting and bud rot were less than in previous years; this is attributed to more growers applying pre-flowering trunk girdle. There were increased reports of Gold3 showing signs of cane die back.

Eastern Bay of Plenty, Waikato and Waihi areas have the highest percent of orchards severely impacted by Psa; cold, damp sites within these areas may contribute to this. A survey of growers across all growing regions found that the orchard issues that are relevant to Psa impact vary in importance with region. The most commonly recorded issue contributing to Psa impact across all regions was the orchard being prone to frost. Most growers are managing this issue by providing frost protection or improving cold air drainage. Comparing regions, the main issues identified in Northland were inadequate shelter and shading in cold areas; in Waikato/Auckland and Hawke's Bay vine stress was a major issue, whilst in Western and Eastern Bay of Plenty being prone to frost was an important issue. Hawke's Bay and Poverty Bay growers reported that heavy soils and root diseases were the main issues.

1.1. Industry production.

General weather for New Zealand: June 2015- June 2016.

Winter temperatures were generally near average for most New Zealand locations. However, record-low temperatures were experienced in late June. Rainfall was higher than normal west of the country whilst the east had lower than normal rainfall for winter. Winter sunshine was near normal for most parts of the country, though higher in eastern areas.

Spring 2015 saw strong El Niño conditions persist in the Tropical Pacific. Spring was generally sunnier and drier than normal, especially in October and November. Temperatures were generally average.

Summer 2015-2016 was characterised by a strong El Niño event. Temperatures were above average. Sunshine and rainfall were near normal for most of the country. However, moist, humid tropical air masses affecting the country (including the remnants of four tropical cyclones) also caused numerous rain events throughout the summer especially in north and eastern areas, and reduced sunshine hours in Bay of Plenty.

2016 was the warmest autumn on record, autumn temperatures were well above average ($>1.20^{\circ}\text{C}$) for New Zealand. Rainfall in northern and eastern parts of the North Island was below normal (50-79%). Sunshine was near normal for most of the country.

From: NIWA Seasonal Climate summaries 2015-2016

Industry Production 2016 Season

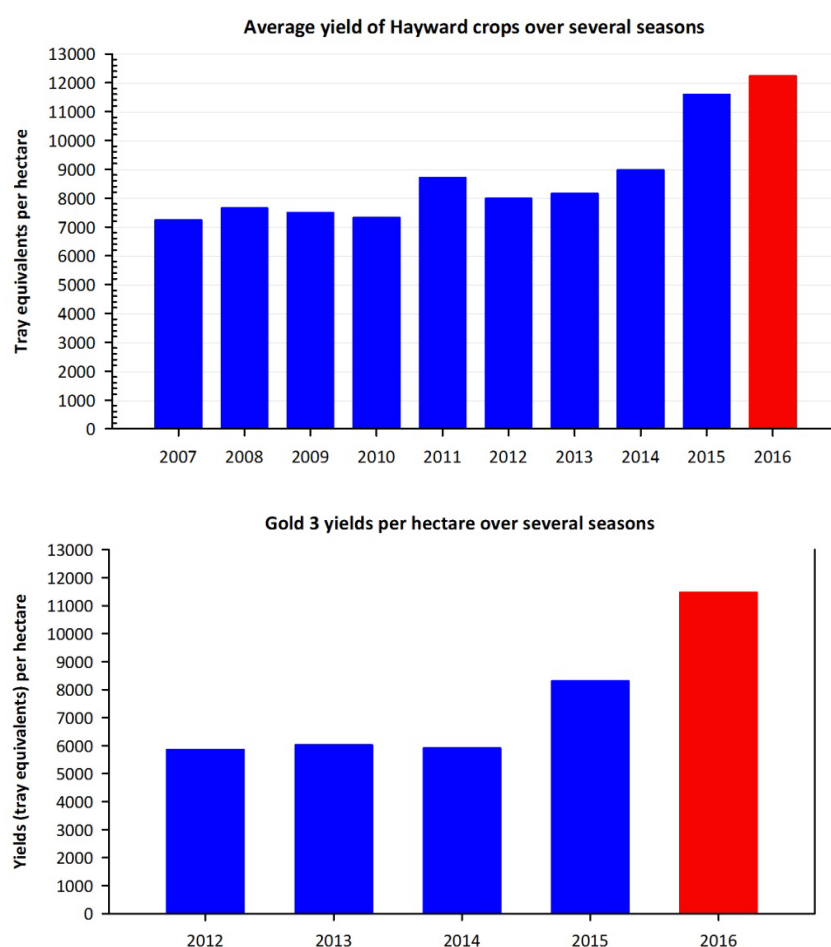
Budbreak and full bloom dates 2015 for Hayward (HW) and Sungold/Gold3 (GA) compared to previous seasons. *From: Te Puke and Kerikeri Infographics*

Location	Cultivar	Date budbreak	Days from av. date (2008-15)	Date Full bloom	Days from av. date (2008-15)
Te Puke	HW	6 October 2015	+10 days	25 November 2015	+2 days
	GA	21 September 2015	+7 days	2 November 2015	0 days
Kerikeri	HW	30 September 2015	-5 days	24 November 2015	+5 days
	GA	25 September 2015	+3 days	4 November 2015	+3 days

Kiwifruit: Total gross yields and yields per hectare by region. *From: Production Summary 2016_all varieties.xlsx*

2016	Class 1 Gross Yields (Tray equivalents)				
Region	Hayward	Green Org	Hort16A	G3	G14
Northland	1,111,611	-	667,882	1,740,298	8,801
Auckland	2,608,589	3,691	4,134	1,687,459	90,620
Katikati	11,979,884	282,656		6,258,860	133,372
Opotiki	5,566,666	195,609		5,350,526	141,069
Tauranga	14,296,195	1,845,909		5,210,833	54,564
Te Puke	47,158,158	451,333		19,469,677	820,124
Waihi	896,092	84,425		566,513	-
Whakatane	4,418,636	19,582		2,319,242	117,779
Total BOP	84,315,631	2,879,514	-	39,175,651	1,266,908
Waikato	2,003,147	1,005,700	9,206	1,108,418	101,248
Poverty Bay	317,361	9,749	446,209	1,290,424	23,708
Hawkes Bay	330,955	-	142,742	895,201	34,838
Lower North Island	465,697	18,220		9,158	15,820
South Island	1,873,574	71,374	476,794	1,347,376	8,653
Total NZ	93,026,565	3,988,248	1,746,967	47,253,985	1,550,596
2016	Class 1 Yields per hectare (Tray equivalents/ha)				
Region	Hayward	Green Org	Hort16A	G3	G14
Northland	9,837		12,795	9,211	7,274
Auckland	9,590	5,859	5,823	9,033	6,454
Katikati	12,402	9,255		12,486	8,769
Opotiki	11,997	8,698		11,189	9,817
Tauranga	12,810	8,739		12,610	6,951
Te Puke	13,439	11,890		12,843	9,329
Waihi	8,961	4,299		11,196	
Whakatane	10,065	5,579		11,234	5,994
Average BOP	11,612	8,076		11,926	8,172
Waikato	9,819	6,673	9,394	7,082	5,704
Poverty Bay	5,877	4,642	9,269	8,816	6,174
Hawkes Bay	7,355		11,493	6,823	4,399
Lower North Island	7,165	7,529		5,324	3,714
South Island	7,234	3,445	10,254	9,690	6,506
Total NZ	12,231	7,945	10,854	11,480	7,938

Average yields per hectare of Hayward and Sungold (Gold3) crops of several seasons



Data from Zespri Documenting the Seasons Hayward and G3 2016

1.2 Psa overview

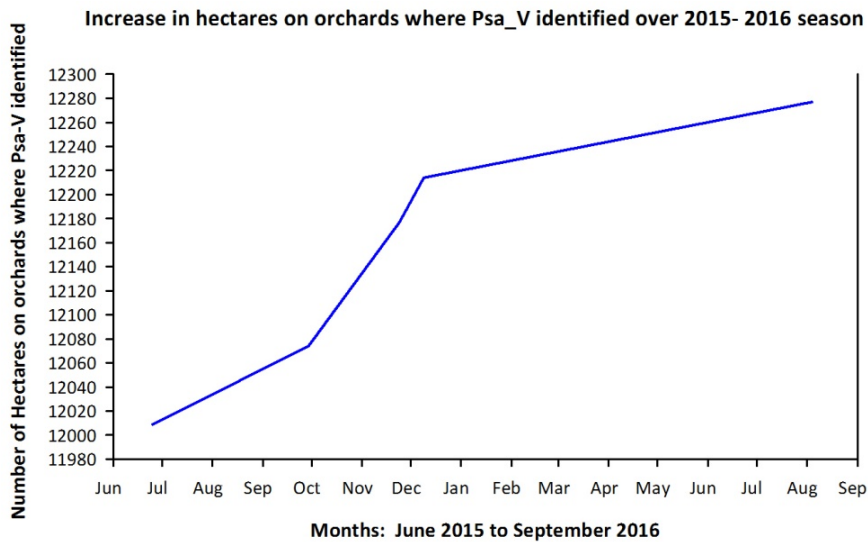
Summary observations

Psa had little impact on overall production levels throughout the 2015/16 growing season with most orchards achieving excellent production. A cold, wet start to the 2015 winter led to concerns that spring may see a significant increase in Psa levels. Fortunately, most regions experienced a relatively dry spring, reducing the overall Psa risk.

Surprisingly, in most regions Hayward leaf spotting and budrot was below levels seen in previous years. The adoption of a pre-flower trunk girdle for budrot control on around 26% of Hayward orchards was a contributing factor, and highlighted the industry's ability to quickly adopt new technology when supported by good science. There was an increase in the reporting of Gold3 showing signs of cane dieback with a number of orchards suffering production impacts. This was particularly prevalent in colder, more challenged areas.

There is some concern that following a number of years of relatively low Psa pressure, growers may become more complacent. However, the overall level of Psa management by growers was pleasing. It is important growers are aware that Psa impacts increase following prolonged periods of high-risk weather; and the need for ongoing orchard hygiene to reduce long-term risk is also essential.

From: Psa year in review 2015 16 draft.docx



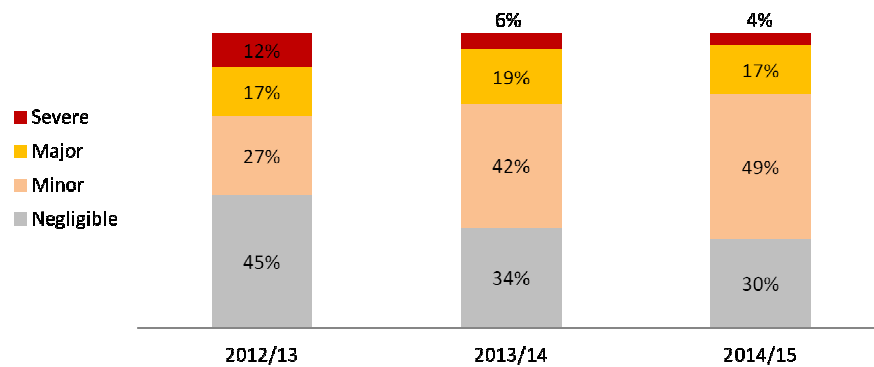
Compiled from KVH Psa Statistics

Historical impact of Psa

The perceived impact of Psa has diminished with 21% assessing the impact as severe or major in 2014/15 where 29% classified it as severe or major in 2012/13

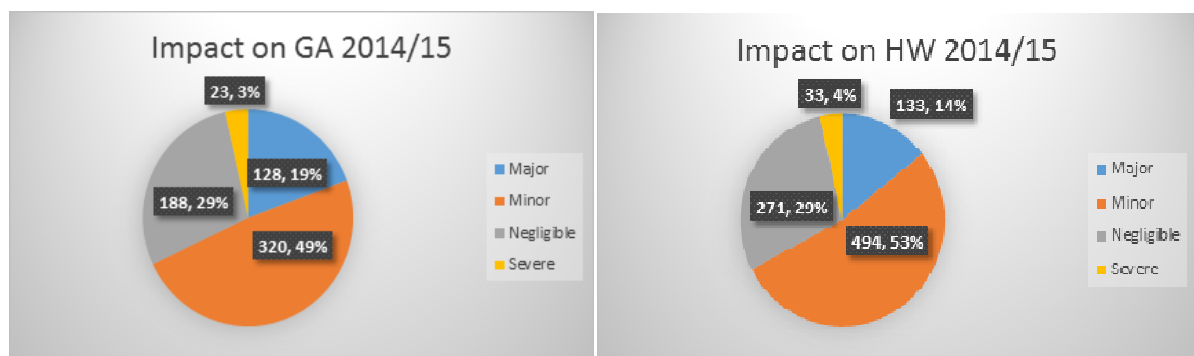
Severity of impact of Psa on orchards from 2013 to 2015 harvest seasons.

Data from all regions combined.



From: Orchard Psa IPM Strategy Report 2016.pptx

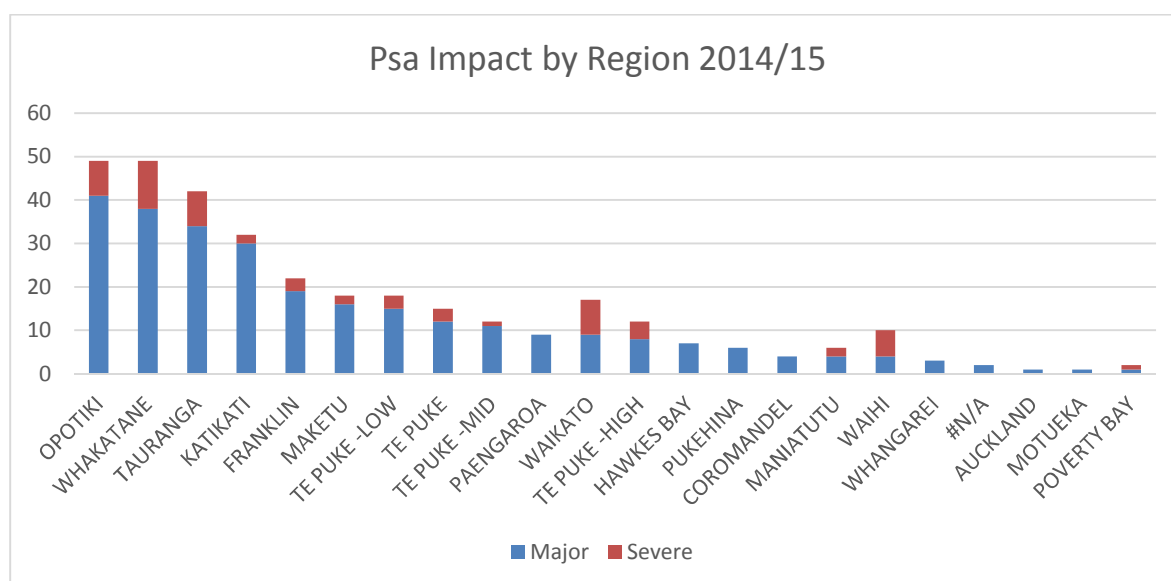
Severity of Psa impact on Gold 3 and Hayward crops in 2014-15 season expressed as % orchards.



From Elly Sharp: Orchard Psa IPM Strategy Form Analysis in: Additional OPIS graphs.docx

1.3 Regional overview

Percent orchards with major or severe impacts from Psa per region (Orchards as percent of total responding to OPIS survey 2015)



From Elly Sharp: Orchard Psa IPM Strategy Form Analysis in: Additional OPIS graphs.docx

Regional summaries 2016.

Kiwifruit Vine Health (KVH) have provided written summaries on Psa status for each region which are below. Information from the grower survey of orchard issues in each region has been included to highlight the difference in relevance of issues across the regions. KVH summary details for Northland, Waikato/Auckland, Western and Eastern Bay of Plenty regions are briefly summarised here for comparisons but are replicated in full in Section 2.0

From: Psa year in review 2015 16 draft.docx

Kerikeri (Recovery region)

The number of Kerikeri orchards with Psa increased from 60 to 73 KPINS representing 68% of orchards. The region's classification changed from 'containment' to 'recovery' in December 2015.

Whangarei (Exclusion region with Controlled Area in place)

The first Psa positive orchard in Whangarei was confirmed in a Hort16A block in September 2015 and an 8km radius Controlled Area was put in place. The region remains an exclusion region with a controlled area notice in place.

OPIS survey of growers identified problems with shelter and shading in cold areas are significant for Northland growers. See following graphs from Orchard Psa IPM Strategy Report 2016.pptx

Growers answered the question: Is this orchard factor an issue in your orchard? Bars show the percent in agreement.

Issue: Shading in cold areas

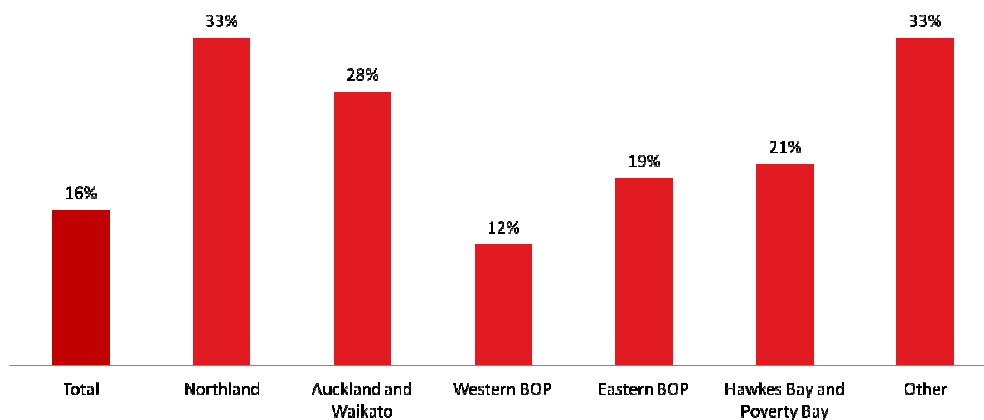


NOTES: 1. Sample: n=1300; Northland n=6, Auckland n=126, Western BOP n=851, Eastern BOP n=263, Hawkes Bay n=39, Other regions n=15

Issue: Gaps in shelter



Issue: Insufficient shelter



NOTES:1. Sample: n=1300; Northland n=6, Auckland n=126, Western BOP n=851, Eastern BOP n=263, Hawkes Bay n=39, Other regions n=15

From: Orchard Psa IPM Strategy Report 2016.pptx

North West Auckland (Containment region)

KVH carried out a monitoring round in this region in early November which resulted in one additional orchard confirmed with Psa, bringing the total in the region to three.

One of the positive orchards removed the Hort16A, however, infection has established in the young Gold3. The last of the Hort16A in this region was removed over winter 2015. Overall, Psa has had very little impact in this region.

Status of this region changed from Exclusion with a Controlled Area in place to a Containment region in December.

South Auckland (Recovery region)

Early spring of 2015 saw significant Psa pressure in the region, particularly on young Gold3 grafts on orchards in the cooler Ardmore area. Challenged Hayward sites in the region continued to face Psa pressure with oozing in male vines common.

OPIS survey of growers identified problems with vine stress as significant for Waikato and Auckland growers. See following graphs from Orchard Psa IPM Strategy Report 2016.pptx

Growers answered the question: Is this orchard factor an issue in your orchard? Bars show the percent in agreement.

Issue: Vine stress



NOTES: 1. Sample: n=1300; Northland n=6, Auckland n=126, Western BOP n=851, Eastern BOP n=263, Hawkes Bay n=39, Other regions n=15

Waikato (Recovery region)

Parts of this region again faced significant Psa challenges with Gold3 and Hayward production levels impacted

Coromandel (Recovery region)

Most orchards in this region had limited impact from Psa over the 2015 /16 growing season. 34 of the 45 KPINs are confirmed with Psa representing 76% of orchards.

Waihi (Recovery region)

Colder sites in the Waihi area have been challenged by Psa for a number of years and this year was no exception.

Katikati / Tauranga (Recovery regions)

With the colder, wetter winter there was a higher level of Psa expression in early spring than seen in the previous two seasons. Many Gold3 blocks had exudate and cane dieback at levels not seen before.

Te Puke (Recovery region)

The majority of the wider Te Puke growing region had little impact from Psa in spring.

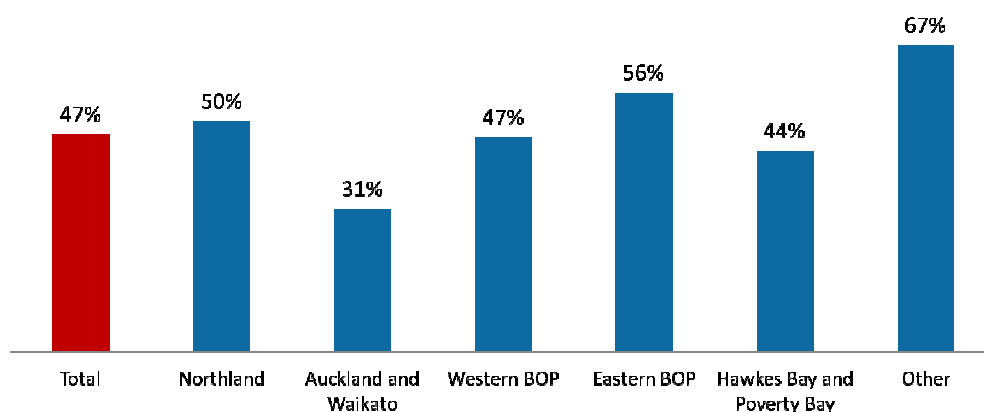
Whakatane / Opotiki (Recovery regions)

The cold, wet winter led to some orchards showing significant Psa symptoms in early spring.

OPIS survey of growers identified problems orchards being prone to frost as significant for Eastern Bay of Plenty growers. See following graphs from Orchard Psa IPM Strategy Report 2016.pptx

Growers answered the question: Is this orchard factor an issue in your orchard? Bars show the percent in agreement.

Issue: Prone to frost



NOTES: 1. Sample: n=1300; Northland n=6, Auckland n=126, Western BOP n=851, Eastern BOP n=263, Hawkes Bay n=39, Other regions n=15

From: Orchard Psa IPM Strategy Report 2016.pptx

Poverty Bay (Containment region)

Spring saw an increase in Psa pressure with 16 additional orchards confirmed as Psa positive, bringing the number of infected orchards to 37. 67% of orchards in the region are now confirmed positive for Psa. There was some Psa infection in Gold3 males in the region. Although more orchards were confirmed positive, Psa had negligible impact on Hort16A and Gold3 crop volumes. Leaf spotting was an issue on a number of Hayward orchards, but overall the impact has been minimal.

Growers converting from Hort16A to Gold3 with colder sites, or more severely affected stumps, experienced difficulty achieving high winter graft success. Re-grafting continued through summer.

The last of the Hort16A orchards in the region were removed following harvest.

Hawke's Bay (Containment region)

A number of Hayward orchards showed leaf spotting for the first time in November 2015. Two orchards went on to suffer from budrot and production loss. Contamination of tools saw one young Gold3 block hit hard with dieback over spring. Other Gold3 orchards saw an increase in Psa symptoms over early spring but a dry, late spring and early summer saw symptoms significantly

reduce. Overall, the region appears to be maintaining good control with more than 60% of the orchards in this region remaining Psa Not Detected.

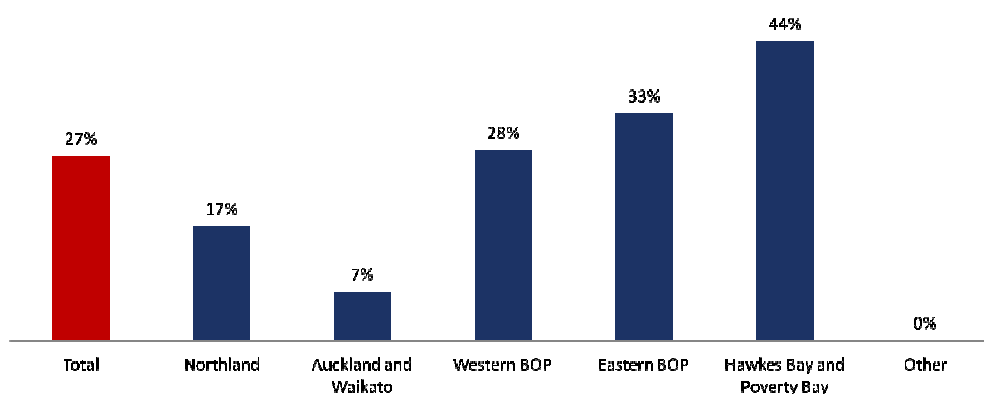
OPIS survey of growers identified problems with heavy soils and root disease as significant for Hawke's Bay and Poverty Bay growers. See following graphs from Orchard Psa IPM Strategy Report 2016.pptx

Growers answered the question: Is this orchard factor an issue in your orchard? Bars show the percent in agreement.

Heavy soils



Root disease



NOTES: 1. Sample: n=1300; Northland n=6, Auckland n=126, Western BOP n=851, Eastern BOP n=263, Hawkes Bay n=39, Other regions n=15

From: Orchard Psa IPM Strategy Report 2016.pptx

Whanganui (Recovery region)

Psa has become more established in the Psa positive orchards in this region over the last 12 months. One additional Hayward orchard was identified with Psa in spring; and 10 of the 17 orchards in the region are now confirmed as Psa positive. Severe Psa was evident in males on some Hayward orchards in spring, impacting pollination. While this was partly offset by artificial pollination there was still a need to remove volumes of poorly-pollinated fruit. A hot, dry summer in the region saw Psa pressure diminish and most orchards went on to produce a good crop. Region status changed from containment to recovery in December 2015.

One Gold3 block where Psa was established removed 5-7 percent of canopy due to Psa infection. The region's two G14 blocks have both been badly affected by Psa. Severe flooding over winter 2015 saw a number of orchards covered in silt. One of these was removed and others have shown increased levels of Psa.

South Island (Exclusion region)

The South Island remains an exclusion region. KVH in conjunction with Mainland Kiwi arranged a monitoring round on 18 Hort16A orchards in November 2015, covering 35 hectares. Sixteen samples were taken and tested for Psa-V, all came back not detected for Psa-V but positive for Pfm (previously known as Psa-LV). The majority of Hort16A blocks have been removed, and one grower will continue to grow Hort16A for harvest in 2017.

2.0 Reviews of four regions: Northland, Waikato/Auckland, Western Bay of Plenty, and Eastern Bay of Plenty.

Introduction and summary

Four kiwifruit production regions, Northland, Waikato/Auckland, Western Bay of Plenty, and Eastern Bay of Plenty, were selected for an in depth review of the production season, grower practices and impact of Psa-V.

Monthly weather data were obtained for each region from the national climate database; weather stations with comprehensive weather data records for the past 40 years and representative of each region were chosen. Stations selected were located in Kerikeri for Northland, Ruakura for Waikato/Auckland, Te Puke for Western Bay of Plenty, and Whakatane for Eastern Bay of Plenty. Monthly rainfall totals, and monthly averages of maximum and minimum daily temperatures were graphed for each site and compared with the normals for each variable for each site. A normal is the average rainfall or temperature for each month over three decades; the most recent normal (1981 and 2010) was used. Graphs are presented in Section 2.5 comparing weather anomalies for the four sites, for each of monthly rainfall, and average monthly maximum and minimum temperatures. The anomalies are differences between the observed value of the variable and the normal value.

Western Bay of Plenty experienced the greatest weather anomalies, with the largest variations in rainfall and cooler than normal winter temperatures. September 2015 was much cooler and wetter than normal for both Western and Eastern Bay of Plenty. All regions experienced warmer than normal night temperatures during the summer months and extending into autumn; Waikato/Auckland also experienced warmer day temperatures during this period. Western Bay of Plenty and Northland had higher than normal rainfall over the summer; whilst Eastern Bay of Plenty and Waikato/Auckland had average or below average summer rainfall.

Weather conditions in Western Bay of Plenty, especially the cooler and wetter winter appeared to impact Psa incidence, especially on colder sites. Similarly some Eastern Bay of Plenty sites were impacted by spells of cold weather in winter and spring. However, overall the severity of impact of Psa appears to be declining in these regions. Although Waikato/Auckland region had average weather over the season, apart from a warmer than usual summer, pockets of cold sites in the region experienced sufficient cold winter temperatures to exacerbate Psa. In contrast, Northland reported minimal impact of Psa.

Production figures show that Northland region has the highest percentage of Gold 3 in its total production; production in the other three regions is still dominated by Hayward. Yield per hectare of all varieties in Northland are much less than the other regions; Waikato/Auckland region showed the greatest yield/ha despite having some sites badly affected by Psa.

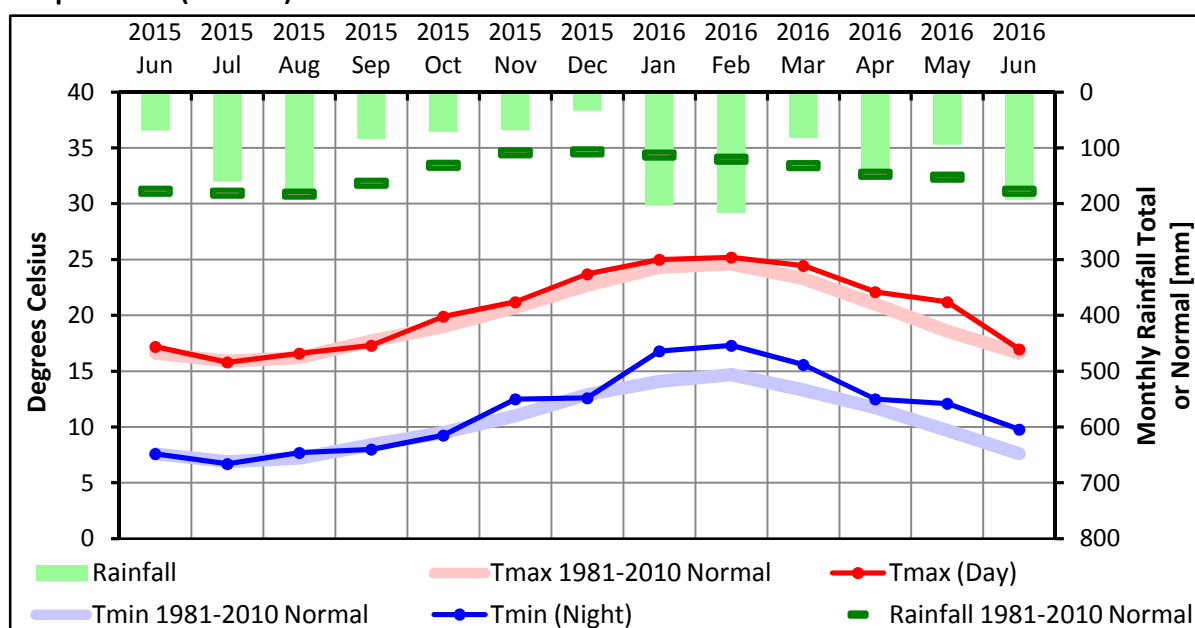
The grower survey showed that the main issue identified as contributing to Psa impact in Waikato/Auckland was vine stress; in Western and Eastern Bay of Plenty it was the orchard being prone to frost, but vine stress was also a key issue. Most growers are managing these issues by managing vine stress and providing frost protection or improving cold air drainage. The main issues identified in Northland were inadequate shelter and gaps in shelter. However, 33% or less of growers who identified these as issues took action in 2015 to resolve the problem.

Each region has a different combination of weather patterns, grower practices and vine productivity which affects the impact Psa-V has on kiwifruit production.

2.1. Northland

Summary of weather.

Graph of monthly rainfall totals and monthly means of daily maximum and daily minimum temperatures (Kerikeri).



Data obtained from the NZ National Climate Database, via NIWA's Cliflo website.

Seasonal Climates: Northland from NIWA Seasonal and Monthly Climate summaries.

Winter 2015			Spring 2015		
Jun	Jul	Aug	Sep	Oct	Nov
Average temperature; below normal rainfall; average sunshine			Average temperature; Average rainfall; Sunshine totals above normal (110-125%); low soil moisture.		
Below av rainfall (< 50% of June normal rainfall),	12 Jul very cold; 15 Jul severe storms, lightning	13 Aug Keikeri had record cool period			On 22 November prolonged thunderstorms impacted northern parts of the North Island.
Summer 2015-16			Autumn 2016		
Dec	Jan	Feb	Mar	Apr	May
Well above average temperature (Kerikeri had warmest summer on record); above average rainfall; average sunshine; soil moisture above normal.			Above average temperature; rainfall below normal; above normal sunshine (110-125%)		
	1-2 Jan heavy rain; strong E winds.		23-24 March, strong winds	2 Apr highest daily temperature on record	
			Winter 2016		
			Jun	Jul	
			Above average temp, sunshine Average rainfall, normal soil moisture.		

Regional production

2016	Class 1 Gross Yields (Tray Equivalents)				
	Hayward	Green Org	Hort16A	G3	G14
Northland	1,111,611	-	667,882	1,740,298	8,801
2016	Class 1 Yields/ha (TE/ha)				
	Hayward	Green Org	Hort16A	G3	G14
Northland	9,837		12,795	9,211	7,274

From: Production Summary 2016_all varieties.xlsx

Impact Psa-V

KVH Regional summaries

Kerikeri (Recovery region)

The number of Kerikeri orchards with Psa increased from 60 to 73 KPINS representing 68% of orchards. The region's classification changed from 'containment' to 'recovery' in December 2015. Overall, the impact of Psa has been minimal, even on the remaining Hort16A orchards. Warmer conditions in the region appear to have slowed infection spread. The last of the uncovered Hort16A orchards were removed following harvest, further reducing Psa risk. Some notch-grafted Gold3 showed significant infection going into winter. These orchards will require a proactive cut-out and spray programme to minimise the impacts going forward.

Whangarei (Exclusion region with Controlled Area in place)

The first Psa positive orchard in Whangarei was confirmed in a Hort16A block in September 2015 and an 8km radius Controlled Area was put in place. A combination of the swift removal of infected vines by the affected grower, along with the proactive Psa management plans already in place by Whangarei growers, means the disease has not been identified on any other orchards in the Whangarei region to date. Two monitoring rounds were completed by KVH in October with focus on orchards close to the positive site and Hort16A orchards.

The region remains an exclusion region with a controlled area notice in place. The last of the uncovered Hort16A has been removed.

Psa year in review 2015 16 draft.docx

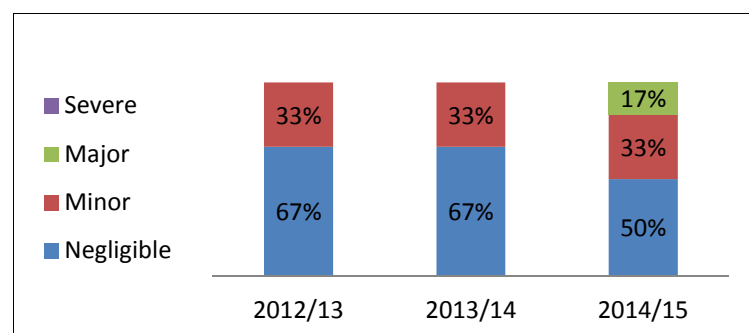
Psa-V statistics from KVH

Psa_V in regions as of 4 August 2016			
Regions	Orchards with Psa-V	Total orchards in region	% orchards with Psa-V
Kerikeri	77	108	71
Whangarei	1	55	2
Northland	78	163	48

Data from: <http://www.kvh.org.nz/vdb/document/453>. Accessed 30 August 2016.

Historical impact of Psa: By region

Impact of Psa-V in Northland region over 2013-15 harvest seasons. Data from OPIS survey.



NOTES: Sample: n=1300: Northland n=6. Estimated productivity impact from bud on flower loss or cone dieback. Negligible = 'No significant impact', Minor = 'Less than 10% loss', Major = '10.25% loss', Severe = '>25% loss'

While northern regions were not initially severely impacted by Psa, there is evidence that it's impact has increased over the 2013/14 to 2014/15 period.

From: Orchard Psa IPM Strategy Report 2016.pptx

Psa management

Issues identified by growers as part of OPIS Survey and reported in OPIS Strategy Report presentation and percent of growers with issue taking action in 2014 and planning action in 2015.

Northland				
Issue	% KPINs with issue	Action	% KPINs taking action in 2014-15	% KPINs planning action in 2015-16
Gaps in shelter	45.9	Fill in gaps	10.7	25
Insufficient shelter	14.8	Erect boundary shelter	33	0
		Overhead or undervine	33.3	66.7
Prone to frost	9	Install or use frost protection	88.9	88.9
		Improve cold air drainage	88.9	88.9
Shading and cold areas	1.6	Manage shading/cold	0	100
Root disease	1.6	Manage root disease	100	100
Vine stress	19.7	Foliar sprays	91.7	91.7
		Identify and manage vines showing symptoms	91.7	91.7

Data from: Orchard Psa IPM Strategy Report 2016.pptx

Use of agrichemicals to control Psa-V

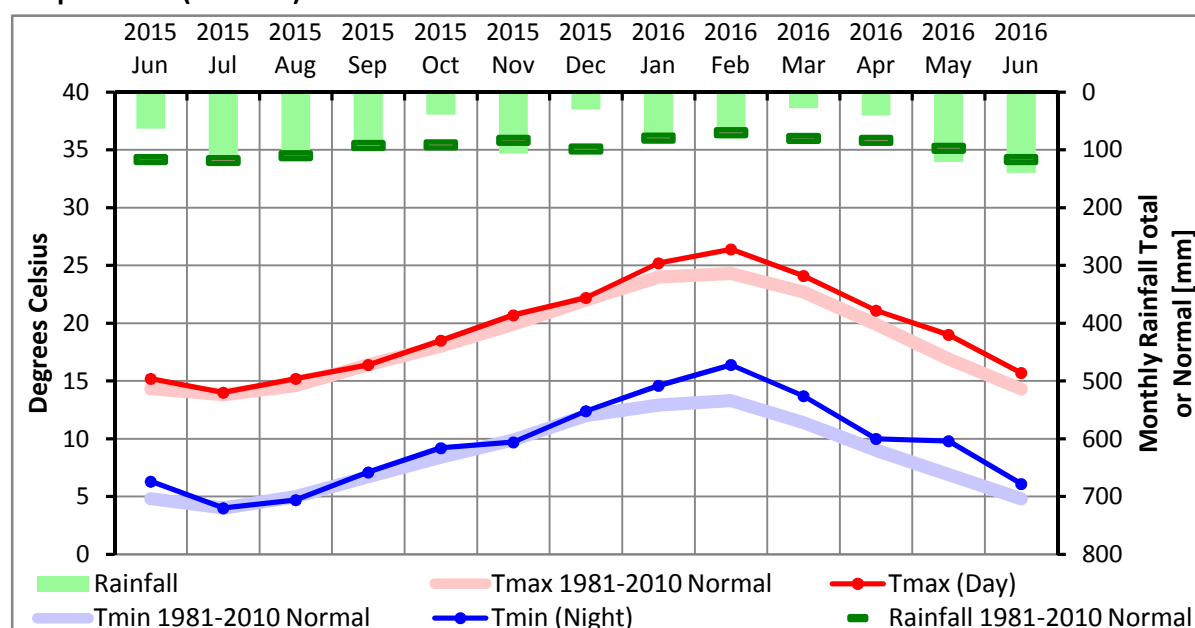
Number of sprays per variety in Northland					
Variety	Actigard	Kasumin	KeyStrepto	Botryzen	Ambitious
GA	69	10	10		1
GK	23	6	11		
HE	2				
HW	38	1			2
Grand Total	132	17	21		3

Copper applications in Northland 2015-16				
Variety	Nordox	Kocide Opti	Hortcare Copper Hydroxide	Coptyzin
GA	58	83	3	
GK	12	21		
HE	3	2		
HW	35	51	1	
Grand Total	108	157	4	

2.2 Waikato and Auckland

Summary of weather.

Graph of monthly rainfall totals and monthly means of daily maximum and daily minimum temperatures (Ruakura)



Data obtained from the NZ National Climate Database, via NIWA's Cliflo website.

Seasonal Climates: Waikato from NIWA Seasonal and Monthly Climate summaries.

Winter 2015			Spring 2015		
Jun	Jul	Aug	Sep	Oct	Nov
Slightly below average temperature; above normal (110-125%) sunshine.			Average temperature; Average rainfall; near normal sunshine.		
Below average rainfall (< 50% of June normal rainfall). Above average temperatures E Waikato	7 Jul heavy rain. 15 Jul heavy rain. 18 Jul very strong winds.	6 Aug strong winds	1 Sep heavy rain and floods.		No spring hail events in early spring in Waikato
Summer 2015-16			Autumn 2016		
Dec	Jan	Feb	Mar	Apr	May
Above average temperature; average rainfall; soil moisture below normal; average sunshine; soil moisture above normal.			Above average temperature (Hamilton, highest autumn temperature on record); rainfall below normal; sunshine below normal; soil moisture normal		
					16 May lightning strikes. 20 May a tornado near Te Awamutu

Regional production

Class 1 Gross Yields (Tray Equivalents)					
	Hayward	Green Org	Hort16A	G3	G14
Waikato /Auckland	4,611,736	1,009,391	13,340	2,795,877	191,868
2016 Class 1 Yields/ha (TE's/ha)					
	Hayward	Green Org	Hort16A	G3	G14
Waikato /Auckland	19,410	12,531	15,216	16,115	12,159

From: Production Summary 2016_all varieties.xlsx

Impact PsA-V

KVH Regional summaries

Waikato (Recovery region)

Parts of this region again faced significant PsA challenges, particularly through late winter and into spring. The Karapiro area was hardest hit with Gold3 and Hayward production levels impacted. The cold winter appears to have led to increased expression of exudate in the spring. This was seen mainly in male vines, and the associated inoculum pressure led to extensive budrot in Hayward, which impacted fruit numbers. A number of Gold3 orchards suffered from significant oozing and cane die back, with up to 40% of canes removed in the worst affected orchards. This region has a high number of organic growers. One Gold3 block converted to conventional growing this year and a number of others may consider moving to conventional growing to increase the range of tools available for PsA management. KVH has worked closely with a number of the more challenged orchards in this region.

Coromandel (Recovery region)

Most orchards in this region had limited impact from PsA over the 2015 /16 growing season and this has resulted in little impact on production. 34 of the 45 KPINs are confirmed with PsA representing 76% of orchards. As in many regions, there are exceptions and the more challenged growing sites continue to face significant PsA pressure. A number of these sites also have environmental issues like drainage impacting on vine health.

South Auckland (Recovery region)

Early spring of 2015 saw significant PsA pressure in the region, particularly on young Gold3 grafts on orchards in the cooler Ardmore area. Oozing and die back on these blocks led to significant cut out on some orchards with cut out continuing into late January. Challenged Hayward sites in the region continued to face PsA pressure with oozing in male vines common. Pre flower trunk girdling was widely used in the area to reduce budrot and production impacts. A drier, late spring and summer, along with proactive management, has enabled most orchards to stay on top of PsA and achieve good production. KVH worked closely with a number of growers facing challenges in this region.

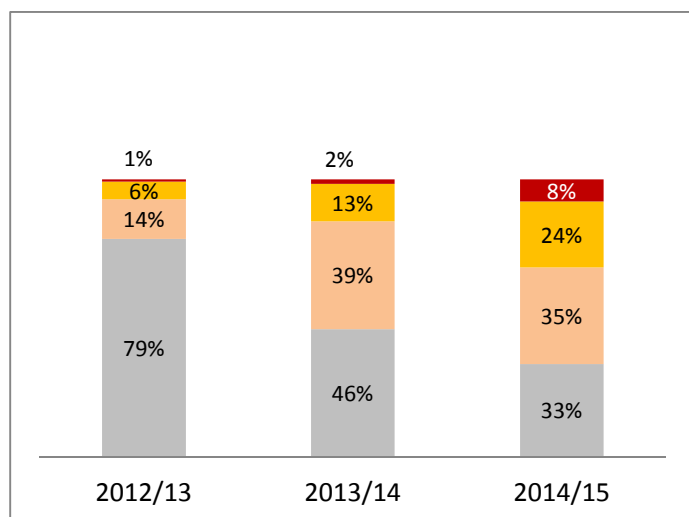
Psa-V statistics from KVH

Psa-V in regions as of 4 August 2016			
Regions	Orchards with Psa-V	Total orchards in region	% orchards with Psa-V
Coromandel	34	46	74
Franklin	91	100	91
NW Auckland	3	23	13
Waikato	57	83	69
Waihi	40	40	100
Total Waikato/Auckland	225	292	77

Data from: <http://www.kvh.org.nz/vdb/document/453>. Accessed 30 August 2016.

Historical impact of Psa: By region Waikato/Auckland

Impact of Psa-V in Waikato/Auckland region over 2013-15 harvest seasons. Data from OPIS survey.



NOTES: Sample: Waikato/Auckland n=126, Estimated productivity impact from bud on flower loss or cone dieback. Negligible = 'No significant impact', Minor = 'Less than 10% loss', Major = '10.25% loss', Severe = '>25% loss'

While northern regions were not initially severely impacted by Psa, there is evidence that it's impact has increased over the 2013/14 to 2014/15 period.

From: Orchard Psa IPM Strategy Report 2016.pptx

Psa management

Issues identified by growers as part of OPIS Survey and reported in OPIS Strategy Report presentation and percent of growers with issue taking action in 2014 and planning action in 2015.

Waikato/Auckland				
Issue	% KPINS with issue	Action	% KPINS taking action in 2014-15	% KPINS planning action 2015-16
Gaps in shelter	11.9	Fill in gaps	42.9	38.1
Insufficient shelter	23.7	Erect boundary shelter	19.0	33.3
		Overhead or undervine	66.7	71.4
Prone to frost	37.9	Install or use frost protection	73.1	73.1
		Improve cold air drainage	41.8	41.8
Shading and cold areas	14.1	Manage shading/cold	32.0	60.0
Heavy soils	16.9	Address drainage issues	56.7	96.7
		Add organic matter	73.3	60.0
Root disease	5.6	Manage root disease	80.0	90.0
Vine stress	57.6	Foliar sprays	94.1	97.1
		Identifiy and manage vines showing symptoms	37.3	36.3

Data from: Orchard Psa IPM Strategy Report 2016.pptx

Use of agrichemicals to control Psa-V

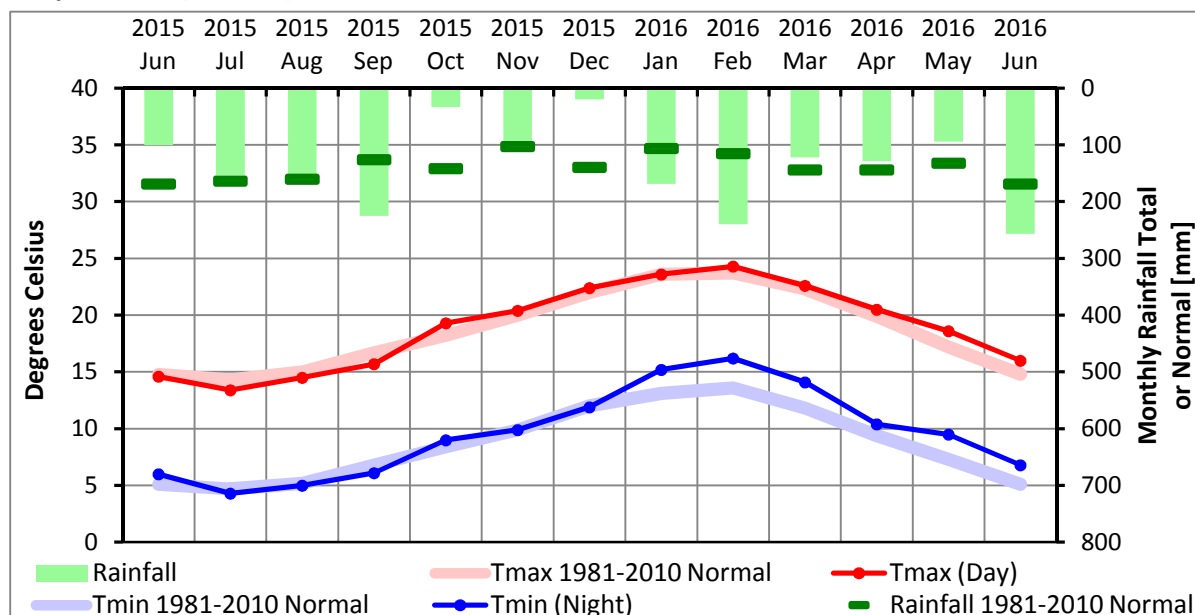
Number of sprays per variety in Waikato/Auckland					
Varieties	Actigard	Kasumin	KeyStrepto	Botryzen	Ambitious
GA	102	44	36		4
GK	2	1	3		
HE	16	3	6		8
HW	131	56	29		59
Grand Total	251	104	74		71

Copper applications in Waikato/Auckland 2015-16				
Variety	Nordox	Kocide Opti	Hortcare Copper Hydroxide	Coptyzin
GA	104	84	13	2
GK	3	3		
HE	18	8	3	1
HW	154	123	29	3
Grand Total	279	218	45	6

2.3 Western Bay of Plenty

Summary of weather.

Graph of monthly rainfall totals and monthly means of daily maximum and daily minimum temperatures (Te Puke).



Data obtained from the NZ National Climate Database, via NIWA's Cliflo website.

Seasonal Climates: Western Bay of Plenty from NIWA Seasonal and Monthly Climate summaries.

Winter 2015			Spring 2015		
Jun	Jul	Aug	Sep	Oct	Nov
Average temperature; below normal rainfall; average sunshine (NIWA). Extreme frosts (-5°C) often early evening			Average temperature (high temperatures briefly early Nov); Average rainfall; near normal sunshine (NIWA). Big fluctuations in temperatures (warm→ cool→warm) Cool night-time temperatures through spring Average wind strength.		
Below average rainfall (< 50% of June normal rainfall), average temperature	8 Jul very cold; 18 July very strong winds; mini tornados Mt Maunganui. Frosts	6 Aug strong winds; 9 August, hail showers; 14 Aug tornado near Katikati. Frosts.	1 Sep heavy rain and floods; 19 Sep heavy rain Te Puke. Hail events @ budbreak in Pongakawa and Katikati	Tauranga/Katikati – October frosts Strong wind in Katikati in mid-October	
Summer 2015-16			Autumn 2016		
Dec	Jan	Feb	Mar	Apr	May
Above average temperature V; average rainfall; soil moisture above normal; below normal sunshine (75-89%). Tauranga had its cloudiest summer on record, with 77% of normal summer sunshine (NIWA).			Above average temperature (Tauranga, highest autumn temperature on record); rainfall near average; sunshine below normal; soil moisture normal (NIWA).		
	8 Jan strong winds				14 May, a tornado ripped through Mt Maunganui, 15 May very strong winds Tauranga

Regional production

2016	Class 1 Gross Yields (Tray Equivalents)				
Region	Hayward	Green Org	Hort16A	G3	G14
Western BOP	74,330,329	2,664,323	-	31,505,883	1,008,060
2016	Class 1 Yields/ha (TE's/ha)				
Region	Hayward	Green Org	Hort16A	G3	G14
Western BOP	11,903	8,546		12,284	8,350

From: Production Summary 2016_all varieties.xlsx

Impact Psu-V

KVH Regional summaries

Waihi (Recovery region)

Colder sites in the Waihi area have been challenged by Psu for a number of years and this year was no exception. Some have struggled to get Gold3 established and in one case the grower has elected to sell licence and return to Hayward. A number of cold Hayward organic blocks had severe Psu in males, leading to budrot. Bactericides were used on colder, conventional Hayward orchards where exudate in males was present.

Katikati / Tauranga (Recovery regions)

With the colder, wetter winter there was a higher level of Psu expression in early spring than seen in the previous two seasons. Many Gold3 blocks had exudate and cane dieback at levels not seen before, and cut out occurred on many colder blocks. As spring progressed and warmer, drier conditions prevailed things quickly improved. Symptoms significantly reduced and most orchards went on to produce excellent crops. The Tarapiro area continued to show symptoms for longer than many other areas and a number of orchards had to cut back young Gold3, impacting on production.

Te Puke (Recovery region)

The majority of the wider Te Puke growing region had little impact from Psu in spring with many Hayward orchards going on to produce record crops. Gold3 is well established on many sites in the region and although symptoms were more prevalent in early spring, Psu has had very little impact on this year's production. Colder, low lying sites are the exception, with Psu hot spots continuing to cause some canopy loss.

Psu year in review 2015 16 draft.docx

Psa-V statistics from KVH

Psa-V in regions as of 4 August 2016

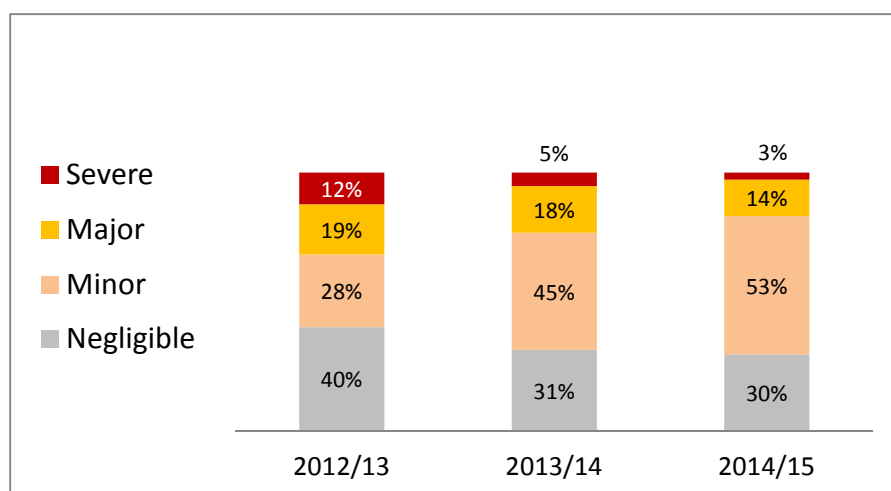
Regions	Orchards with Psa-V	Total orchards in region	% orchards with Psa-V
Katikati	405	469	86
Tauranga	557	599	93
Te Puke	1075	1095	98
Western BOP	2037	2163	94

Data from: <http://www.kvh.org.nz/vdb/document/453>. Accessed 30 August 2016.

Historical impact of Psa: By region

Impact of Psa-V in Western Bay of Plenty region over 2013-15 harvest seasons. Data from OPIS survey.

The impact of Psa was major to severe on around 30% of orchards in the BOP in 2012/13 and while the impact has declined in the Western region, it remains problematic in the Eastern BOP.



Sample: n=1300: Western BOP 851, Estimated productivity impact from bud on flower loss or cone dieback. Negligible = 'No significant impact', Minor = 'Less than 10% loss', Major = '10.25% loss', Severe = '>25% loss.' From: *Orchard Psa IPM Strategy Report 2016.pptx*

Psa management

Issues identified by growers as part of OPIS Survey and reported in OPIS Strategy Report presentation and percent of growers with issue taking action in 2014 and planning action in 2015.

Western BOP				
Issue	% KPINS with issue	Action	% KPINS taking action in 2014-15	% KPINS planning action 2015-16
Gaps in shelter	15.0	Fill in gaps	40.2	51.2
Insufficient shelter	10.9	Erect boundary shelter	36.1	43.7
		Overhead or undervine	43.7	39.5
Prone to frost	48.1	Install or use frost protection	88.2	82.0
		Improve cold air drainage	49.7	53.7
Shading and cold areas	14.5	Manage shading/cold	55.3	54.7
Root disease	28.3	Manage root disease	77.1	84.2
Vine stress	40.4	Foliar sprays	85.3	82.4
		Identifiy and manage vines showing symptoms	82.1	76.9

Western BOP includes following districts from survey: Katikati, Maketu, Maniatutu; Paengaroa; Pukehina; Tauranga, Te Puke (high,low etc)

From: Orchard Psa IPM Strategy Report 2016.pptx

Use of agrichemicals to control Psa-V

Number of sprays per variety in Western BOP					
Variety	Actigard	Kasumin	KeyStrepto	Botryzen	Ambitious
GA	811	470	255	2	15
GK					
HE	56	35	24	1	46
HW	1308	626	390	14	663
Grand Total	2175	1131	669	17	724

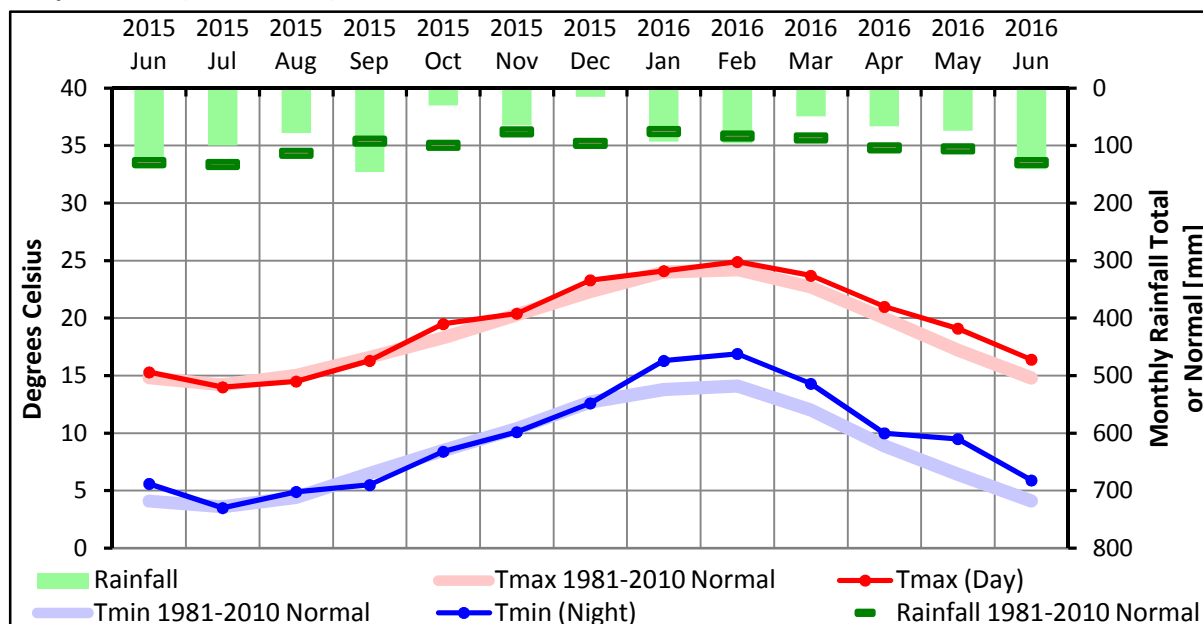
From Psa Spray Data

Copper applications in Western Bay of Plenty 2015-16				
Variety	Nordox	Kocide Opti	Hortcare Copper Hydroxide	Coptyzin
GA	815	899	48	18
GK		1		
HE	57	68	1	
HW	1268	1398	63	15
Grand Total	2140	2366	112	33

2.4 Eastern Bay of Plenty

Summary of weather.

Graph of monthly rainfall totals and monthly means of daily maximum and daily minimum temperatures (Whakatane).



Data obtained from the NZ National Climate Database, via NIWA's Cliflo website.

Seasonal Climates: Eastern Bay of Plenty from NIWA Seasonal and Monthly Climate summaries.

Winter 2015			Spring 2015		
Jun	Jul	Aug	Sep	Oct	Nov
Average temperature; below normal rainfall; average sunshine			Average temperature; average rainfall, sunshine totals above normal (110-125%).		
Av rainfall, above av temperature					

Summer 2015-16			Autumn 2016		
Dec	Jan	Feb	Mar	Apr	May
Above average temperature; average rainfall; soil moisture above normal; below normal sunshine (75-89%)			Above average temperature; rainfall below average; sunshine near normal; soil moisture normal;		
	8 Jan strong winds				12 May strong winds

Regional production

2016	Class 1 Gross Yields (Tray Equivalents)				
	Hayward	Green Org	Hort16A	G3	G14
Eastern BOP	9,985,302	215,191	-	7,669,768	258,848

2016	Class 1 Yields/ha (TE's/ha)				
	Hayward	Green Org	Hort16A	G3	G14
Eastern BOP	11,031	7,138		11,211	7,905

From: Production Summary 2016_all varieties.xlsx

Impact Psa-V

KVH Regional summaries

Whakatane / Opotiki (Recovery regions)

The cold, wet winter led to some orchards showing significant Psa symptoms in early spring. As Psa pressure has been greater for a number of years in the region many growers are more proactive with their cut out and spray programmes but hot spots remain. Pre-flowering trunk girdling of green varieties was widely adopted in the region and most orchards were able to get a good fruit set and go on to produce excellent crops.

Psa year in review 2015 16 draft.docx

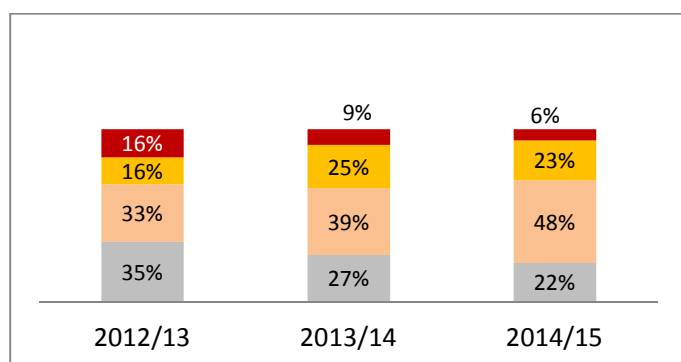
Psa-V statistics from KVH

Psa-V in regions as of 4 August 2016			
Regions	Orchards with Psa-V	Total orchards in region	% orchards with Psa-V
Opotiki	206	227	91
Whakatane	152	160	95
Eastern BOP	358	387	92.5

Data from: <http://www.kvh.org.nz/vdb/document/453>. Accessed 30 August 2016.

Historical impact of Psa: By region

Impact of Psa-V in Eastern Bay of Plenty region over 2013-15 harvest seasons. Data from OPIS survey.



Sample: n=1300: Eastern BOP n=263. Estimated productivity impact from bud on flower loss or cone dieback. Negligible = 'No significant impact', Minor = 'Less than 10% loss', Major = '10.25% loss', Severe = '>25% loss'

The impact of Psa was major to severe on around 30% of orchards in the BOP in 2012/13 and while the impact has declined in the Western region, it remains problematic in the Eastern BOP

From: Orchard Psa IPM Strategy Report 2016.pptx

Psa management

Issues identified by growers as part of OPIS Survey and reported in OPIS Strategy Report presentation and percent of growers with issue taking action in 2014 and planning action in 2015.

Eastern BOP				
Issue	% KPINs with issue	Action	% KPINs taking action in 2014-15	% KPINs planning action 2015-16
Gaps in shelter	29.8	Fill in gaps	61.6	77.9
Insufficient shelter	20.1	Erect boundary shelter	43.1	62.1
		Overhead or undervine	44.8	43.1
Prone to frost	58.8	Install or use frost protection	71.8	72.9
		Improve cold air drainage	41.2	40.0
Shading and cold areas	19.4	Manage shading/cold	58.9	75.0
Heavy soils	29.8	Address drainage issues	51.2	46.5
		Add organic matter	66.3	64.0
Root disease	34.3	Manage root disease	67.7	78.8
Vine stress	40.5	Foliar sprays	91.5	88.0
		Identify and manage vines showing symptoms	80.3	82.1

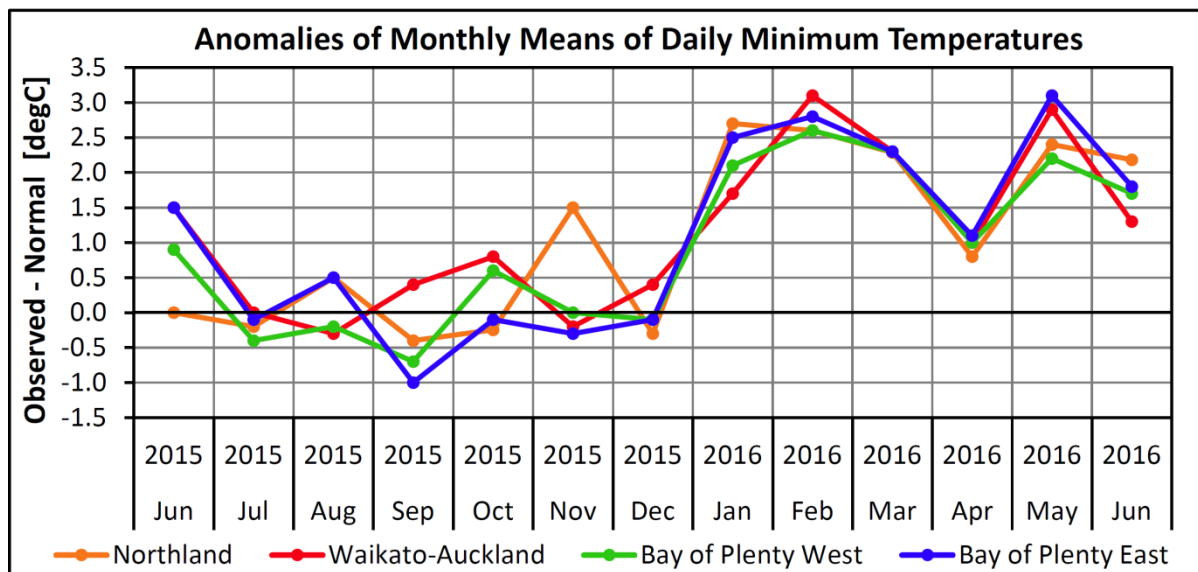
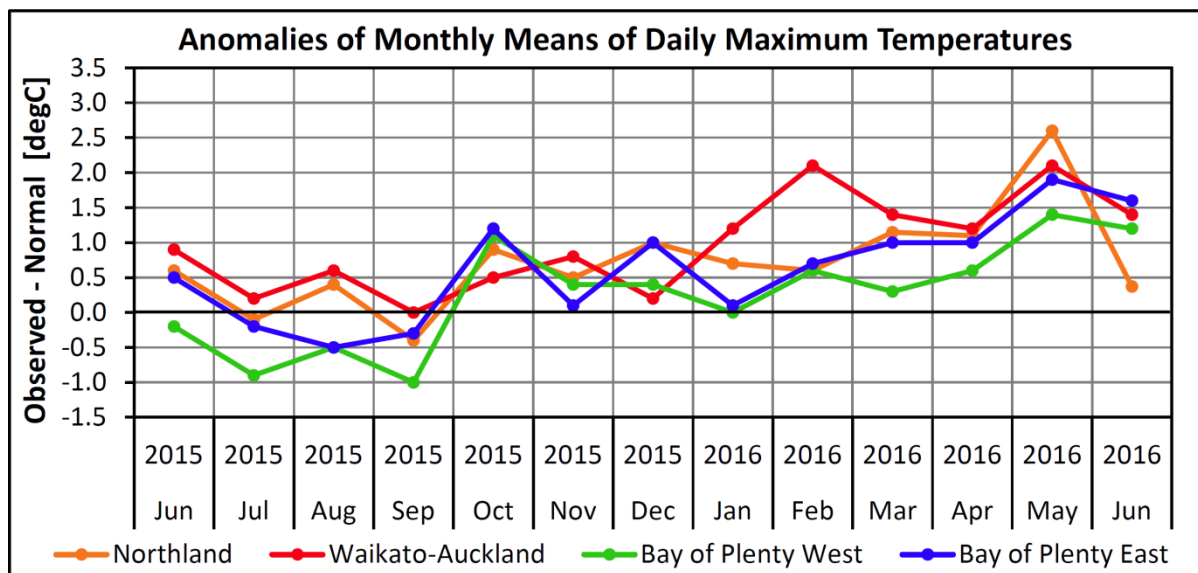
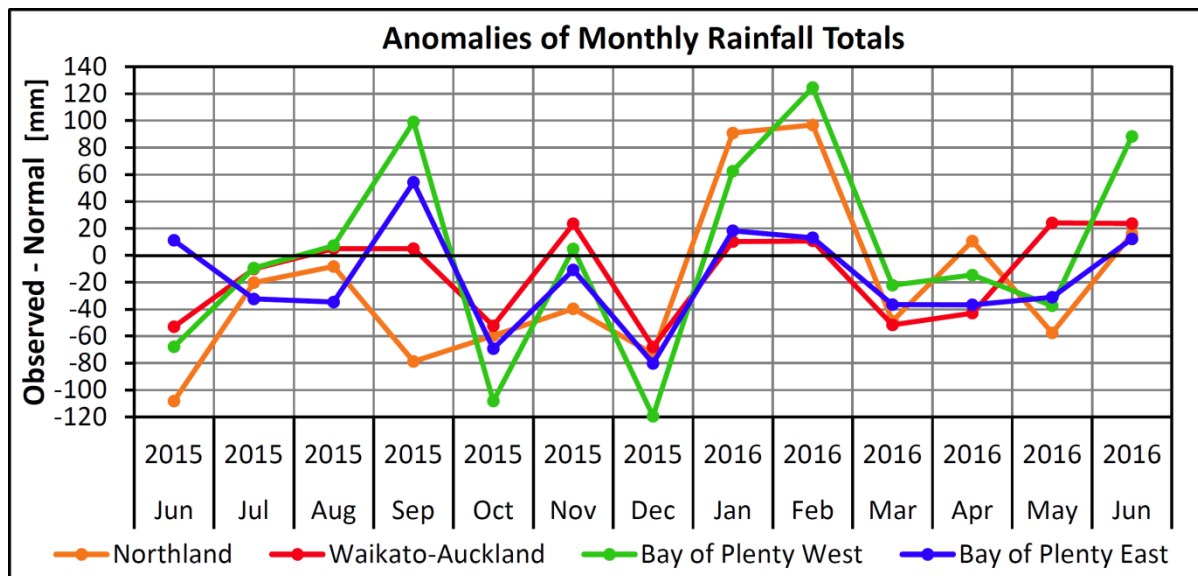
From: Orchard Psa IPM Strategy Report 2016.pptx

Use of agrichemicals to control Psa-V

Number of sprays per variety in Eastern BOP					
Variety	Actigard	Kasumin	KeyStreplo	Botryzer	Ambitious
GA	144	132	143		19
HE	14	14	14		19
HW	155	158	137		176
Grand Total	323	304	294		214

Copper applications in Eastern Bay of Plenty 2015-16				
Variety	Nordox	Kocide Opti	Hortcare Copper Hydroxide	Coplyzin
GA	213	211	1	2
HE	21	18		
HW	238	227		1
Grand Total	472	456	1	3

2.5 Weather comparisons using anomalies



3.0 Crop Protection

Introduction and summary

Changes in crop protection strategy, especially for Psa management, occurred during the 2015-16 season. Worldwide concerns over the use/misuse of antibiotics/ bactericides in agriculture and the identification of Psa-V strains with streptomycin resistance and tolerance to copper resulted in an industry review of bactericide use and initiated the development of an Integrated Fruit Production system for kiwifruit. A recommendation was made to Zespri Board to reduce the use of bactericides for Psa control.

The Crop Protection Standard (CPS) for 2015 restricted the use of bactericides to two applications only. However, for severely affected orchards third and fourth applications were allowed under a Justified Approval (JA). Growers applying for such a JA were visited by KVH staff to assess the level of Psa infection in the orchards and ensure best management practices were being applied. Kasumin was reintroduced to the CPS in 2015.

Analysis of grower spray diaries showed that Kocide Opti, Nordox 75WG and Actigard were the most widely applied Psa protectants. A grower survey showed that the greatest number of Psa protectant applications occurred in spring.

3.1 Crop Protection Standard- Major changes in Psa controls

2015-2016 Season

- Reintroduction of Kasumin
 - Use allowed until 3 weeks prior to start of flowering (was previously 1 x week)
 - No residues detected at harvest 2016
- Antibiotic use restricted to 2 x applications (3rd and/or 4th allowed under JA only)
- Ambitious rate at 50ml/100L
 - Application window defined as the first part of budphase to control leafspot
- Caplit (CPPU) allowed in CPS as per Ambitious
- Actigard – Sygenta let their soil applied label application lapse – soil applications now off label.

2014-2015 Season

- Removal of Kasumin for Psa – due to residues detected at harvest 2014 on 3 x KPINs
 - timing trials conducted to determine of application window
- Max 4 x applications of antibiotics permitted (ACVM say max 6)

2013-2014 Season

- Introduction of Kasumin (antibiotic) – pre-flowering use only
 - Came into market late – possibly used within 7 days from start of flowering
 - Residues detected at harvest 2014 on 3 x KPINs
- Max 4 x applications of antibiotics permitted (ACVM say max 6)
- Introduction of Ambitious (CPPU) – pre-flowering use only
 - Rate 25-75ml/100L
- Botry-Zen listed as a Psa control product – pre-flowering/flowering use only
- Intent to Spray for KeyStrepto and Kasumin required
 - 10% audited by AgFirst

2012-2013 Season

- Introduction of Actigard (acibenzolar S-methyl)
- Intent to Spray for KeyStrepto required

2011-2012 Season

- KeyStrepto (antibiotic) introduced – pre-flowering use only
 - 60g/100L – max 1.2kg/ha
 - 100% audits required by KVH
- Copper introduced to control Psa

From : Psa update - Changes to CPS as at 08072016.docx

3.2 Key changes during 2015-16 season: Bactericide review

Bactericide review process 2015

Winter 2015 a working group was set up by Zespri as part of the annual review of use of agrichemicals in the Crop Protection Standard to review the use of Antibiotics (bactericides) in the production of kiwifruit.

The drivers behind this review:

- Minimise exposure to the market risk associated with bactericide residues,
- Address impacts of additional incidents of bactericide resistance
- To move toward removal of bactericides.
- Introduce a set of tools and practices which may effectively replace bactericides as IFP or Zespri Pure models are developed.
- To offer growers clear and timely advice as to what their options will be for the growing season ahead.

Results of the review

Findings of streptomycin resistance and reports of copper tolerance further necessitated the development of control strategies that are less reliant on agrichemicals.

A recommendation was made to the Zespri Board to plan to start to reduce reliance on bactericide use in the control of Psa. The recommendation included the development of an Integrated Fruit Production (IFP) programme for Psa Management to be developed over the next 3 seasons.

The Board accepted the recommendation, and also to review this annually until bactericides can be removed from the programme.

Think tank workshop

In addition to the review a think-tank workshop was held to get ideas from the wider industry, science community and relevant stakeholders.

As part of an IPM/IFP approach, Justified Use of agrichemicals is required. An Orchard Psa IPM Strategy (OPIS) form was developed which growers were required to fill in. This is now compulsory for any grower who wants to apply bactericides.

There was also a process implemented because of the restriction to two applications of bactericides, whereby growers had to submit a Justified Approval form if they wanted a third application. Those growers who applied a third bactericide were visited by KVH during the spring to determine whether

those growers were experiencing increased Psa pressure and give support and guidance on orchard management techniques.

From: Bactericide review process 2015.docx

Resistance to Psa control Products

The potential for Psa bacteria to develop resistance to control products has been a concern for KVH and the industry since Psa was discovered in NZ.

For this reason, a monitoring and testing programme has been in place since 2011 which tests Psa bacteria for any signs of product resistance.

Results:

- streptomycin-resistant Psa was first identified in April 2015 and has since been detected on a small number of orchards across three growing regions.
- Psa bacteria with resistance to copper were identified in mid-2015 and recent rounds of monitoring and testing have shown an increase in the number of samples with low levels of copper resistance.
- While the level of resistance identified is still well below the concentration of copper in a spray tank (when applied at recommended rates), the development is concerning.

KVH has been actively working with the affected growers to reduce both the impact of Psa on their orchard, and the potential to spread the resistant bacteria to other orchards.

KVH has developed a 'Best Practice Guide' for growers to help limit resistance developing on orchards and is working with the New Zealand Committee on Pesticide Resistance to develop a national resistance management strategy.

In addition to the resistance monitoring programme, Otago University, Massey University and Plant and Food Research are undertaking studies looking at the genome sequence of Psa and how the bacteria are evolving on orchards. All these researchers have identified the presence of additional genes that they believe are associated with copper and streptomycin resistance in Psa. A PCR based test has been developed to detect the two genetic types of streptomycin resistance. However, copper resistance can be due to a larger number of genes, meaning it is difficult to develop a rapid test for this.

From: Psa year in review 2015 16 draft.docx

Resistance Monitoring from 1st July 2015 to 30th June 2016

Samples were collected from Te Puke, wider Bay of Plenty region, Coromandel, Poverty Bay, Northland and Whanganui region. The table below summarises the positive finds out of 99 KPINS. The numbers denote the number of KPINS identified with resistance.

Date	Region	Streptomycin resistance		Copper resistance	
		rpsL	StrA/B	0.64mM	1.28mM
Oct 2015	Te Puke	3*	4*	6	1
Dec 2015	Whakatane		3		
	Te Puke	1			
March 2016	Te Puke		1	12	
	Coromandel		1	1	
	Whakatane		4	3	
	Opotiki			1	
	Kerikeri			1	

**1 Te Puke orchard had both types of streptomycin resistance present, plus copper resistance at 0.64mM.*

Streptomycin resistance in December 2015 was confirmed by MPI at levels greater than 1000ppm (higher than field rate). Levels of copper resistance are still at levels lower than field rate. Even though copper resistance was not detected in the December 2015 round, it can be seen to be increasingly detected in March 2016 (from 7 to 18 KPINS). Streptomycin resistance has varied between 4 and 7 KPINS.

From : Resistance Monitoring from 1st July 2015 to 30th June 2016.docx

Review of orchards applying more than two bactericides in 2015. December 2015

Objective

To summarise the main observations from visits to orchards that applied 3 or more bactericides this spring.

Background

As part of the revised Zespri Crop Protection Programme for bactericide use in 2015 it was agreed that all growers who wished to apply bactericides needed to complete an "Orchard Psa Integrated Pest Management Strategy form (OPIS) and submit this to Zespri. The window for bactericide applications was from budburst to 21 days prior to flowering for Kasumin and 7 days prior to flowering for KeyStrepto. Any growers who wished to apply more than two bactericides to their orchard were required to apply for Justified Approval (JA). Growers who were granted a JA were subject to a visit from KVH to review Psa management strategy on their orchard.

This season Zespri received 37 JA requests for a 3rd bactericide application and none for a 4th application, 35 of these went on to apply a 3rd bactericide. Last season 120 orchards applied a 3rd bactericide and 29 of these went on to apply a 4th application.

Region	No. KPINS visited
Opotiki	5
Edgumbe / Whakatane	9
Waihi / Katikati	5
Tauranga	2
Te Puke	4
Maketu / Pongakawa	6
Waikato	4
Total	35

Observations

- The vast majority of orchards visited had significant Psa pressure this year and many had suffered significant loss previously from Psa.
- In a few cases the grower had limited Psa pressure and were taking a cautious approach to their Psa-V spray programme this year.
- There was a high awareness around the need for care with bactericide use and all growers had included the third bactericide because they believe there was a genuine need for it.
- Many of the orchards visited were defined as challenging sites. Winter cold was believed to be a contributing factor to the Psa pressure in the majority of orchards. For some poor drainage was also a factor.
- In all cases the use of bactericide was part of a much wider comprehensive spray programme. In all cases coppers were being applied and in many cases the programme also included Actigard and or Ambitious.

- Most growers were following a recommended spray programme provided by their Pack-house or orchard advisors.
- Three orchards visited had suffered from hail which prompted an early bactericide application.
- In the majority of cases growers had an active Psa cut out programme as part of their Psa management programme. For some the need to focus on more cut out was discussed.
- Improved male management also needed consideration on some sites.
- Many of the Hayward orchards visited had suffered from severe budrot in previous years.
- The overall level of leaf spot and budrot seen was less than seen in previous years. The practice of girdling for budrot has been picked up by the majority of Hayward growers visited.

Points for Discussion

- Bactericides are still an important part of the Psa-V control program especially on challenging sites.
- Growers visited believe they need ongoing access to bactericides and depending on the season this could involve more than two applications.
- KVVH will continue to support availability of bactericides to growers with Psa pressure and encourage responsible use.
- Zespri has begun the development of an Integrated Fruit Production system (IFP) for the Industry. It is hoped this may help reduce the reliance on bactericides over time.

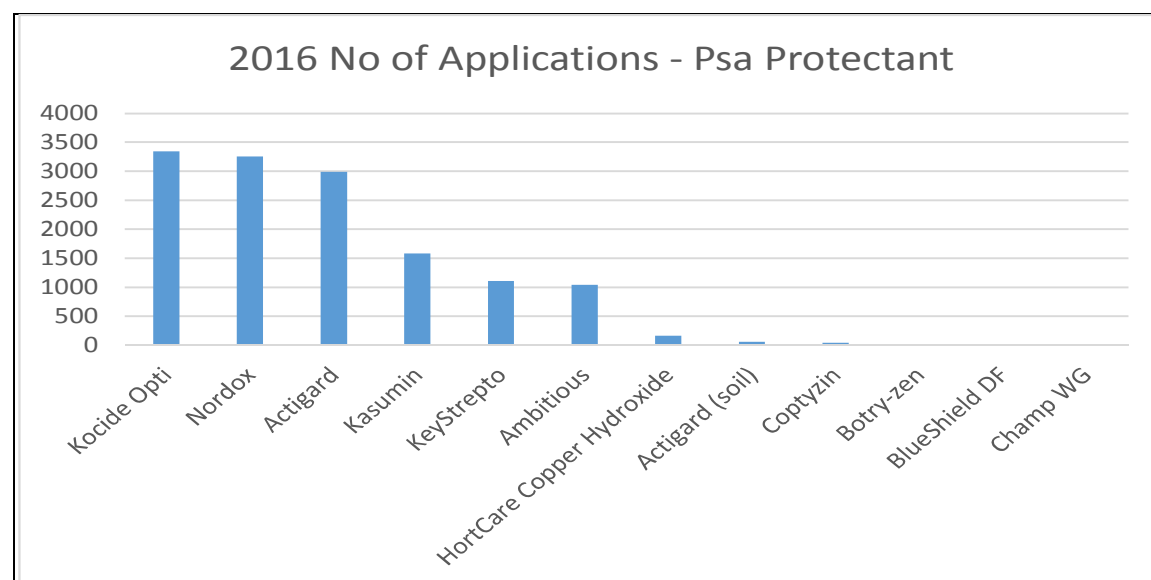
From Review of orchards applying more than two bactericide in 2015.pdf

3.3 Management using agrichemicals

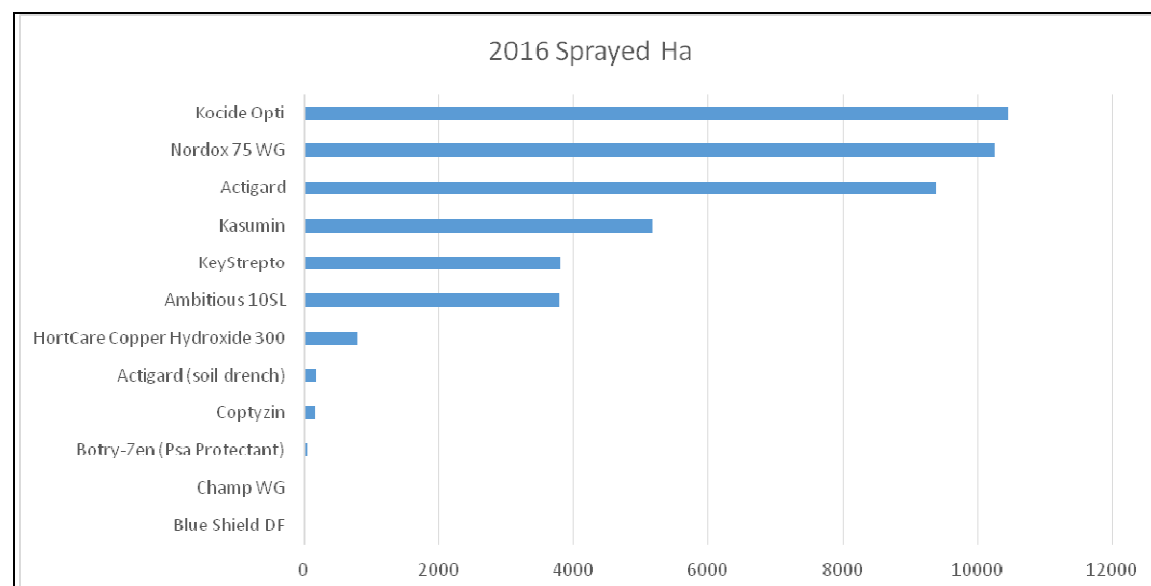
General results from survey and spray diary records

97.9% KPINs applied agrichemicals to control Psa-V. (KVH statistics)

Agrichemical use all varieties and regions

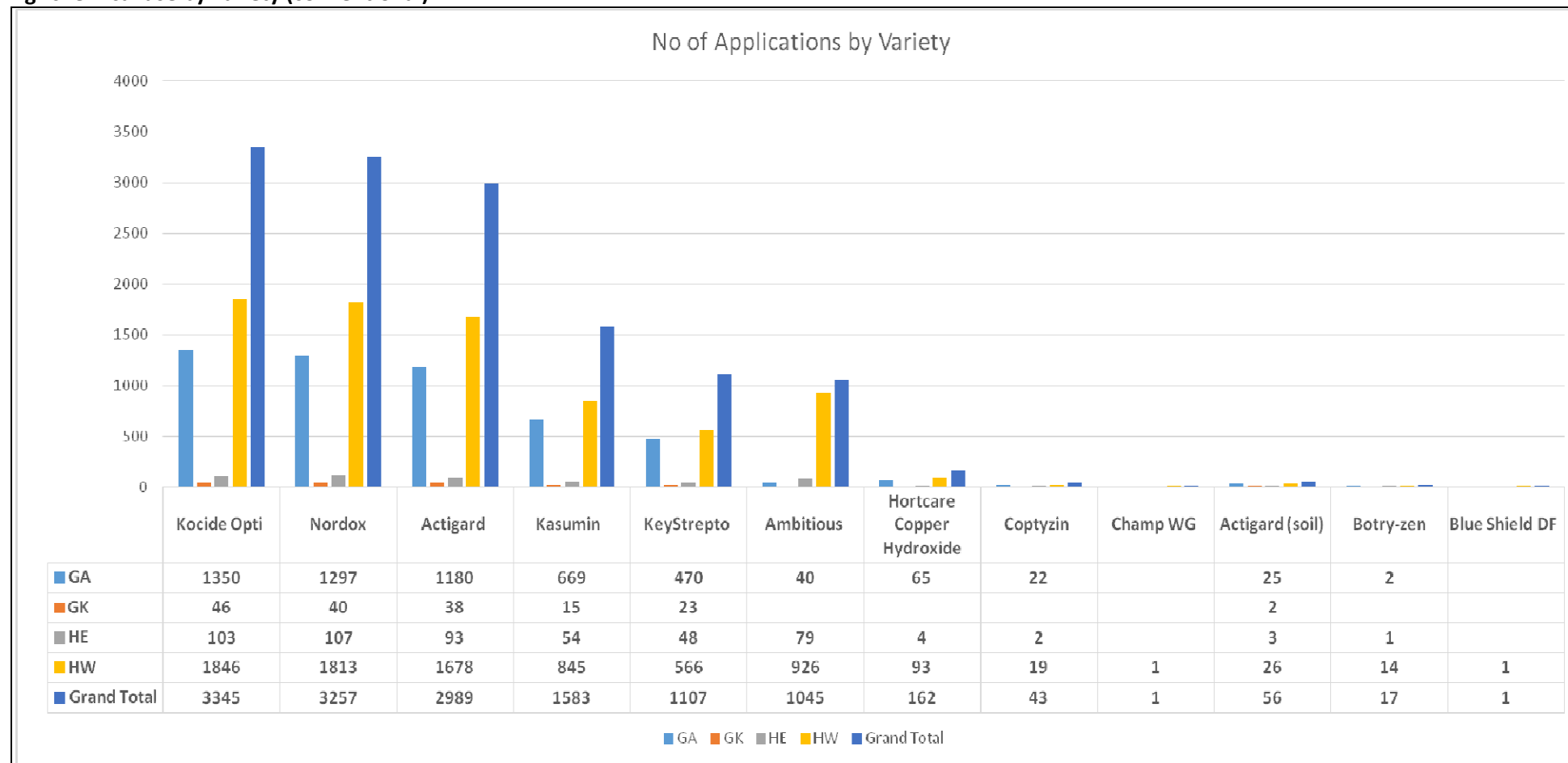


From: 2016 Psa Protectant Spray Use Analysis.xls



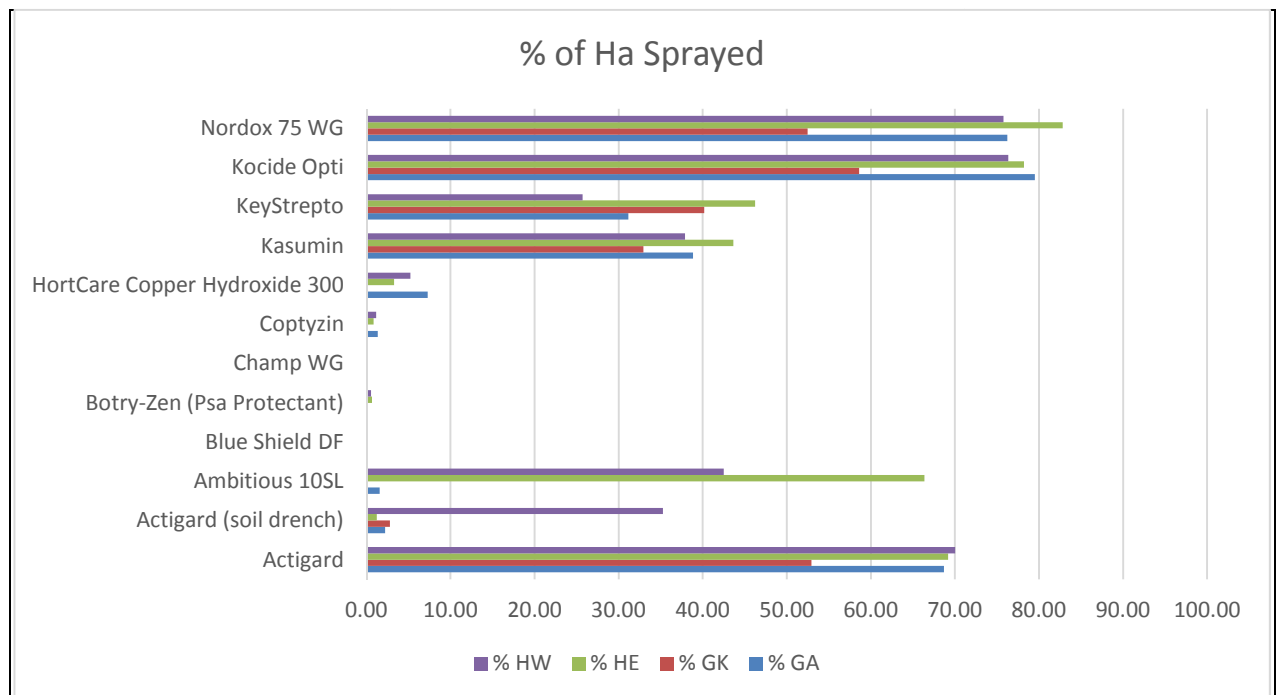
From: 2016 Psa Protectant Spray Use Analysis.xls

Agrichemical use by variety (conventional)



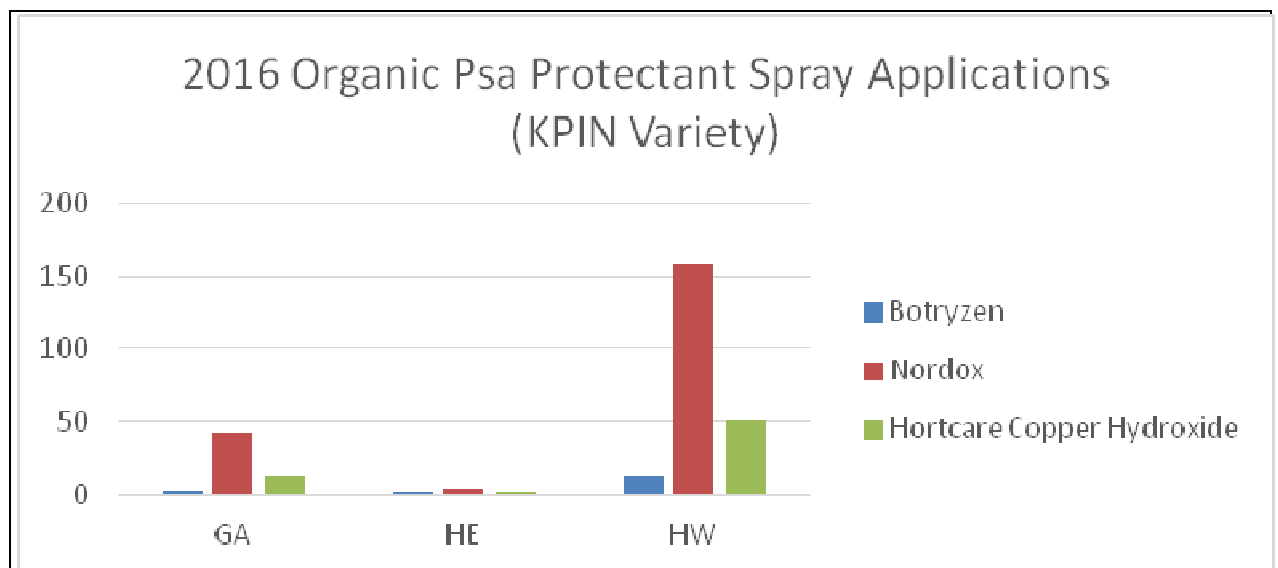
From 2016 Psa Protectant Spray Use Analysis.xls

Agrichemical use by variety (conventional)



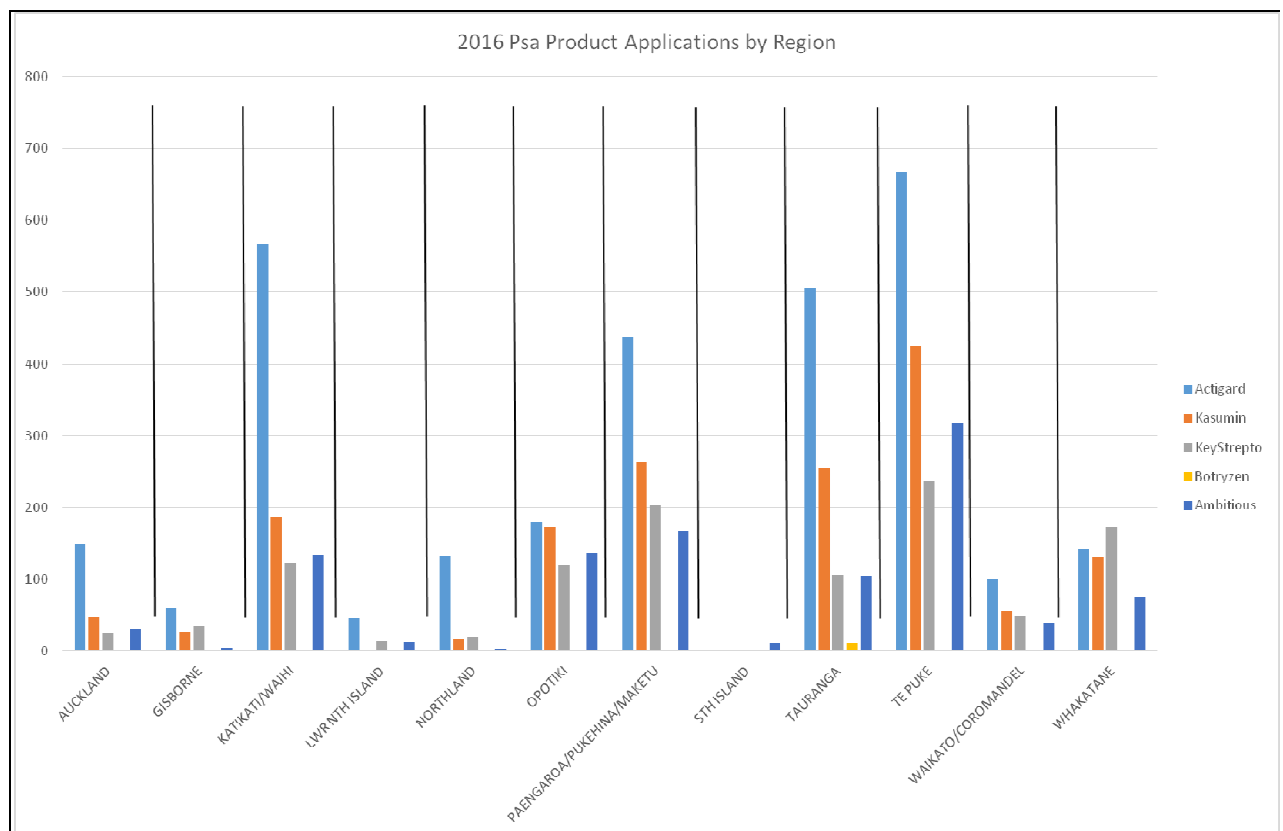
From 2016 Psa Protectant Spray Use Analysis.xlsx

Agrichemical use by variety (organic)

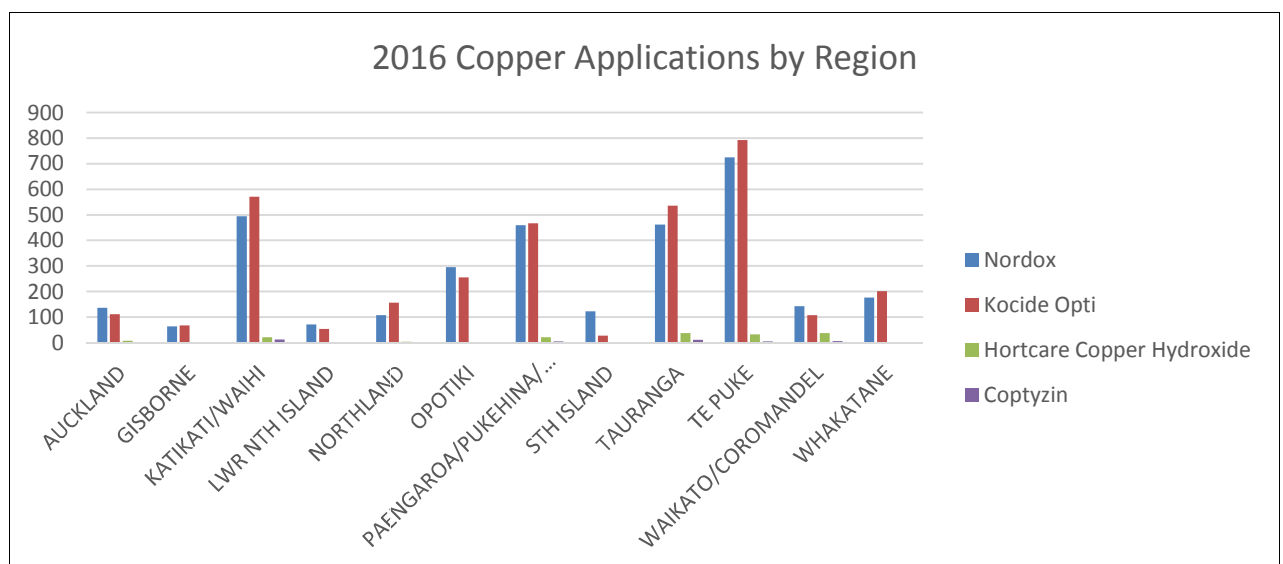


From 2016 Psa Protectant Spray Use Analysis.xlsx

Agrichemical use by region



From Psa Spray Data 2016



From Psa Spray Data 2016

4.0 Industry activities and communication plans

Introduction and summary

Zespri and Kiwifruit Vine Health (KVH) both provided support and advice to growers on Psa management throughout the period according to the season. Advice was given through orchard visits, field days, crop protection forums and grower workshops and via Zespri and KVH bulletins, websites and publications such as Zespri Kiwiflier, NZ Kiwifruit Journal. KVH developed a Psa-V Seasonal Management Wall Chart. Most meetings and field days were held in the Bay of Plenty. However, the Crop Protection Forums toured all growing regions and all growers were able to access published information.

Key messages from KVH included best practice to limit potential for resistance to Psa control products including the ongoing need for good hygiene practices, regular cut out of Psa symptoms and use of products at label rates.

Key messages from Zespri were for growers to maintain vigilance for Psa throughout the year; to maintain protective sprays and develop healthy canopies in winter, being aware of pruning only in dry weather. In spring growers were given a strong message to reduce reliance on agrichemicals, especially bactericides. Messages were also focused on management pre and post flowering, and on managing male vines. In summer the key message was the importance of spring trunk girdles on Hayward vines. Autumn messages were focused on protecting scars after harvest and managing orchard environment to reduce cold.

Most growers were managing the key issues identified as contributing to severity of Psa impact on their orchard. However, of those reporting issues with poor shelter or heavy soils less than 50% were taking steps to manage these. Spring girdling is a practice that is adopted by less than 50% of growers who reported the practice as being relevant to their orchard.

4.1 Zespri lead Psa-V activities

Industry meetings

Date	Meeting
June 2015	Focus Orchard Network (FON) field days: Psa management discussions with growers
24 June 2015	Orchard Productivity Centre (OPC) Tech Forum- antibiotic use
19th August 2015	Zespri Psa Integrated Fruit Production Think-Tank
31 August to 11 September 2015	Crop Protection Forums: with growers
10 September 2015	Psa Research Strategy meeting
October 2015	FON field days: Psa management discussions with growers
1 October 2015	Psa Workshop
28 January 2016	Psa Tech Forum
9 February 2016	Psa steering group meeting.
February 2016	FON field days
1 June 2016	Research meeting: current research programme review
June 2016	FON field days

4.2 KVH lead activities and communications

Communication of best practice advice of Psa control has remained a KVH focus.

KVH key messages included:

- best practice to limit potential for resistance to Psa control products including the ongoing need for good hygiene practices,
- regular cut out of Psa symptoms
- use of products at label rates.

The development of a Psa-V Seasonal Management Wall Chart was well received by growers.

Spring grower meetings were held in Te Puke and containment and exclusion regions. The purpose of these meetings was to emphasise the value of reducing risks to Not Detected orchards. Messages also included key measures to reduce spread of Psa-V on positive orchards.

In addition to KVH regional meetings the team regularly attend the OPC FON field days and supported Zespri Crop Protection Road Shows to promote Psa best practices and answer grower questions.

One-on-one meetings with growers in areas where Psa pressure continues to have a significant impact on production were held. These included growers in Kerikeri, Ardmore, Waihi, Waikato, Whakatane and Whanganui.

35 orchards who applied a third bactericide were visited by KVH to review overall Psa management practices and discuss cultural practices to reduce the dependency on bactericides. KVH also visited orchards where Psa product resistance had been identified.

From Psa year in review 2015 16 draft.docx

4.3 Zespri Communications

Summary of key messages by season and topic given to growers through meetings, field days and Zespri publications.

Winter 2015

Psa crop protection

Continue to monitor for Psa regularly, especially before bud-burst, and remove secondary infection promptly. Blow torching of cankers will help to lower inoculum from exudate.

Ensuring good spray coverage of leaf scars will help prevent Psa infection in the leaf fall period. If leaf fall is protracted multiple sprays may be required to maintain coverage. *Kiwitips and OPC Tips Psa messaging June, July and August 2015*

Maintain a protective copper cover for Psa control through winter. A copper application before and after winter pruning is recommended. Observe recommended timings for application of budbreak sprays in relation to copper sprays. *Winter 2015 FON field day- Psa Messaging. From Psa messaging stocktake.docx*

OPC Tech Forum focused on antibiotic use (24 June).

Crop Protection Forums general Psa management messages:

Focus on integrated Psa management with less reliance on agrichemicals (incl. bactericides)

- Requirement to implement an IPM strategy for Psa
- Introduced requirement of OPIS form as a requirement for growers who want to apply bactericides. Must consider and document the unique Psa pressures on orchard.

Psa cultural options include:

- Remove material
- Hygiene
- Canopy management and male management
- Pre-flowering trunk girdle
- See also KVH Psa-V Seasonal Management Wall Chart 2015-16

Agrichemicals should be used wisely

- Alternate modes of action
- Use full label rates
- Ambitious
 - Use 50ml/100L
 - Use in first part of budphase
 - Not recommended on gold varieties
- Actigard
 - Extensive evidence of efficacy
 - Systemic - allow 4–7 days to elicit a plant response.
 - Small number have noticed some reduction in canopy growth, particularly when applied in the early spring growth period
 - Syngenta - first application at 21-28 days pre-flowering
- Bactericides
 - Do not fit Zespri brand
 - Use to knock-down inoculum prior to infection events or after high-risk weather (prolonged rainfall, hail or storms).
- KeyStrepto
 - Can be applied until 7 days before flowering (male or female) during budphase
 - AI nozzles and suitable adjuvant MUST be used (drift-reducing early, super-spreader later on)
 - Consider bees – prepare the orchard
 - Alternate with other Psa control products
- Kasumin
 - Reintroduced this season
 - Can be applied until 21 days before flowering (male or female) during budphase
 - AI nozzles and suitable adjuvant MUST be used (drift-reducing early, super-spreader later on)
 - Consider bees – prepare the orchard
 - 48 hour REI applies
 - Alternate with other Psa control products

Crop Protection Forums (31 August/11 Sept) (Bactericide review)

Vine management and Winter pruning

Ensure good vine health and performance and minimal variability. The combination of higher yields, Psa and its associated control options is placing stress on vines. Refer to 'Managing Stressed Vines' KiwiTech Bulletin. *Kiwiflier August 2015- Dealing with Stressed vines*

Develop an evenly spaced canopy of high quality wood that will require minimal summer intervention. Time winter pruning activities to drier periods. Treat larger wounds with a wound

dressing that contains a bactericide. Consider fine mulching and the use of digesters to accelerate break down of pruned plant material (Psa-V can survive in winter prunings on an orchard floor for up to 15 weeks). *Winter 2015 FON field day- Psa Messaging*

Removing late growth and opening up dense areas will help reduce Psa expression in spring and facilitate spray coverage. *Kiwitips and OPC Tips June and July 2015*

Ensure optimal flower numbers by considering wood quality, lower than average predicted winter chill, and flower bud loss from Psa. Growers who didn't trunk girdle in February will also have less return bloom. *Kiwitips and OPC Tips June and July 2015*

Environment management

Improving soil drainage in wet areas and ensuring drainage of cold air will assist in preventing spring Psa symptoms. Improving shelter to prevent cold air entering your orchard and/or trimming up the bottom 1m of natural shelter to allow cold air to drainage may have significant benefits in spring. *Kiwiflier July 2015 - Minimise Spring Psa infection now!*

Spring 2015 (September to November 2015)

Budbreak

Be vigilant for signs of Psa exudate as sap flow starts because these point sources can become the origin of significant volumes of inoculum. Remove cankers by cutting, burning or scraping. Paint any open wounds. Refer to Psa-V secondary symptoms and exuding stumps flowcharts available on the KVH website. Act swiftly to remove cankers when there are only a small number of isolated cases. Target a final copper application at winter rates close to budbreak. Commence a comprehensive Psa protection program at budbreak. Spray to reduce inoculum loads prior to high risk weather events. Use the KVH risk model to assist in identifying those conditions. *Kiwitips and OPC Tips Psa messaging September 2015, From Psa messaging stocktake.docx*

Psa Management and control during spring growth

Spring and the pre-flowering period are key infection times. Apply a combination of proven products on a regular basis to improve control e.g. Coppers, Actigard, Key Strepto. Kasumin.

- Apply before risk periods. *Also in November 2015 FON field day*
- Follow Zespri/KVH protocols for bactericide use.
- Focus on pre-flowering sprays to prevent flower bud infection on Green varieties.
- Alternate direction of travel to improve coverage.
- Treat cankers to prevent inoculum spread.
- A trunk or cane girdle 3-4 weeks days before flowering is likely to provide good control of budrot in Green varieties. Leaving 10 vines ungirdled to test effectiveness is good practice. Look on the Zespri Canopy for an assessment protocol.

Other resources were: [Psa webinar – Options for Psa control](#)

October 2015 FON field day; From Psa messaging stocktake.docx

An application of copper and Actigard immediately preflowering will assist with Psa protection during flowering when spray opportunities are limited. Use coppers at the full summer rates for example Nordox 75WG is 37g per 100l and Kocide Opti is 70g per 100L.

KeyStrepto and Kasumin appear to have some limited reach back effect so there is benefit in applying after the event if it was not possible before.

Allow five days between copper and oil sprays and three days after oil before applying copper to minimise the risk of phytotoxicity. Target the leader area (use Massotti nozzles or a handgun for maximum coverage). *Kiwitips and OPC Tips October 2015 From Psa messaging stocktake.docx*

Management during and after flowering

Psa is still active, particularly on colder sites. Renew copper coverage after completing work in the male and female canopies. Maintain vine to vine tool hygiene Also in *Kiwitips and OPC Tips November 2015*.

Use a wound protectant or copper spray on the major cuts. *Kiwitips and OPC Tips October 2015 From Psa messaging stocktake.docx*

Early Chieftan flowers can be collected for pollen, without impacting on pollination. Ensure flowers are not collected from vines with Psa symptoms.

An application of copper and Actigard immediately pre-flowering will assist with Psa protection during flowering when spray opportunities are limited. Botryzin has a limited label claim for Psa. It may be a useful product to use over flowering if wet weather is expected (follow label recommendations). Continue to use coppers at the full summer rates for example Nordox 75WG is 37g per 100l and Kocide Opti is 70g per 100l.

Organic growers should focus on Psa control (copper) pre-flowering and scale control (oil) immediately post- flowering if challenged with copper/oil intervals. *Kiwitips and OPC Tips November 2015, From Psa messaging stocktake.docx*

Managing male vines

The ideal male vine needs to be a highly compatible variety, provide plenty of flowers at the right time, take up minimum space but be well distributed across the orchard and **finally not provide a source of Psa within the orchard**. A fully spurred up male is best so address the vine structure first. To minimise risk around Psa follow KVHs best practice guidelines. *Kiwiflier November 2015- Its male pruning time*

Managing males

- Remove obviously Psa infected canes and wood – round one
 - Round 4 ~ April - This is a crucial one from a Psa perspective
 - M33 appears more tolerant of Psa than M91 but timing varies from year to year , site to site and some data suggests M91 may give larger fruit in Gold3 so maintain both varieties if possible
 - Chieftan (and M56) are much superior to Matua from a pollination perspective and probably with respect to Psa tolerance as well. Re-graft any Matua now or in winter.
- November 2015 FON field day; From Psa messaging stocktake.docx*

Summer 2015-16 (December 2015 to February 2016)

Maintain Psa control sprays over summer.

Until canopies stabilise in midsummer, continue to use coppers at the full summer rates prior to infection events or following periods of orchard work. (e.g Nordox 75WG is 37g per 100l). *Kiwitips and OPC Tips December 2015, January 2016 and February 2016*

Minimise risks associated with copper use by applying under good drying conditions, using recommended summer rates and using in conjunction with other proven products. Apply a

protectant spray immediately after a hail event. *Kiwitips and OPC Tips January 2016 and February 2016. From Psa messaging stocktake.docx*

Correct trunk girdling

Increase fruit size of Hayward and Green14 by trunk girdling approximately four weeks after fruit set. *Kiwitips and OPC Tips December 2015*

Girdling too deep increases the risk of Psa so monitor staff closely and use a girdling knife if possible. Refer to Kiwitech bulletins N46 Trunk Girdling pictorial. Also in *Kiwitips and OPC Tips January and February 2016*

Girdling - Technique is important

Applying a girdle correctly is crucial if the full benefit is to be obtained and negative effects avoided. Too shallow will result in wounds not healing and receiving no benefit from the girdle, going too deep can result in girdles not healing before winter producing poor growth in spring. Increased Psa symptom expression has also been associated with girdling too deep. Ensure tools are cleaned between vines. If using a chain clear the woody material prior to immersing in the sterilising media to preserve the life of the steriliser. A spray with copper solution is considered good practice. *Kiwiflier January 2016 From Psa messaging stocktake.docx*

Do not girdle sick vines or vines with secondary Psa symptoms. Pick a dry period, sterilise girdle tools between vines and protect girdle wounds with repeated protectant sprays. *Kiwitips and OPC Tips January 2016 and Kiwitips and OPC Tips February 2016*

Autumn is a key time for Psa infection.

Cooler, wetter autumn conditions favour disease development and spread. Fruit stalks and leaf scars, immature late growth, and wounds due to frosts and storms, provide possible infection entry points to vines at this time of year. Actions taken during this period will influence the severity of symptoms in the subsequent spring.

Maintain coverage of protectant sprays. At least one postharvest Actigard® application should be considered where Psa infection has historically been a concern. Growers should ensure fruit stalks are protected with proven products such as copper and Actigard® to minimise autumn infection in all varieties. Ensure leaves are actively photosynthesising if applying Actigard®.

Males require intensive management in autumn to minimise risk of Psa infection and maximise flowering next spring.

Resources: [Autumn Psa Protection in gold Kiwifruit](#) NZ Kiwifruit Journal March/April 2015 February 2016 FON field day. *From Psa messaging stocktake.docx*

Autumn 2016 (March to May)

Autumn is a high risk period maintain controls

Autumn infection leads spring expression.

Evidence/ further guidance:

- Cooler, wetter autumn conditions favour disease development and spread.
- Fruit stalks and leaf scars, immature late growth, and wounds due to frosts and storms, provide possible infection entry points to vines at this time of year. Note –autumn infection may not express visually until the following spring.

- Psa-V severity will be worse in seasons/regions when winter is colder and early spring is wetter.

Autumn 2016 Psa Messaging Tech forum discussion Also in: Kiwiflier April 2016 - Don't forget the post-harvest sprays

Understand your orchard –weather stations, monitoring temperatures

Mitigate against the extremes of frosts

Consider options to warm up your orchard. Under-vine shelter may trap cold air. Many orchards lift under-vine shelter through winter for cold air drainage.

Plan frost protection and monitor weather conditions. Water vs fans should be site dependant.

Consider orchard drainage issues

Questions at Tech Forum: What is the effect of different temperatures and the duration of temperatures in G3 on the spread of Psa. Is frost a cause of Psa due to entry points? Or does it affect existing Psa present in the plant?

Autumn 2016 Psa Messaging and Tech Forum Psa, 28 January 2016

Revisit your Psa orchard hygiene management plan for all activities leading up to and including harvest, as it is a time of high people and machinery movement during a period of increased infection risk. *Kiwitips and OPC Tips March 2016*

Autumn is a high risk period of Psa infection so control sprays should recommence if there have been limited applications over summer. Minimise risks associated with copper use by applying under good drying conditions, using recommended summer rates and using in conjunction with other proven products. Apply a protectant spray immediately after a hail event. Remember copper has a 7 day preharvest interval so application can continue into the harvest period. *Kiwitips and OPC Tips April 2016. Also similar message Kiwitips and OPC Tips March 2016 and Kiwiflier April 2016*

Post-harvest Actigard

Time for 2 applications. Up to four applications of Actigard can be applied to orchards over one season –i.e. from harvest to harvest. Reapply three weeks later if canopy conditions allow. The vine's defence system is thought to be activated for three weeks with the peak activation at two weeks. Repeat applications in this time may heighten protection. Ground applications are still possible via JA but not promoted because it is off-label.

Autumn 2016 Psa Messaging Tech forum discussion

Growers should ensure fruit stalks are protected with proven products such as copper and Actigard® to minimise autumn infection in all varieties. Ensure leaves are actively photosynthesising if applying Actigard®. *Kiwiflier April 2016 - Don't forget the post-harvest sprays. Also similar message in Kiwitips and OPC Tips April 2016 and Autumn 2016 Psa Messaging Tech forum discussion*

Questions at Tech Forum: Is there any work going on with what Actigard is actually doing to the plants? And are there potential other products that work the same?

Protecting fruit stalks is definitely an Actigard application; protecting leaf scars is not. Is Actigard being taken up through other entry points? *Tech Forum Psa, 28 January 2016. From : Tech Forum Notes.docx*

Accelerating leaf fall

A 1.25kg copper sulphate with a good copper programme throughout the year may mean you are close to your maximum copper budget

Question: Urea – will it affect your return bloom? *Tech Forum Psa, 28 January 2016*

Check all varieties for Psa infection and remove any dead material from the orchard. If leaf fall is protracted, multiple applications of copper may be required to maintain coverage of the fresh leaf scars. *Kiwitips and OPC Tips May 2016*

Protect vines through winter.

Paint large pruning cuts.

Strung Canopies: Apply protectant prior to bringing canes down. Apply Actigard™ and copper four to seven days prior to lowering canes. Avoid excessively acute angles with G3. Elicitors and copper will minimise infection risk. Applications to dormant vines or cut-off stumps are unlikely to be effective. *Autumn 2016 Psa Messaging Tech forum discussion; From OPC TECH Forum: Tech Forum Psa Autumn 2016.pdf*

Be particularly cautious when using your sprayer to spray both harvested and non-harvested vines. Traces of non-approved products in the tank or from spray drift could result in unacceptable fruit residues. *Kiwitips and OPC Tips April 2016*

Manage male vines

Remove soft upright non terminating growth in males to maintain light on spurs and reduce likelihood of Psa infection. Refer to KiwiTech Bulletin N69 Male Management. *Kiwitips and OPC Tips March 2016. Also in: Kiwitips and OPC Tips April 2016 From Psa messaging stocktake.docx.*

Males: In all varieties tissue damaged in winter can become infected. Late growth is most easily damaged by frost (-2°C) or wind. If frost is severe enough (-4°C) even well hardened canes can be damaged. Matua is more susceptible than Chieftain, M91 more susceptible than M33.

- Continue trimming rounds through autumn and winter.
- Remove, button stub or tie down high growth to maintain a low, flat, open canopy. Ensure late growth is removed prior to periods of high-risk autumn and winter weather including frosts. *Autumn 2016 Psa Messaging Tech forum discussion*

Grafting with Psa

2012 trial in a heavily infected orchard showed ~66% success. Vines remained free of symptoms until late spring 2013

- Consider grafting across to more tolerant varieties, including males. Notch-grafting is an option. Source budwood in compliance with KVH Protocols.
- Consider grafting four scions onto mature stumps in situations where Psa-V symptoms have been high and where established trunks are available for re-grafting.
- Grow suckers to provide additional grafting options, particularly if blocks have been previously infected with Psa-V.

Autumn 2016 Psa Messaging Tech forum discussion; From OPC TECH Forum: Tech Forum Psa Autumn 2016.pdf

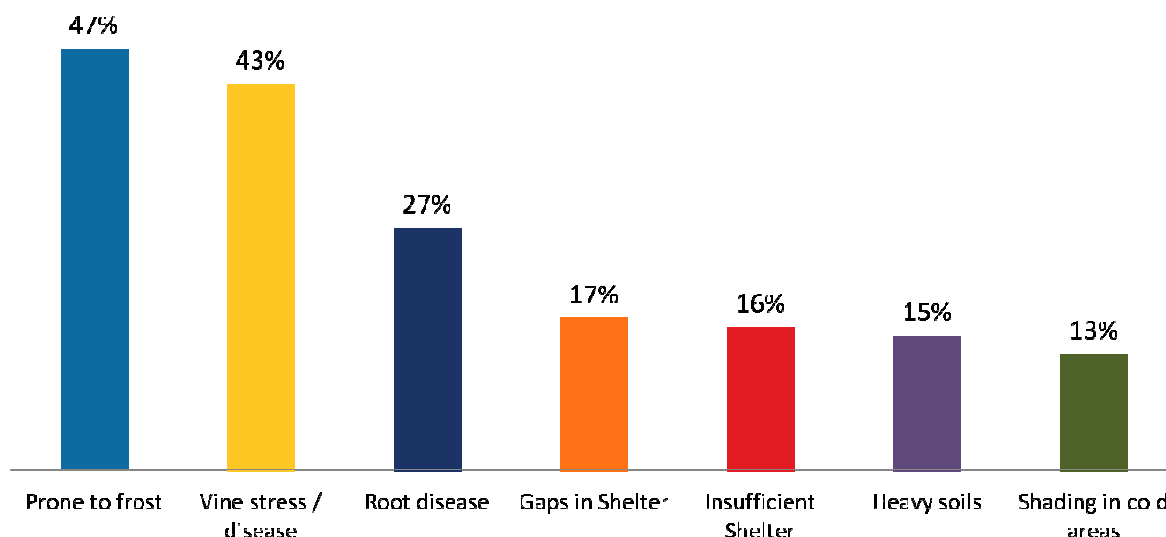
4.4 Review of grower attitudes, knowledge and practices from all regions

Sample information selected from: Orchard Psa IPM Strategy Report 2016.pptx

Orchard environment: Understanding orchard issues

Almost half of all orchards indicate that being prone to frost is an issue and 43% have issues with vine stress, and disease followed by about a quarter (27%) that have issues with root disease

% orchards with issues as indicated. Sample: n=1300



From: Orchard Psa IPM Strategy Report 2016.pptx

Grower actions in response to orchard issues.

Prone to frost

Of those prone to frost 91% have installed/use frost protection; 44% taken action to improve cold air drainage.

Vine stress/disease

Growers use foliar sprays to manage vine stress on 92% KPIN's reporting vine stress issues; 80% growers identify and manage vines with symptoms of stress and disease.

Root disease

Root disease is perceived to be a significant problem for orchards in Hawke's Bay and Poverty Bay. 91% of growers with issues manage vines showing symptoms of root disease.

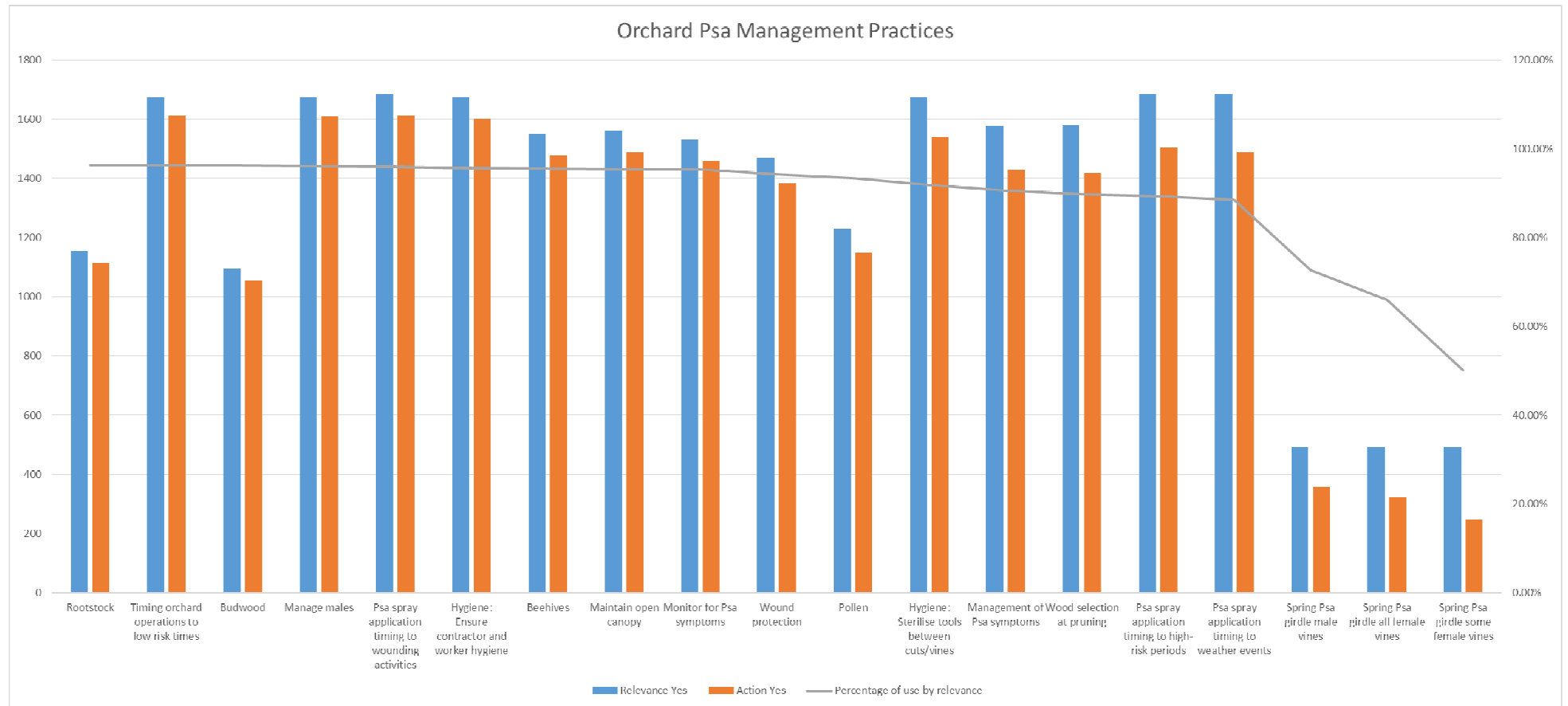
Gaps in shelter and insufficient shelter

70% of growers with properties having issues with gaps in shelter, plan to fill in those gaps; 38% plan to install under vine or overhead shelter. Of those with insufficient shelter, 44% plan to erect boundary or block shelter.

Heavy soils

77% of orchards in Hawke's Bay and Poverty Bay reported having problems with heavy soils. Of these 28% plan to address drainage issues and 22% use or plan to apply organic matter annually.

Psa Management Practices: number of orchards where growers indicate a management practice is relevant and number where action is taken.



From Elly Sharp in Orchard Psa Management Practices.docx

5.0 Innovation and Development

Introduction and summary

Early in the season Zespri held a think tank to discuss the development of an Integrated Fruit Production system to reduce reliance on agrichemicals, and especially bactericides, in kiwifruit production. A decision was made to revise and re-launch the Kiwigreen programme. Further reviews identified that further research into Psa biology, epidemiology and effective management are required to support the development of an IFP programme.

The Psa Steering group recommended that research projects need to move from short term, broad focus approach to fewer, multiyear projects. Four research programmes were prioritised:

1. Systemic Psa infection and management of the endophytic population
2. Growing G3 economically in a Psa environment
3. Understanding Psa population dynamics for improved control
4. Understanding the Kiwifruit Microbiome

5.1 Development of Integrated Fruit Production System

Zespri Psa Integrated Fruit Production Think-Tank

Wednesday 19th August 2015

Objective: To develop the framework for an industry-wide Integrated Fruit Production system with Psa as a high priority objective.

Rationale:

Zespri must continue to strive to exceed customer and market expectations for 'greener' produce to maintain its market premium. In addition there are potential risks which could be as significant as Psa which need to be included in risk planning.

Actions:

1. Set up the steering group (directors) and executive team and administration processes.
2. Identify a small number of programmes or practices that can be introduced on a trial basis to a small number of orchards for 2016 season. These are ideas and practices we know that work now but are not widely used.
We need to take all sectors of the community with us if the re-launch of Kiwigreen is to be successful.
3. Look at the present Best Practice on-orchard and see how they can be used to improve normal management practices. These include orchard practices that are successful and KPI's across the industry so that orchardists can make the best use of present practice. The reasons for the success of these practices may not yet be fully understood.
4. Determine areas of critical need or importance where a change in present practice is essential. Determine a course of action to change present practice.
5. Determine the present state of knowledge and understanding across the whole industry so that gaps can be identified and research priorities determined.

At a later stage, the less urgent but still important priorities can be discussed.

Summary of future workstreams

These include (but are not limited to):

1. Research & Science.
Research is needed to get a better basic understanding of Psa before solutions can be developed, thus research should be the top priority.
2. Management
Management tools, training, education and apps should follow research results. However, management ideas based on present knowledge may be ready to promote to industry now.
3. Products
These are aids that are developed, maybe on the back of publicly or privately funded research, probably by suppliers to the industry and will be sold to growers
4. Community
Communication is an integral part of the complete process. It is essential to keep all groups informed, particularly growers as they need to be adopting the changes as they are released to the industry.

From: Zes15 psa ifp think tank 150819.docx

5.2 Psa Research

Psa Research Strategy. September 2015

Following on from the Psa Steering Group (SG) meeting a strategy session was held to identify R&D gaps in the programme and prioritise areas for research. In addition to discussion on R&D protocols five work streams were identified:

- 1) Chemical/ biological
- 2) Detection and Psa Genetics
- 3) Epidemiology
- 4) Management
- 5) New Cultivars

Priority projects were identified for each work stream as below.

R&D Protocols

- Undertake a review of work to date within each research area. Ensure R&D linkage with Francesco Spinelli, other Italian research groups and wider international groups.
- Protocols for testing products within the field need to be standardized, including having a common methodology to ensure Psa infection events through the use of a watering system.
- A metabolomics R&D provider is being identified in New Zealand to assess and develop metabolomics projects.

Chemical/ Biological

- Bacteriocin research is underway but may have reached a road block. An update on this work will be presented at the November SG meeting.
- A literature review of all existing research into leaf microbiology associated with Psa will be commissioned. A PD will be generated for the November SG meeting.
- Endophytes; engage with a wider group including AgResearch and Lincoln University.
- Obtain commercially available compounds identified to date through the metabolomics project which potentially have activity against Psa. An update to be provided at the December SG meeting.

Genetics

- A literature review of the current status of genetic work with regards to Psa including the genes associated with quorum sensing and infection processes.

Epidemiology:

- A review on the work to date is required to ensure all areas are being investigated, especially Psa over-wintering, spring infections, mode of entry in G3; winter orchard management and vine immunity/tolerance.

Management:

- KVH weather prediction model: is this being utilised and is it value for money
- Plastic tunnel system design and efficacy review.
- Best practise for frost protection for Autumn/ winter.

New Cultivars:

- Bryan Parkes to give an update at November SG meeting with regards to New cultivars and in particular, Rootstock Psa tolerant cultivars.

Management of Psa research projects

Report on February Psa steering group meeting. February 2016

Psa Steering group considered alternative approaches to the management of research projects. Past approach has been to support many projects lasting one season or less over a broad range of topics covering both fundamental and applied research. This allowed us to gather information in a relatively short period of time to help neutralise the financial impact of Psa.

Record production figures and high OGR for the industry last season demonstrate this approach supported effective industry response to Psa. However, most growers are aware of the constant threat the bacteria places on an orchard's productivity at a maturity area level, a whole vine level, leader, cane and even flower bud level. Gap analysis sessions with growers last year identified a few more focused areas for future research to fill knowledge gaps.

It is suggested that Psa research focus on multiyear programmes running across 3 or 4 growing seasons. Within these programmes would be individual projects that are synergistic within the programme and form milestones working towards the programme objective. These individual projects would also allow shorter term results to be fed out to the industry.

It is also proposed that each programme has a working group, made up of scientists, industry representatives including growers, to help guide the direction of the programme.

At this stage 4 programmes are proposed. Initial scoping suggests programme budgets may run between \$1.5 to 2.5 million per programme over a 4 or 5 year period. This represents a similar level of investment to the current annual Psa R&D budget.

The four programmes are:

1. Systemic Psa infection and management of the endophytic population
2. Growing G3 economically in a Psa environment
3. Understanding Psa population dynamics for improved control
4. Understanding the Kiwifruit Microbiome

From: Psa Strategy.docx (Sep 2015)

Review of current innovation research programmes for Psa control and resistance management. June 2016

Novel Psa Control products

1. Biopesticides for the control of Psa – Plant and Food Research. Co-funding of MBIE Next Generation Biopesticide programme
2. Persistence of Trichoderma – Bioprotection Research Centre, Lincoln University. Co-funding of MBIE Next Generation Biopesticide programme
3. Marine Bioactives – University of Waikato. Funding of Blue Skies programme and MSc student
4. Novel Elicitors – HortEvaluation. Investigating efficacy and safety of a number of novel elicitors

Resistance Management

1. Resistance Monitoring programme – Hill Labs. Ongoing monitoring programme (previously VLS)
2. Understanding streptomycin and copper resistance and methods to manage them – Plant and Food Research. Funding of Post-doc position (tbc)
3. Prevalence of resistance genes in the environment (Te Puke and North Island) – University of Otago (tbc)
4. Determining functionality of plasmids and ICEs carrying resistance genes - University of Otago (tbc)

Non-Compliance monitoring for Forchlorfenuron (development of a nil residue test)

1. Forchlorfenuron (N-(2-Chloro-4-pyridyl)-N'-phenylurea) (CPPU) Aerial Imaging and Metabolites on Hayward:- detecting the Zespri-non-compliant use of CPPU without the reliance on the presence of CPPU residue.

Impact of Actigard on vine health

1. Impact of spring application of Actigard on Gold and Green varieties. Plant and Food Research
2. Impact of Autumn Actigard on components of yield in Gold3 kiwifruit. Eurofins

From: Research current state.doc

Source Documents and References

1.0 The production season and impacts of Psa

Psa year in review 2015 16 draft.docx

Orchard Psa IPM Strategy Report 2016.pptx

Production Summary 2016_all varieties.xlsx

Additional OPIS graphs.docx

NIWA Climate summaries: <https://www.niwa.co.nz/climate/summaries/seasonal>. Accessed August and September 2016.

Zespri Infographic: Budbreak Kerikeri and Budbreak Te Puke accessed from Zespri Canopy website <https://canopy.zespri.com/EN/grow/opc/infographics/Documents/budbreak-infographic-kerikeri.pdf> Accessed September 2016.

Zespri project: Hayward Documenting the Seasons 2015-2016 (project underway) J Adams.

Psa-V statistics from KVH website: http://www.kvh.org.nz/maps_stats Accessed August 2016

2.0 Reviews of four regions

Weather data were obtained from the New Zealand National Climate Database, via NIWA's Cliflo website, <https://cliflo.niwa.co.nz/>

The results of analysis of the raw data are in the following files:

WeatherSummary_201506to201606_BoPE.xlsx

WeatherSummary_201506to201606_BoPW.xlsx

WeatherSummary_201506to201606_Nland.xlsx

WeatherSummary_201506to201606_WaikAkl.xlsx

WeatherAnomalies.xlsx

NIWA Climate summaries: <https://www.niwa.co.nz/climate/summaries/seasonal>. Accessed August and September 2016.

Psa-V statistics from KVH website: http://www.kvh.org.nz/maps_stats Accessed August 2016

Production Summary 2016_all varieties.xlsx

Psa year in review 2015 16 draft.docx

Orchard Psa IPM Strategy Report 2016.pptx

3.0 Crop Protection

Psa update - Changes to CPS as at 08072016.docx

Bactericide review process 2015.docx

Review of orchards applying more than two bactericide in 2015.pdf

Resistance Monitoring from 1st July 2015 to 30th June 2016.docx

2016 Psa Protectant Spray Use Analysis.xlsx

Orchard Psa IPM Strategy Report 2016.pptx

Psa year in review 2015 16 draft.docx

Psa Spray Data 2016.xlsx

4.0 Industry activities and communications plans

Psa messaging stocktake.docx

Tech Forum Notes.docx

Tech Forum Psa Autumn 2016.pdf

Psa workshop Notes Dec 2015.docx

Psa year in review 2015 16 draft.docx

Bactericide review process 2015.docx

Orchard Psa IPM Strategy Report 2016.pptx
Orchard Psa Management Practices.docx

5. Innovation and Development

Zes15 psa ifp think tank 150819.docx
Psa Strategy.docx (Sep 2015)
Research current state.docx