IPDM for the citrus industry

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Citrus Industry IPDM Extension Program

CT19011 – Report on the Citrus IPDM practice survey, 2022

To obtain benchmark data on integrated pest and disease management (IPDM) practices in the Australian citrus industry, stakeholders were surveyed in 2022. The survey data collected helped to guide the activities and publications for the Citrus Industry IPDM Extension Program to meet on-farm needs.

This report is separated into summaries from NSW DPI, QDAF and DPIRD collaborators, reflecting the data obtained from their respective regions.

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Summary

The survey was undertaken from April to July 2022. Data saturation was achieved in the Riverina, and strong trends were identified in other regions. A total of 110 participants were interviewed nationally. The median orchard area of participants was 60 ha. There was a good representation of a typical family-owned and managed citrus orchard while also gathering data from some larger, corporate-type orchards.

The survey identified pests and diseases of grower concern and participants also rated their perceived level of control. The cultural, biological and chemical practices used to manage the pests and diseases were recorded. The use of crop monitoring and IPDM specialists varied between regions. Rural supply store horticulturists were also important decision-making people for pest management.

Irregular supply of some key beneficial insects and availability of effective, multi-activity insecticide chemistry has resulted in decreased beneficial insect releases. Field days and websites were the most frequent sources cited for additional pest or disease information.

Survey results

Participants

The survey collected data from 110 participants. Most (88%) participants identified themselves as the 'grower' (Table 1 and Figure 1). Almost all (98%) participants worked full-time in the citrus industry (Figure 1). The Australian citrus industry has mostly experienced owners and orchard managers, with many people having likely grown up in the industry.

Table 1. Roles and experience of the IPDM survey participants.

Participant role	Proportion of respondents (%)	Experience (years)
grower/orchard owner/orchard manager	75	28
grower/orchard manager	9	19
orchard manager	9	28
grower/orchard owner	4	23

The 52 Riverina participants surveyed had an average of 33 years of citrus experience, while the 24 Sunraysia participants had an average of 23 years of experience. The size of the orchard managed by the participants varied from 4 to 2,200 hectares (ha). Only 4 respondents represented orchards larger than 500 ha. The median orchard area was 60 ha, so many family-owned and operated orchardists were interviewed (Figure 1).

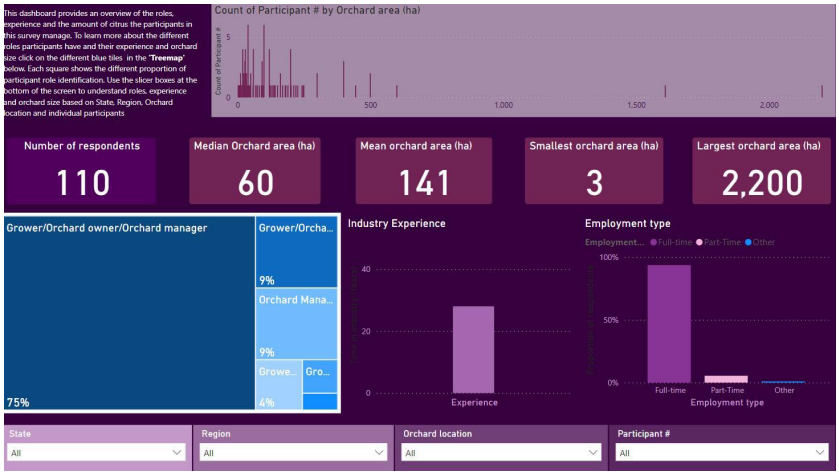


Figure 1. A screen shot of the survey participant dashboard.

Australia-wide, the IPDM practice survey covered 15,678 ha, 61% of the industry by area that Citrus Australia Limited reported in the 2018 Australian citrus tree census. Riverina survey participants collectively manage 5,651 ha of citrus orchard (Table 2). The data from other regions involved more than half of the regional planted area (Table 2).

Table 2. The number of IPDM survey participants per region compared to Citrus Australia Limited (CAL) regional area data from the 2018 Australian citrus tree census.

Region	Participants (n)	IPDM surveyed area (ha)	CAL survey area* (ha)
Riverina	52	5,651	7,648
Sunraysia	24	3,981	5,342
Riverland	11	2,822	5,600
Queensland	16	2,753	4,592
Western Australia	7	471	1,022

The survey participants were chosen to reflect the varietal mix of each region. For example, in the Riverina, most growers have navel orange or Valencia orange as their main variety. In this region, the data collected was representative of the region, with most participants surveyed having either Valencia orange (38%) or navel orange (46%) as their focus crop. Mandarin-focused growers represented 7% of the Riverina survey participants, which is comparable to the Citrus Australia regional plantings data of 5% (Table 3).

Table 3. Number (and proportion) of participants surveyed for each focus variety compared to Citrus Australia Limited (CAL) Riverina regional data from the 2018 Australian citrus tree census.

Variety group	Number of participants for each focus variety	Variety group as a percentage of Riverina citrus plantings (CAL 2018)
Valencia and common	20 (38%)	53%
Navel orange	24 (46%)	39%
Mandarin	4 (7%)	5%
Lemon and lime	3 (<1%)	2%
Blood orange	1 (<1%)	
Grapefruit	0	1%

Figure 2. A screen shot of the market focus for pest and disease management of navel orange growing participants of the IPDM practice survey nationally.

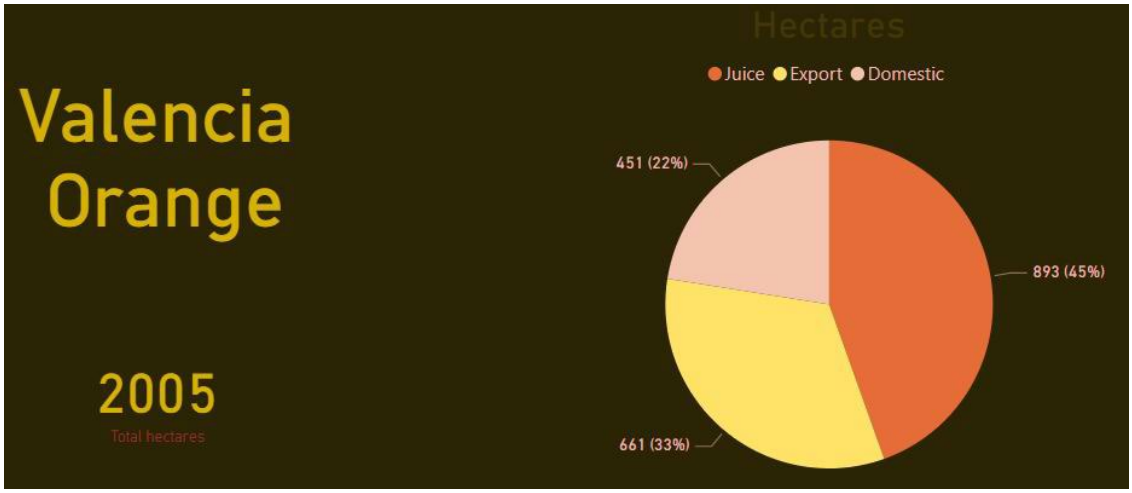


Figure 3. A screen shot of the market focus for pest and disease management of both Valencia orange growing participants of the IPDM practice survey nationally.

The market focus for pest and disease management varied between both varieties and states for the same variety (Table 4). An area of 6,907 hectares of national navel orange plantings was represented (Figure 2). Most (96%) of the navel orange production growers had an export focus for pest and disease management. Valencia orange producers had 33% of the area managed for an export market focus, 22% had a domestic pest management focus, and almost half (45%) were managed for juice processing. Contracted juice fruit has a greater tolerance for blemish and some insect pests than export navel orange production. A Valencia orange grower in the Riverland will likely have a lower tolerance to insect pests like Katydid and Red scale, as they are export focused. In contrast, a contracted juice Valencia orange grower in the Riverina has a higher tolerance for fruit blemishes and pests of quarantine concern (Table 4). This data means the IPDM extension program must consider the differing needs and production constraints of event participants in the different regions nationally.

Table 4. The market focus for pest and disease management decisions for Valencia orange production in differing production regions nationally.

Region	Export (%)	Domestic (%)	Juice (%)
Riverina	25	24	51
Sunraysia	63	9	28
Riverland	85	1	14
Queensland	0	100	0
Western Australia	57	43	0

Knowledge of pests and disease

Participants were asked to rate their knowledge of pests and diseases specific to their region. Responses varied for different pests (Figure 3). A 'degree of concern' was calculated, which the IPDM extension team will use to focus their efforts on the pests and diseases affecting participants (Table 5).

Citrus black core rot has a low degree of concern. Even though 30% of survey participants had no knowledge of the disease, only 5 of the 110 survey participants listed black core rot as a concern. Consequently, limited IPDM extension program resources should be spent on citrus black core rot. Queensland fruit fly, red scale, citrus gall wasp and oriental spider mites are pest examples that require extension efforts. Phytophthora root rot is a disease that extension efforts can also justify resources on (Table 5).

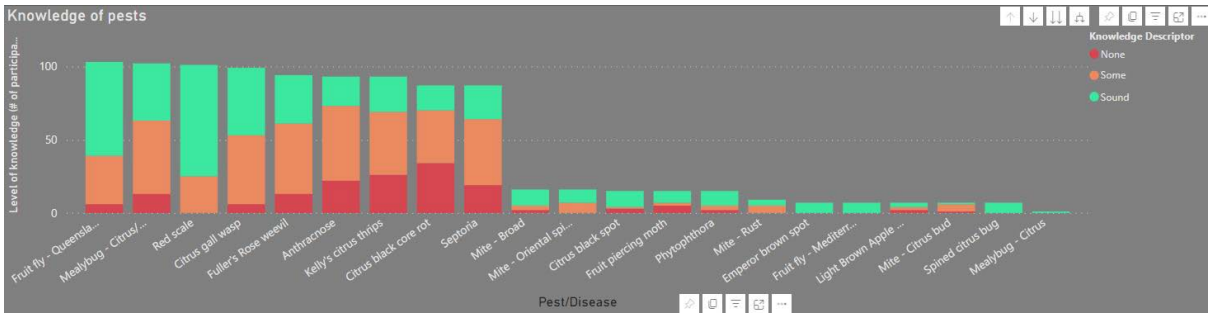


Figure 4. Participant knowledge of pests and diseases.

Table 5. 'Degree of concern' indicates how many participants ranked a particular pest or disease in their top 3 pests of concern against how many people were asked about their knowledge of this pest.

Pest	Degree of concern	Disease	Degree of concern
Red scale	68	Phytophthora	25
Citrus gall wasp	55	Citrus black spot	10
Queensland fruit fly	34	Anthracnose	9
Mealybug/citrus	19	Emperor brown spot	6
Light brown apple moth	16	Septoria	6
Oriental spider mite	10	Black core rot	5

Tri-state – Riverina, Sunraysia and Riverland regions

Andrew Creek, NSW Department of Primary Industries

Pests and diseases of concern

Survey participants were asked, 'Over the past 5 years, what have been the 3 main diseases of concern?'. Most tri-state participants did not list any diseases of concern, which reflects growing citrus in the dry, southern tri-state regions, where a seasonally applied autumn copper spray of good coverage is sufficient to manage citrus diseases currently in the region. Phytophthora root rot was the greater disease concern, followed by Anthracnose and Septoria. Sudden death was listed by 2 of the 52 Riverina survey participants, reflecting the use of Tri22 rootstock compared to the Riverland and Sunraysia.

The tri-state growers were generally quick to nominate 3 pests of concern. Red Scale was listed in each region, yet the level of control was adequate to good.

Riverina

Citrus gall wasp was cited by 42 of the 52 respondents in the Riverina. Alarmingly, 33% of these growers reported poor control, 48% indicated 'adequate control – but could be better ', and only 17% had good control (Figure 4). Citrus gall wasp, red scale and Queensland fruit fly were the 3 main pests of concern in the Riverina (Figure 4). Only half of the Riverina participants that listed light brown apple moth and Anthracnose indicated good control. Riverina growers mostly reported poor and adequate control for elephant weevil. Leaf minor and mealybugs were also pests that concerned Riverina growers.

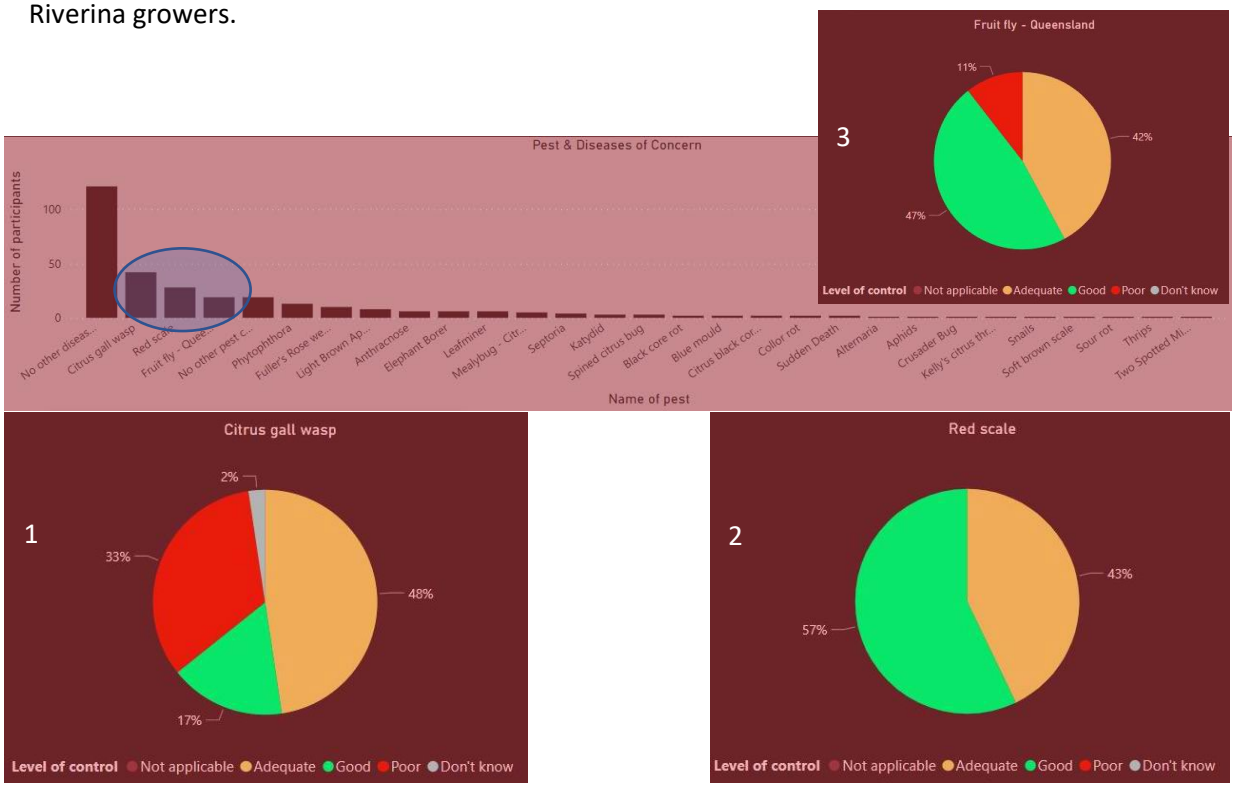


Figure 5. Riverina pests and diseases of concern and the IPDM survey participants' rated level of control.

1 – poor control (unacceptable amount of fruit rejects)
2 – adequate control (okay levels of fruit rejects but could be better)
3 – good control (acceptable amount of rejects)
4 – don't know

Sunraysia

Red scale, Queensland fruit fly, Mealybugs and Light brown apple moth were the pests of concern over the last 5 years for Sunraysia growers (Figure 5). The Sunraysia survey participants generally cited good or adequate control of their nominated pests. Only 16% nominated Citrus gall wasp as a pest of concern, much less than the 80% of Riverina survey participants. Twelve per cent of Sunraysia survey participants listed snails as a concern, and the level of field control being achieved was considered adequate to poor.

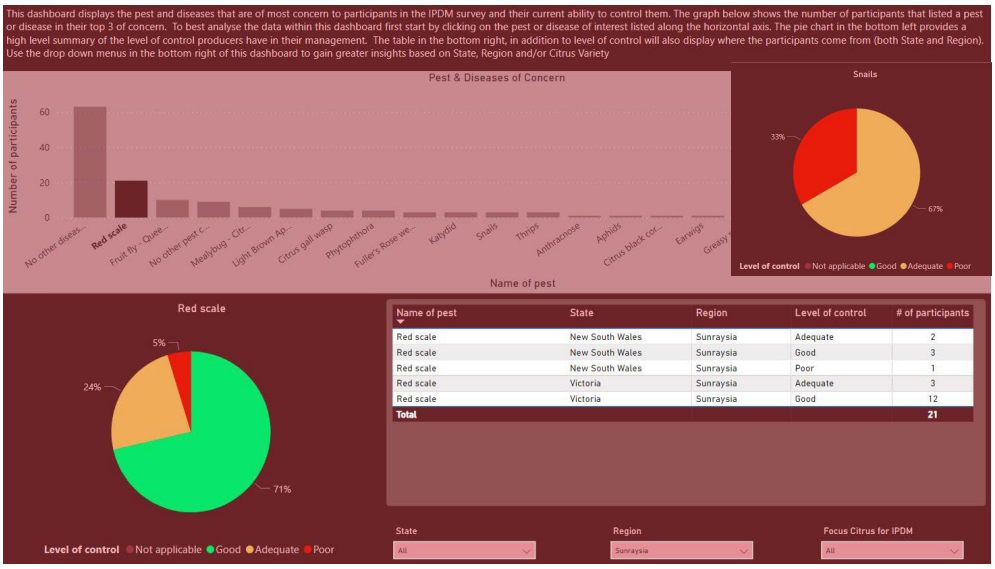


Figure 6. Sunraysia pests and diseases of concern and the rated level of control for red scale and snails.

Riverland

Citrus gall wasp, red scale and mealybug were the most common pests of concern over the past 5 years for the Riverland growers surveyed (Figure 6). Recent management practices must be working, as 78% of the people who nominated citrus gall wasp indicated good control. Red scale control was considered adequate, but growers mentioned a desire for improvement. The South Australian Riverland region has been experiencing Queensland fruit fly outbreaks. Two of 11 respondents indicated that Queensland fruit fly was a pest of concern over the past 5 years, with a poor to adequate level of control. Earwigs were an increasing insect pest in the region.

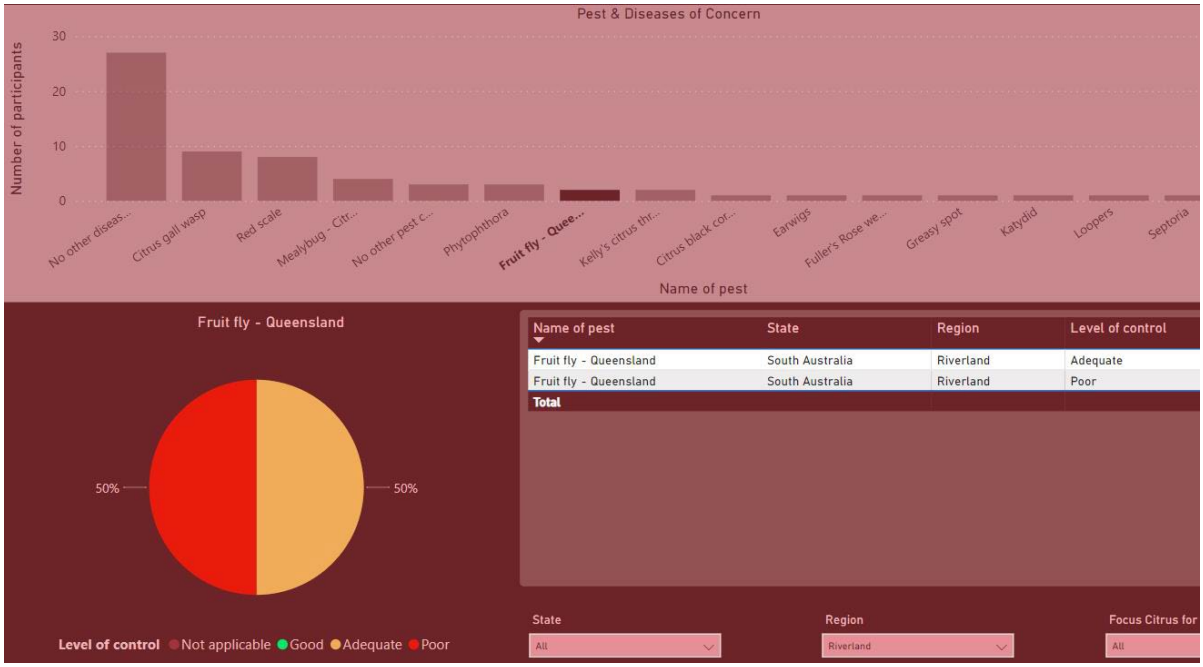


Figure 7. Riverland pests and diseases of concern and the rated level of control for Queensland fruit fly.

Biological and cultural control practices

Most survey participants currently bait spray to control Queensland fruit fly; a few in the Riverina and Sunraysia chose to cover spray.

Decaying fruit is generally not removed from under the tree canopy. Some Queensland mandarin growers removed fallen fruit and a few mixed businesses in Sunraysia that have almond orchard sweepers also did.

Most growers try to minimise dust within the orchard. It is difficult to manage dust during summer in the dry, western production regions of Sunraysia and Riverland. During discussion, participants indicated speed limit signage was used primarily to improve orchard safety, however, reduced dust was a secondary benefit of signage.

Most navel orange blocks were monitored to a protocol for pests (Figure 7), but Valencia blocks were not (Figure 7). This is understandable, considering 51% of the Riverina Valencia orange was managed for pests with a juice market as focus and returns have been low (Table 4).

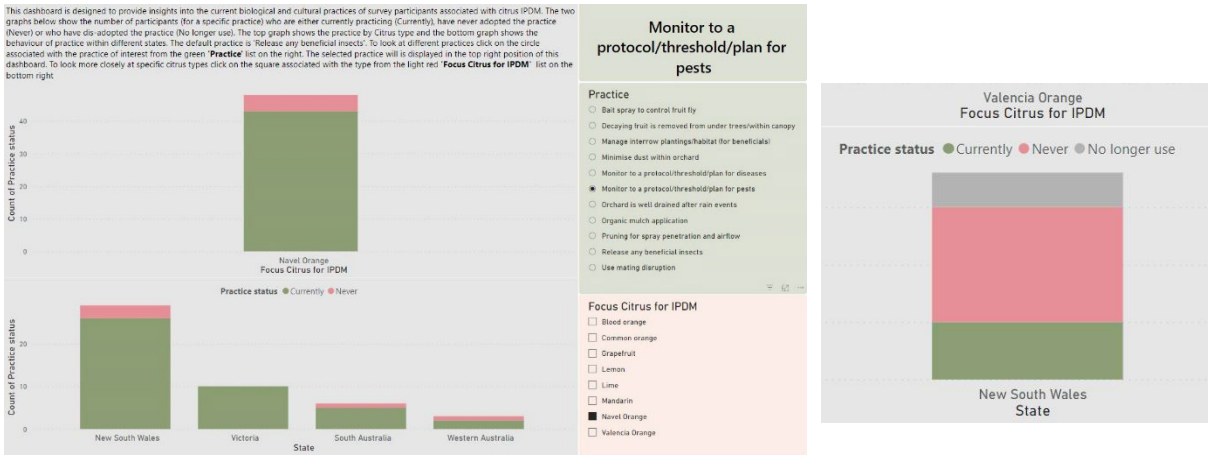
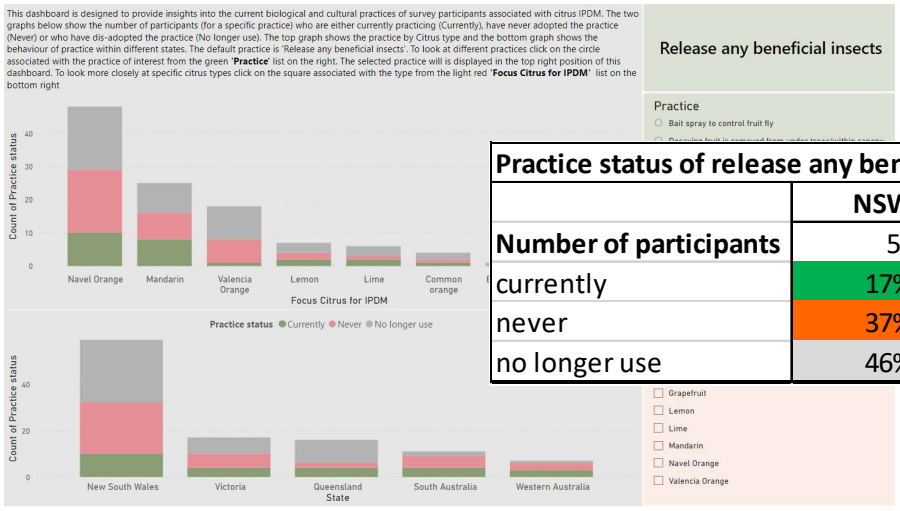


Figure 8. Comparison of navel orange and Valencia orange responses to 'monitoring to a protocol/threshold/plan for pests'.

Survey participants reported navel orange, mandarin and Valencia orange orchards were well drained after rain. Most participants indicated organic mulch was never applied under the tree, while 30% indicated they applied organic mulch under the tree. Some Riverina survey participants reported using composted cattle feedlot manure or chicken shed litter. A Sunraysia participant indicated they 'no longer use' organic mulch due to rising production costs and freight for manure. One Riverina participant discussed spreading straw mulch under the tree with machinery, but due to the increasing cost of freight for bales and the large volume of straw required, they 'no longer use 'straw organic mulch application.

Pruning regulates crop load and helps manage canopy height. We asked about pruning in the context of pest and disease management. All (100%) mandarin, lemon, grapefruit and blood orange growers and 97% of navel orange growers prune for spray penetration and airflow as part of pest and disease management. A third of the Valencia orange and Common orange varietal focus survey participants 'never' prune for spray penetration and airflow.

An equal proportion of respondents (40%) from all citrus focus varieties' no longer use 'or 'have never used' beneficial insects as part of their pest management; 20% indicated they 'currently 'release beneficial insects. Responses were similar for all states (Figure 8).



Practice status of release any beneficial insects			
	NSW	VIC	SA
Number of participants	59	17	11
currently	17%	24%	18%
never	37%	35%	45%
no longer use	46%	41%	36%

Figure 9. The practice status of beneficial insect release as part of pest management for differing citrus varieties and comparison of differing states.

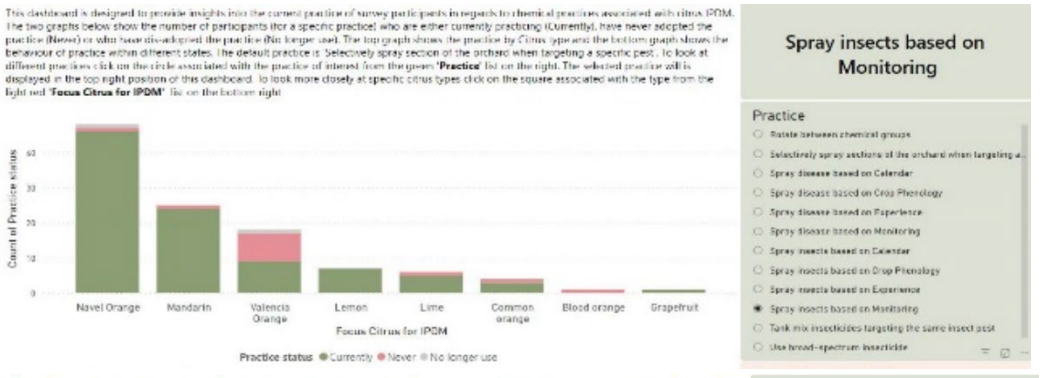
Some tri-state survey participants were questioned about why they 'no longer use 'beneficial insect release as part of their pest and disease management. The responses varied. Many said that systemic chemicals provide good control. Another respondent said, 'The packing shed requirements for minimal blemish are so tight, with the chemicals I use, there is no point releasing beneficial insects'. The cost of beneficials was another reason participants stopped using them. *Aphytis* spp. was the most reported beneficial insect that participants purchased in the past and have since stopped using. Availability of *Aphytis melinus* was minimal in 2021–22 and there was no commercial supply in the 2022–23 season. *Aphytis lingnanensis* was available.

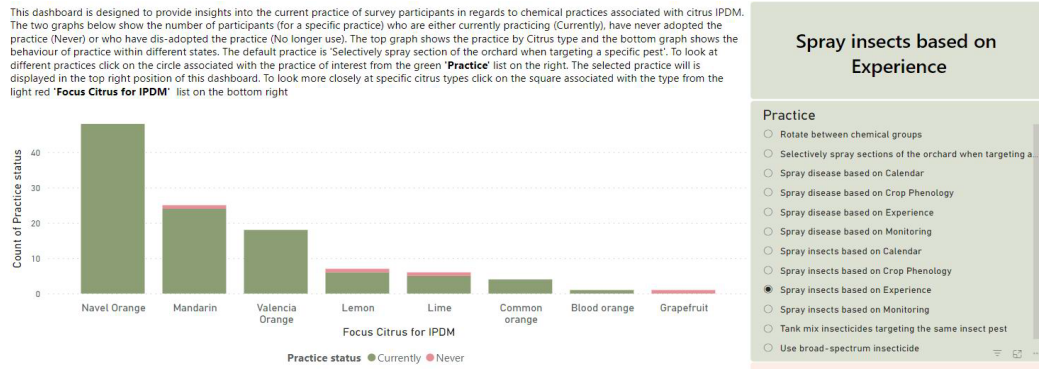
Mating disruption is rarely used as part of pest management, with most survey participants answering, 'never use '. Some (12%) mandarin survey participants indicated they 'no longer 'use mating disruption. One of these participants was questioned further and had used light brown apple moth mating disruption ties and found they were costly to purchase and dispense the ties. Fifteen per cent of navel orange participants reported currently using mating disruption as part of their pest management. Two participants clarified they were currently testing red scale mating disruption.

Spray practices

Monitoring data and grower experience were equally important factors when deciding to spray insecticides (Figure 9). Monitoring data was less important for Valencia participants, with most being contracted juice growers in NSW. Ten per cent of the 110 survey participants indicated they 'no longer' spray insects based on the calendar, and the majority (65%) 'never' spray insects based on the calendar.

However, seasonal pest patterns still influence some growers' decisions to spray. The arid, dry inland production regions historically grew Valencia and navel oranges. Usually, they managed pests and diseases with a ½ rate chlorpyrifos tank mixed with horticultural mineral oil in mid-November and an autumn copper spray. Almost 80% of survey respondents were from the tri-state production regions, and the survey data reflects that, with calendar or season timing of sprays being important for some. Valencia orange and common orange growers did not spray for diseases based on monitoring; an autumn coper spray provides adequate control. Most survey participants relied on experience and calendar-timed sprays to manage citrus diseases. Monitoring for diseases was important in the Central Burnett and Far North Queensland growing regions.





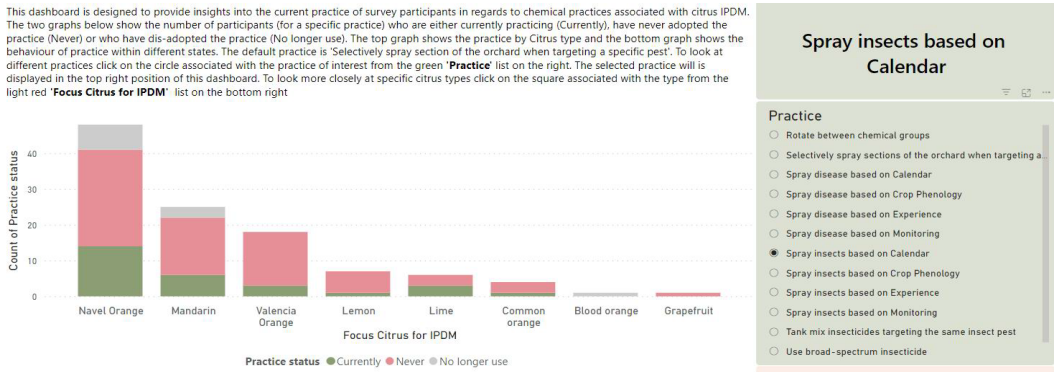


Figure 10. The practice status of 'monitoring', 'experience' and 'calendar' as influencing factors on chemical control spray decisions for pest management of differing citrus varieties.

Chemical rotation

Most (93%) IPDM survey participants currently rotate between chemical groups. The 'never' rotate between chemical group responses were relatively few and from processing orange and lime production. All citrus categories, except limes, indicated they 'never' tank mix insecticides targeting the same insect pest.

Survey participants were asked, 'Do you selectively spray sections of the orchard when targeting a specific pest 'to understand whether people have incorporated a 'hot spot' approach to their spraying. Most (92%) of the Navel orange-focused survey participants selectively sprayed sections of the orchard (Figure 10). Results were similar for mandarin, Valencia orange and lemon, with few growers 'never' selectively spraying.

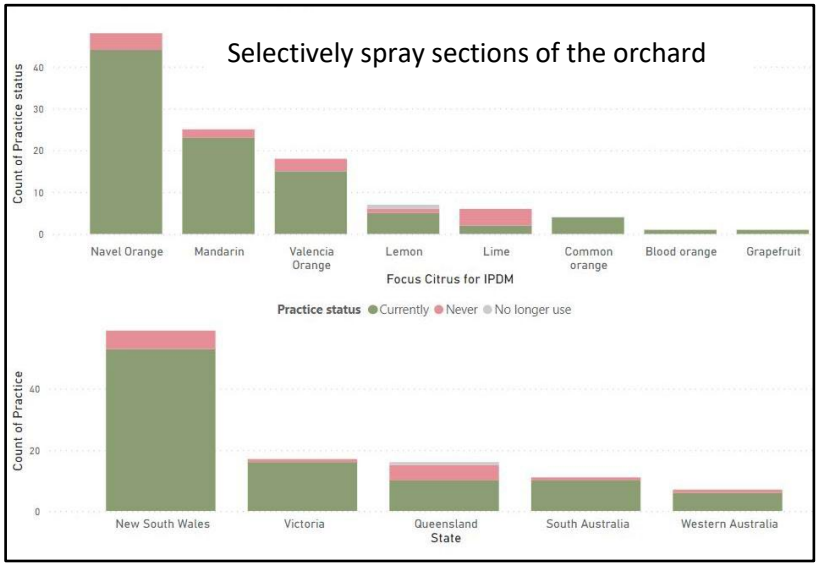
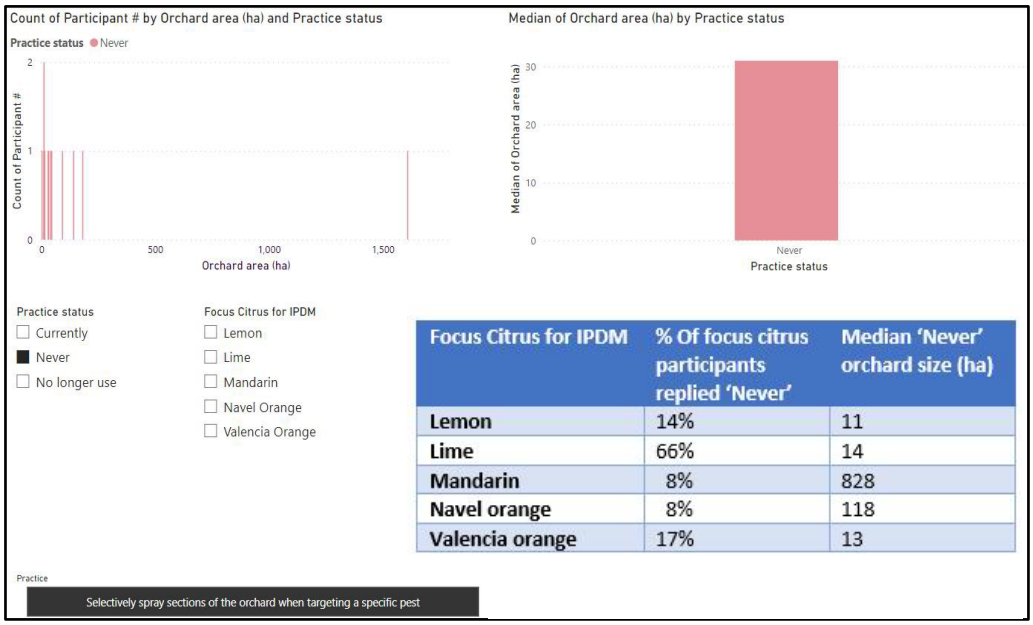


Figure 11. Dashboard showing data on the practice of 'selectively spray sections of the orchard when targeting a specific pest' for differing citrus varieties and state comparison data.

The survey data showed those individuals who selected 'never' for selectively spraying sections of the orchard when targeting a specific pest were mostly from smaller orchards (Figure 11).



Focus Citrus for IPDM	% Of focus citrus participants replied 'Never'	Median 'Never' orchard size (ha)
Lemon	14%	11
Lime	66%	14
Mandarin	8%	828
Navel orange	8%	118
Valencia orange	17%	13

Figure 12. Dashboard showing the median orchard size of orchards from which respondents indicated they 'never' selectively spray sections of the orchard when targeting a specific pest for differing citrus focus varieties.

Those who responded with 'never' were from a new orchard development and not currently cropping. In young orchards, insect pest pressure is reduced compared to a block of mature citrus trees. Hence, pests like soft scale and Citrus leaf miner were likely to be managed similarly across an entire new orchard.

Responses were mixed for the question, 'Do you use broad-spectrum insecticides?' with 70% of survey participants using broad-spectrum insecticides. Broad-spectrum insecticide chemistry is the only registered chemical control option for some insect pests, for example, Katydid, a common insect pest in the southern states. Interestingly 22% of navel orange, 36% of mandarin, 33% of Valencia orange and 33% of lemon participants indicated they either 'Never use' or 'No longer use broad-spectrum insecticide (Figure 12).

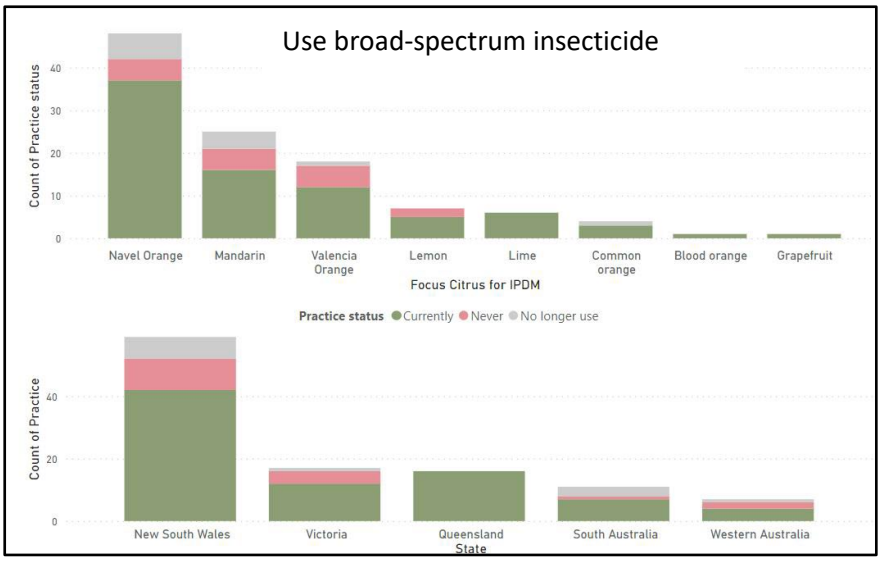


Figure 13. The practice status of 'Use broad-spectrum insecticide' for differing citrus varieties and the practice status compared between states.

Even though 70% of growers indicated they use broad-spectrum insecticide chemistry, they currently also use softer chemistry options (Figure 13).

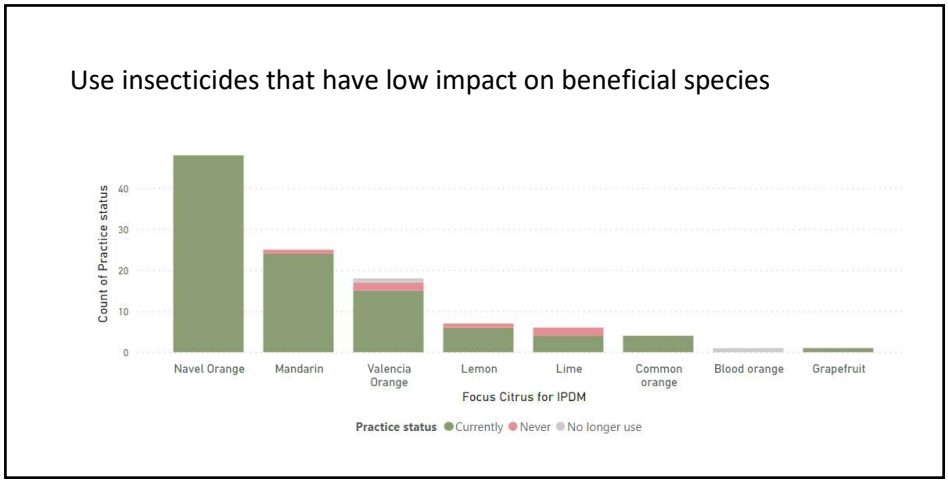


Figure 14. The practice status of 'Use insecticides that have low effect on beneficial species' for differing citrus varieties.

Recent chemistry use data show an intention to use 'softer' insecticide chemistry to preserve natural beneficials rather than actual industry practice. There may also be a lack of industry knowledge on the effects of differing insecticide chemistry on natural beneficials in the orchard. For example, 100% of Navel orange varietal focus participants indicated they use insecticides that have a low effect on beneficial species (Figure 14). However, if we tally the softer insecticide chemistry used by Navel orange growers for lepidopteran pests (i.e. the sum of BT, methoxyfenozide, spinetoram and tebufenozide (Figure 16), compared to the medium-high effect on beneficials chemistry (carbaryl, chlorpyrifos, cyantraniliprole, methomyl, and acetamiprid + pyriproxyfen), it is soft chemistry 18% vs 89% for the broader spectrum chemistry.

Even if we disregard the cyantraniliprole, as an application of this product in export navels was more likely for Fuller's rose weevil, and the acetamiprid + pyriproxyfen for red scale was the more likely target pest, it is soft chemistry 18% vs 66% for the broader spectrum chemistry. Perhaps 66% of navel growers each had Katydid as a pest that required control, and broader spectrum chemistry is the only control option available.

Decision making

Survey participants indicated 'Personal experience' is most important for pest and disease decision-making. Pest scouts or pest and disease experts were most widely used in SE Queensland, Sunraysia and the Riverland. Ninety per cent of Sunraysia participants used a pest scout, whereas in the Riverina, 53% of growers surveyed used a pest scout (Figure 14). Rural supply store horticulturists are important decision-makers for Riverina, Sunraysia and Riverland growers. Government officers, neighbours and friends are rarely used in pest and disease decision-making.

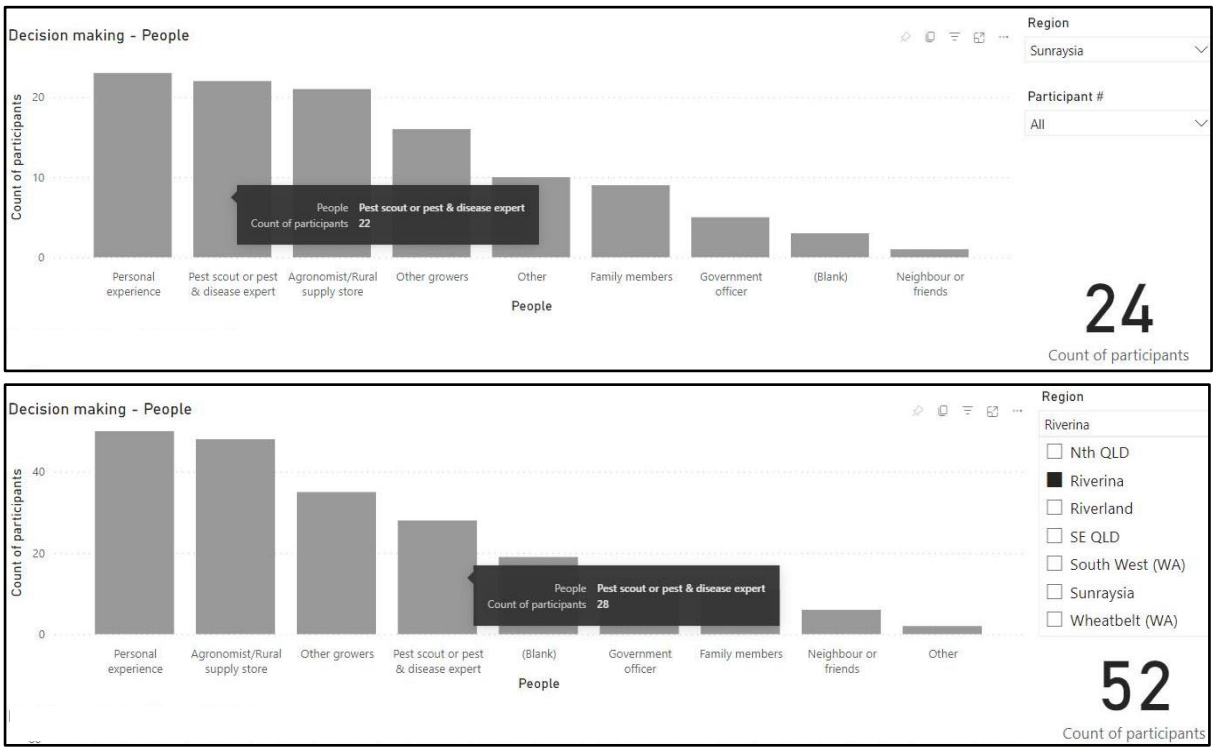


Figure 15. Pest scout or pest and disease experts were used more widely in Sunraysia than the Riverina. Agronomists and rural supply store horticulturalists are equally important decision makers.

A relationship with a good pest scout and or a rural supply store horticulturist is extremely important to citrus growers. Question 11 of the survey asked, 'Where else do you seek information to help make a pest and disease management decision?' Many times, the participant's response reflected how busy Australian citrus growers are. 'I do what the pest scout says' or 'I am too busy, that is why I have a pest scout and 'I do whatever my agronomist tells me'.

Not all participants answered question 11 and perhaps indicated their preference for information generally. Sixty-two per cent of participants indicated field days were a good additional information source to help make pest and disease management decisions. Fifty-four per cent of participants indicated websites were an important information source. One participant mentioned, 'a quick Google search or web sites was a quick way to seek information'. Thirty-one per cent of the

participants surveyed indicated magazine articles, 20% newsletters and only 4% indicated webinars as an additional information source.

Recent chemistry use

Survey participants reported chemical use for pest and disease management for a representative focus variety block in their orchards. Based on their effect on beneficial insects, a score was placed on the different chemistries used by respondents to help us identify potential growers for IPDM demonstration sites. A score of 10, 5 or 1 was used respectively for high, medium and low impact. Insecticide use varies between navel orange growers, and some did not apply an insecticide at all (Figure 15).

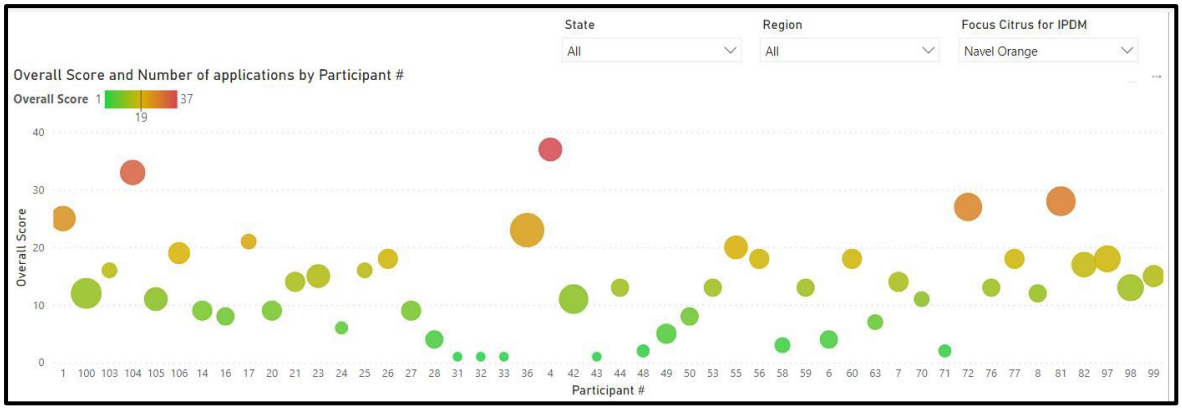


Figure 16. IPDM score based upon chemistry use for the navel orange focus survey participants.

The tri-state chemical use results are summarised in Figures 16, 17 and 18. The data shows the tri-state region extensively uses copper fungicides, spirotetramat and noenicitinoid insecticides. In April 2018, the European Union (EU) voted to restrict the use of 3 neonicotinoid compounds (imidacloprid, clothianidin, and thiamethoxam) to use in greenhouses only to limit environmental risks. The APVMA is currently assessing whether the Australian registered neonicotinoid products continue to meet the safety and labelling criteria in accordance with the Agvet Code.

Spirotetramat (e.g. Movento®) has recently come off patent in Australia. Lower-cost, generic products are likely to become common, and their use will increase. Some insect and mite pests readily develop resistance to chemical products that are applied regularly or used in a manner that is not according to label directions.

Methomyl and chlorpyrifos are used where softer insecticide chemistry options are not available to manage some insect pests. There was greater chlorpyrifos use in Valencia oranges compared to navel oranges, as they have a greater domestic and juice processing market focus. The USA ban on chlorpyrifos residue has restricted the use of chlorpyrifos products in navel oranges. Methomyl use was greater than chlorpyrifos in navel oranges.

Navel orange (Riverina, Sunraysia and Riverland)

Average 2.1 fungicides applied
Average 2.4 insecticides applied
Average 0 miticides applied
Average 0.3 bait spray for QLD fruit fly

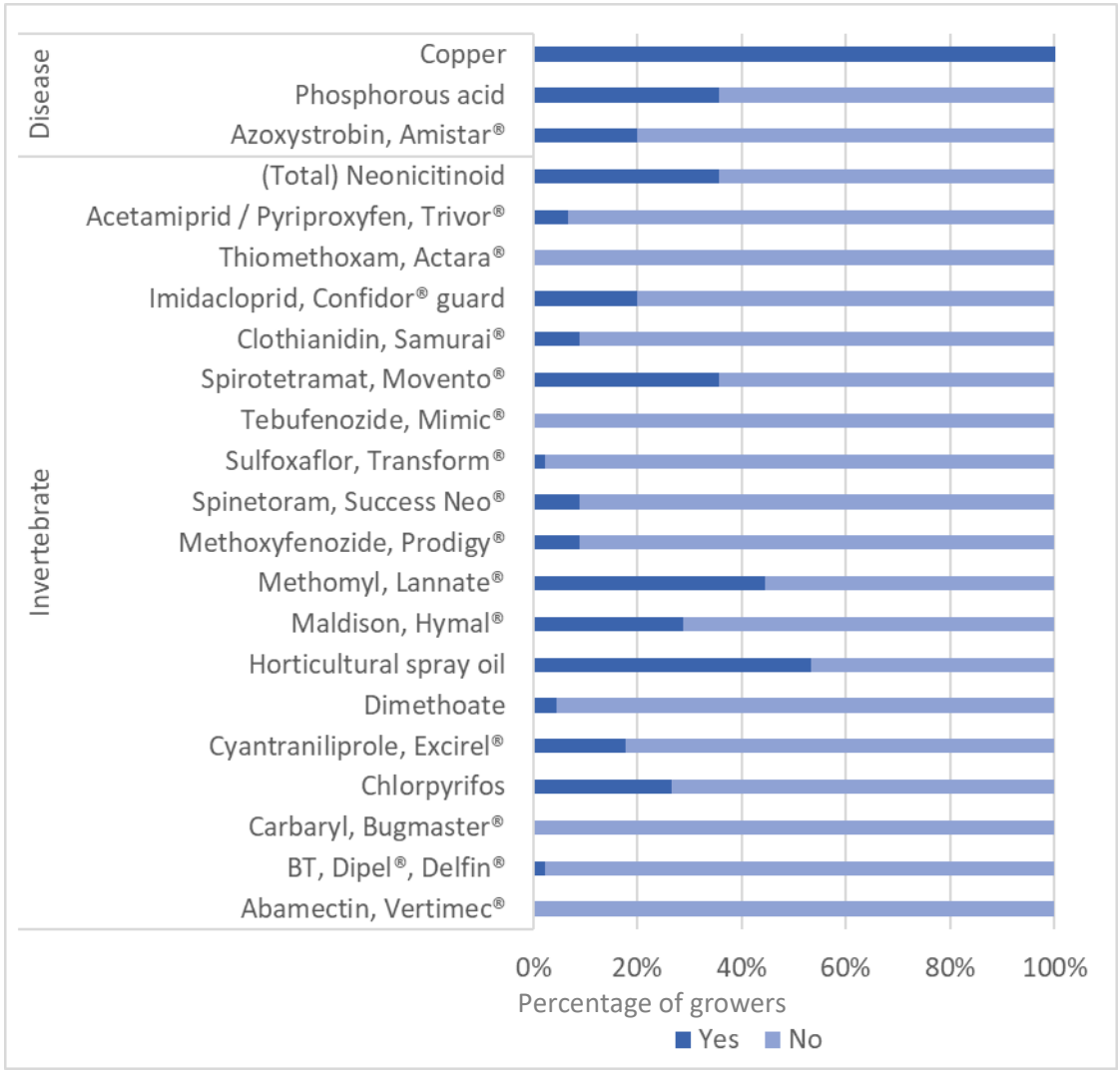


Figure 17. Chemicals used in the 2021–22 season for the 45 navel orange focus variety IPDM practice survey participants from the Riverina, Sunraysia and Riverland regions. Each participant reported chemical use for a representative block on their orchard.

Valencia and Common oranges (Riverina, Sunraysia and Riverland)

Average 1.6 fungicides applied
Average 0.9 insecticides
Average 0 miticides applied
Average 0.8 bait spray for QLD fruit fly

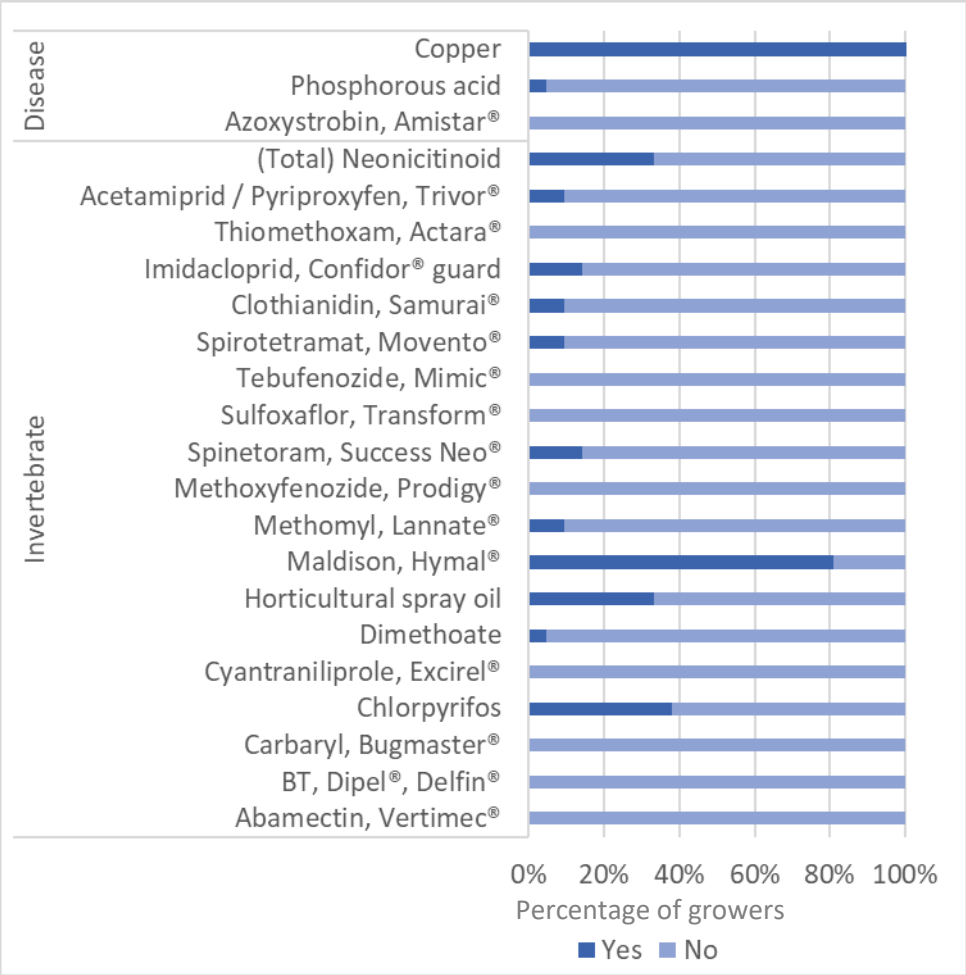


Figure 18. Chemicals used in the 2021–22 season for the 21 Valencia and Common orange focus variety IPDM practice survey participants from the Riverina, Sunraysia and Riverland regions. Each participant reported chemical use for a representative block on their orchard.

Mandarin (Riverina, Sunraysia and Riverland)

Average 1.6 fungicides applied
Average 1.9 insecticides applied
Average 0.1 miticides applied
Average 0 bait spray for QLD fruit fly

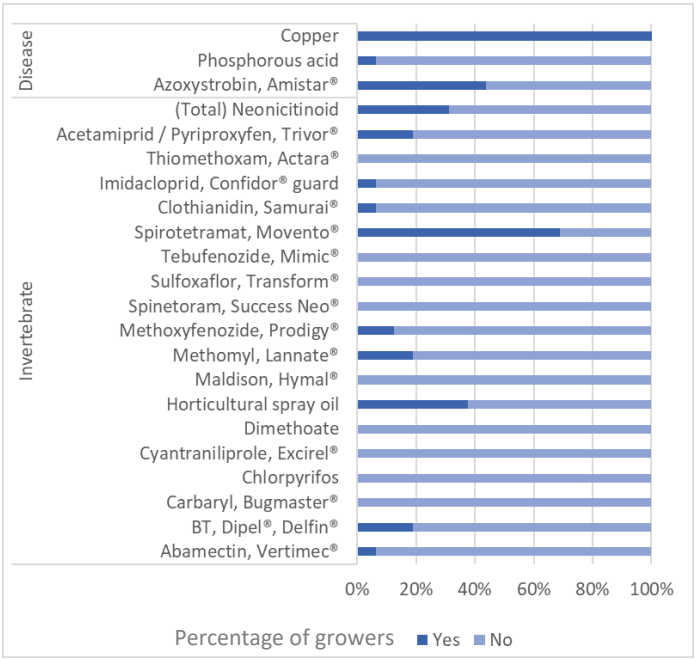


Figure 19. Chemicals used in the 2021-22 season for the 16 – mandarin focus variety IPDM practice survey participants from the Riverina, Sunraysia and Riverland regions. Each participant reported chemical use for a representative block on their orchard.

Chemistry use was higher for grapefruit, limes and lemons than Navel, Valencia and Common oranges. Grapefruit, limes and lemons are predominantly grown in Queensland, where a warmer climate increases the diversity of pests and also the number of pest generations annually. The increased number of wet days, higher humidity and heat greatly increase citrus disease pressure. SE Queensland mandarin growers use more fungicides than southern mandarin production (Figure 19).

Mandarin (SE Queensland)

Average 14.2 fungicides applied
Average 3.2 insecticides applied
Average 2.2 miticides applied
Average 6.0 bait spray for QLD fruit fly

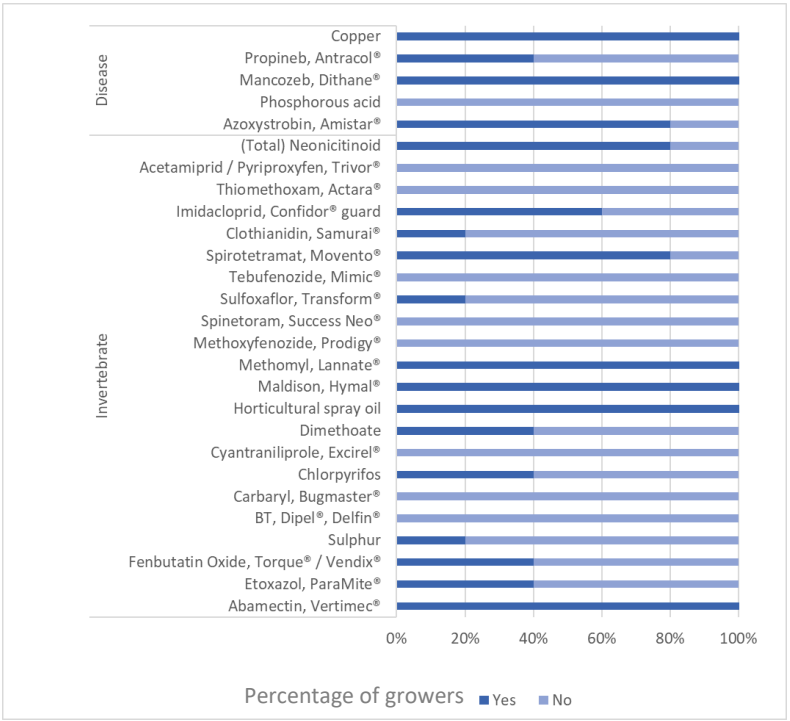


Figure 20. Chemicals used in the 2021-22 season for the 5 – mandarin focus variety IPDM practice survey participants from the Central Burnett region. Each participant reported chemical use for a representative block on their orchard.

North Queensland

Emily Pattison, Queensland Department of Agriculture and Fisheries, Mareeba

Queensland citrus growers were given a survey designed to determine pest and disease concerns. In north Queensland there were 9 survey respondents; one grapefruit grower, one lemon grower, six lime growers and one mandarin grower. This was representative of the north Queensland citrus growers according to a regional industry profile conducted in 2018 by the Queensland Department of Agriculture and Fisheries.

The farm size of north Queensland survey respondents ranged from 3 ha to 1610 ha, with a median of 40 ha. The experience of survey respondents in the citrus industry averaged 21.7 years.

The survey identified oriental spider mites as the number one pest or disease issue for citrus growers in north Queensland (Figure 20). Seven out of the 9 growers surveyed identified it as a pest of concern; of that 7, 6 growers reported that they currently achieve poor pest control. The next most concerning pests were fruit spotting bug, mealybug, and broad mite, which were only pests of concern for three growers.

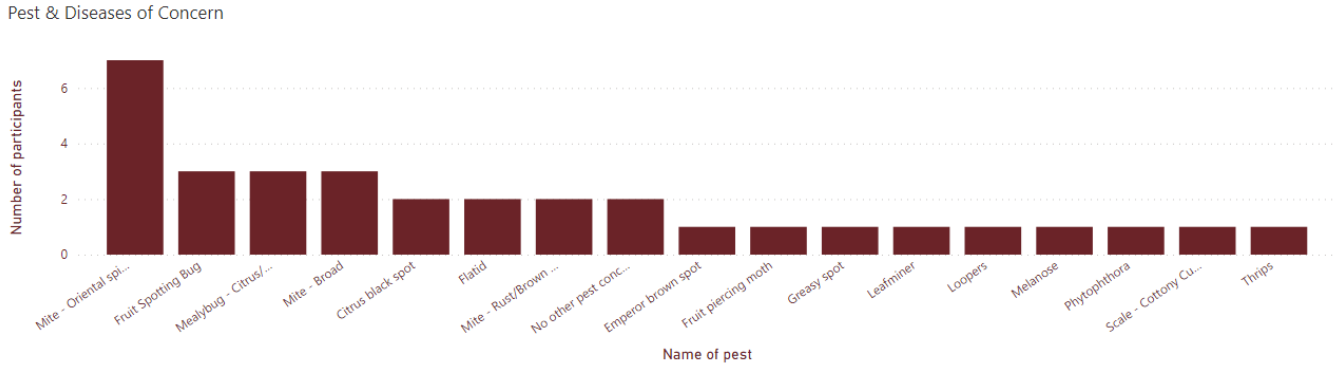


Figure 21. Pests or diseases of concern as rated by north Queensland Citrus growers.

The survey respondents indicated a very chemically reliant approach to controlling pests in the region, with an average of 35 pesticides and fungicides applied annually by each grower. Additionally, growers tended to favour disruptive, broad-spectrum chemistries such as methomyl (Lannate®) and chlorpyrifos (Lorsban®) over softer options (Table 6). There was also a high use of miticides, which reflects the seriousness of the oriental spider mite issue and the poor control achieved.

Table 6. The top 5 insecticides used in North Queensland citrus expressed as an average number of applications per grower each year.

Chemical	Average applications/Year
Methomyl (Lannate®)	8
Sulfur	8
Abamectin	7
Horticultural oils	6
Chlorpyrifos (Lorsban®)	3

Only one grower surveyed indicated they did not monitor for pests and diseases, but there were still 3 growers still practising calendar spraying for pests. All but 2 growers rotated between chemical groups to manage resistance, however, three growers tank-mixed different insecticide products to target the same pest.

The incidence of growers releasing beneficial insects was low, with only 4 currently releasing any and 3 that had in the past but no longer used them. Similarly, there were only 3 growers that managed inter-row plantings to retain the beneficial insects. Pruning for spray penetration and airflow was the most common cultural practice used (by 8 growers) in the region.

The survey results indicated that the area is experiencing substantial pest issues, particularly from oriental spider mites, and that the current method relies heavily on chemicals for control. While there is awareness of IPM best practices, there has been only moderate uptake.

Southeast Queensland

Seven citrus growers responded to the survey in the Southeast Queensland region; six mandarin growers and one lemon grower. The average farm size in this region was comparatively larger than in north Queensland, with the smallest orchard being 24 ha and the largest being 200 ha, with a median orchard size of 126 ha.

The biggest pest and disease issue for growers in the Southeast region was citrus black spot disease, which all growers rated as a disease concern (Figure 21). Despite it being rated a pest of concern by so many growers, only one grower reported they were not achieving adequate control of the disease (Figure 22). This was followed by emperor brown spot, which was considered a disease of concern by five growers. For Southeast citrus growers, red scale was considered the pest of most concern, rated by four growers.

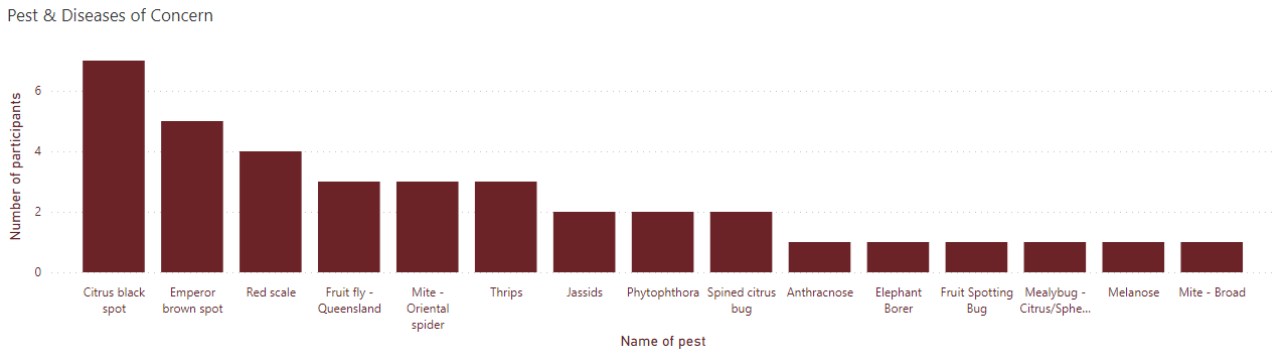


Figure 22. Pests or diseases of concern as rated by Southeast Queensland citrus growers.

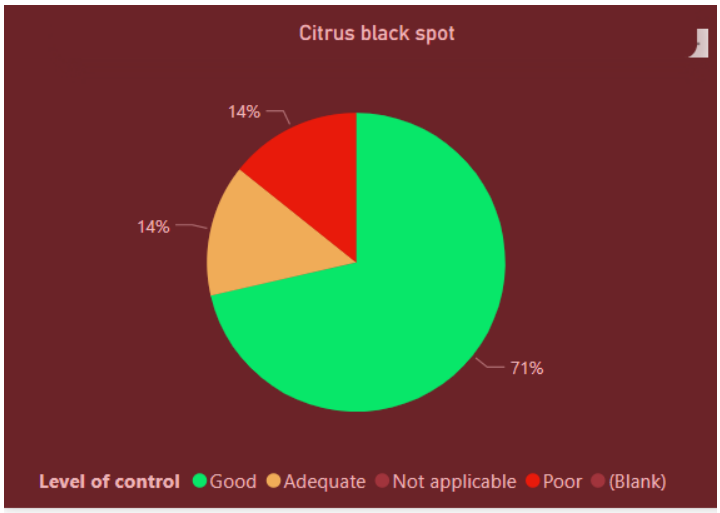


Figure 23. The level of control of citrus black spot as considered by the growers who rated it a pest of concern.

Chemical use in Southeast Queensland reflected the disease issue identified in the survey, with fungicide use dominating insecticide use (Table 7). Growers were applying an average of 14 fungicides a year with mancozeb, copper and azoxystrobin being the most popular, and 10 applications of pesticides, five of which were maldison to control Queensland fruit fly. Despite the number of maldison sprays used each year, only 3 growers rated fruit fly as a pest of concern. Two of these growers reported good control and one reported adequate control, suggesting that fruit fly control systems that integrate maldison are very effective.

Table 7. The top 5 insecticides used in Southeast Queensland citrus expressed as an average number of applications per grower each year.

Chemical	Average applications/year
Mancozeb (Dithane®)	9.4
Maldison	4.7
Copper	3.5
Horticultural oils	1.8
Methomyl (Lannate®)	1.8

Generally, good spray practices were being undertaken in Southeast Queensland. All respondents rotated between chemical groups, selectively sprayed an orchard area to target a pest and never tank-mix insecticide products to target the same pest. All 7 growers sprayed for disease based on monitoring; however, 5 growers supplemented this with calendar spraying. In terms of insect pests, only 2 growers used calendar spraying.

Southeast citrus growers demonstrated good knowledge and use of cultural and biological practices for pest and disease control. All growers monitored to a threshold for pests and diseases, minimised dust in the orchard, pruned for airflow and spray penetrations and used a bait spray for fruit fly control. Six out of the 7 growers manage inter-row plantings to encourage beneficial insects. It was interesting that all 7 growers had released beneficial insects in the past, but had not continued this.

The survey showed that citrus growers in Southeast Queensland have more issues with disease than insect pests; however, they were achieving good control of the issue. Despite that, their knowledge and implementation of IPM practices were high.

Western Australia

Western Australian orchards in the southwest region (Harvey, Manjimup) and the wheatbelt region (Moora, Gingin) were included in the survey. While only 7 surveys were completed, this included most of the largest producers as well as some smaller producers. These businesses captured a total of 471.5 hectares of production, which is close to 50% of the total production area in the state. Most participants were growing for the domestic market (86%). For the total production area of those surveyed, 45% was being grown with pest and disease management based on an export market focus.

Varieties

The main varieties grown by surveyed Western Australian growers were navel orange, mandarin and lemons (71.4% of participants), followed by Valencia orange (42.9%) and some also growing lime (28.6%), grapefruit (28.6%) and common orange (14.3%) (Figure 23.).

Navel orange was the most common variety grown by total area (Figure 24), with 228.7 hectares for the participants (56% of the total production area). Mandarins were the second highest area with 109.6 ha (27% of the total area).

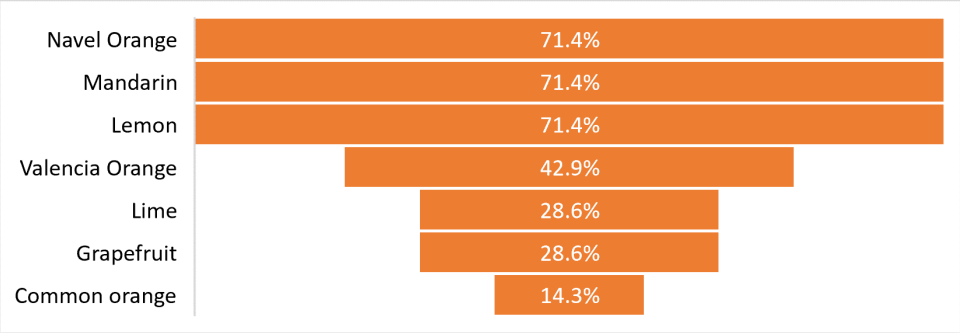


Figure 24. Percentage of survey participants growing each variety.

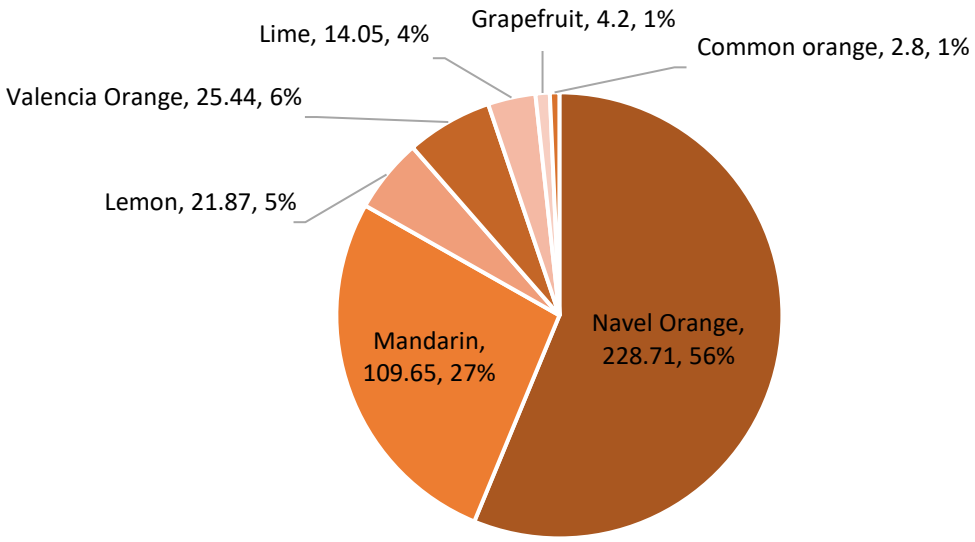


Figure 25. Total area (hectares) of each variety grown by survey participants in WA.

Pests and diseases of concern

All participants listed red scale as a pest of concern. Light brown apple moth was an issue for 40% of participants, but only in the wheatbelt growing region (Figure 25). Thrips were also an issue for 40% of participants in both regions. Mealybug was a problem for 30% of participants, all in the southwest region. Other pests of concern were citrus bud mite (southwest only), aphids, pink wax scale and cottony cushion scale.

Seventy per cent of participants reported good control of red scale, with the remaining 30% having an adequate level of control (Figure 26). All participants who listed LBAM, aphids, pink wax scale and cottony cushion scale as pests of concern reported a good level of control of these pests. Only 30% had good control of thrips with 70% having adequate control. Participants with Kelly's citrus thrips, citrus bud mite and mealybug felt they had an adequate level of control of these pests.

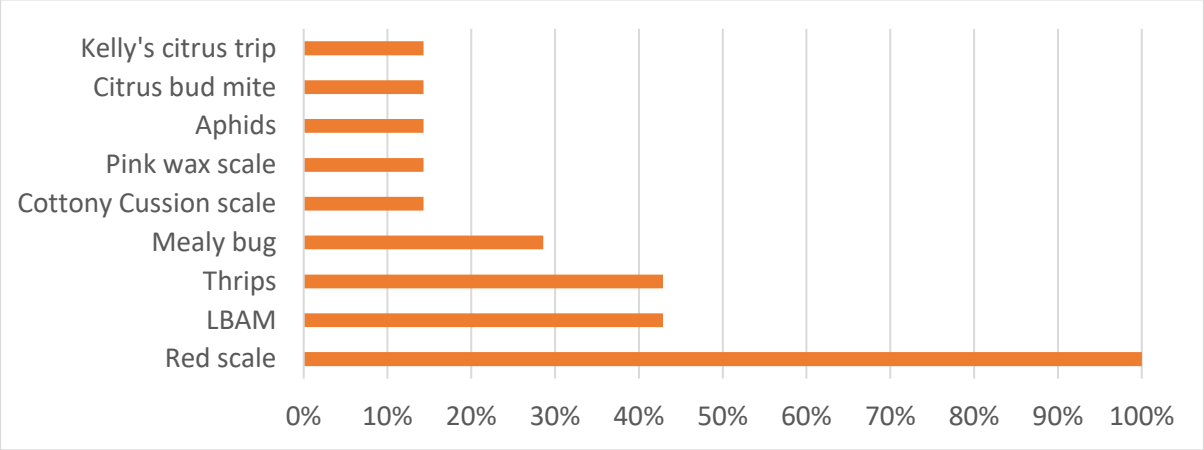


Figure 26. Main pests of concern for WA participants over the last 5 years.

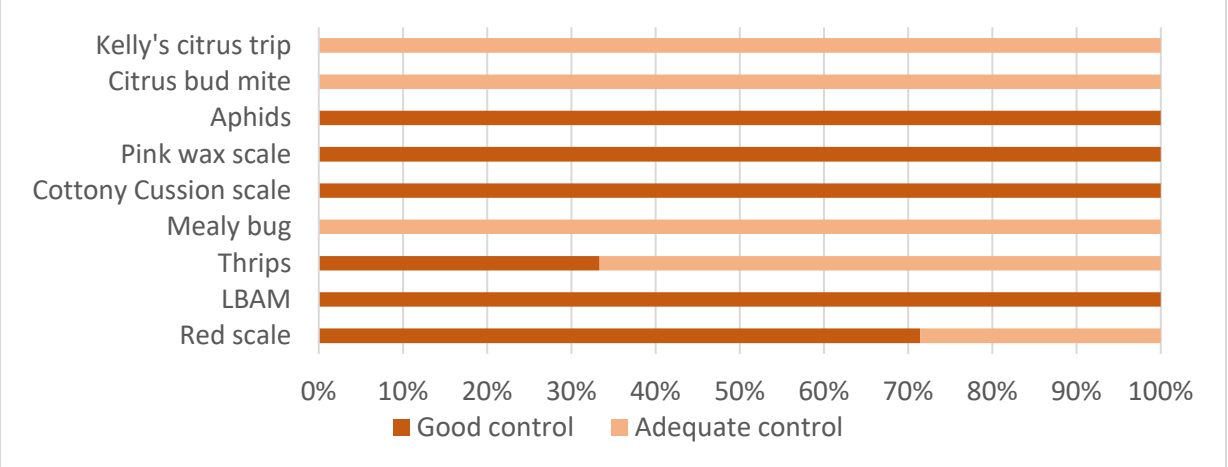


Figure 27. Level of control of the main pests of concern for WA participants.

Diseases were not as much of an issue for WA orchards in the last 5 years (Figure 27). For 28% of participants, phytophthora was a disease of concern, but they had good control (Figure 28.). Anthracnose and citrus black spot were an issue for 145 of the orchards surveyed and a poor level of control of these diseases was reported. Botrytis and Alternaria brown spot were a concern for 14% of participants who had an adequate level of control of the disease. Black core rot and sooty mould had good control for the 14% of participants who had an issue with this disease in the last 5 years.

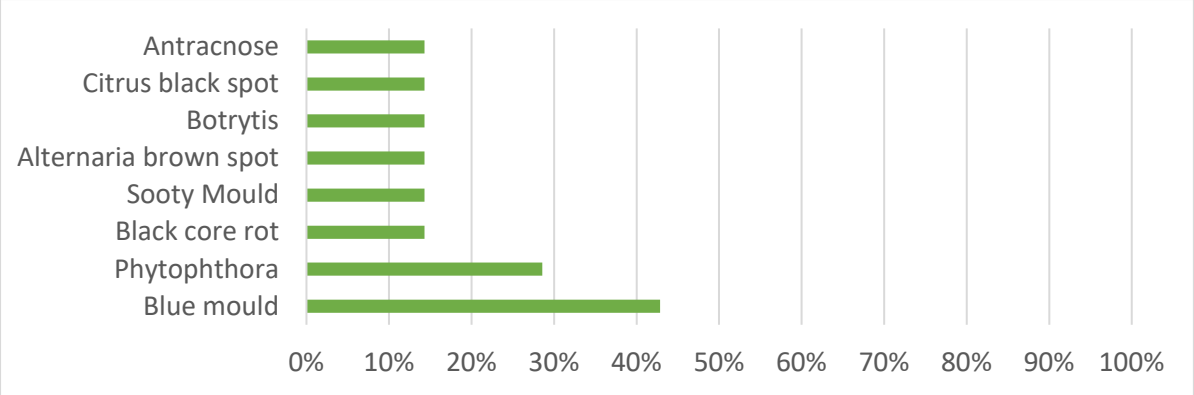


Figure 28. Main diseases of concern for WA participants.

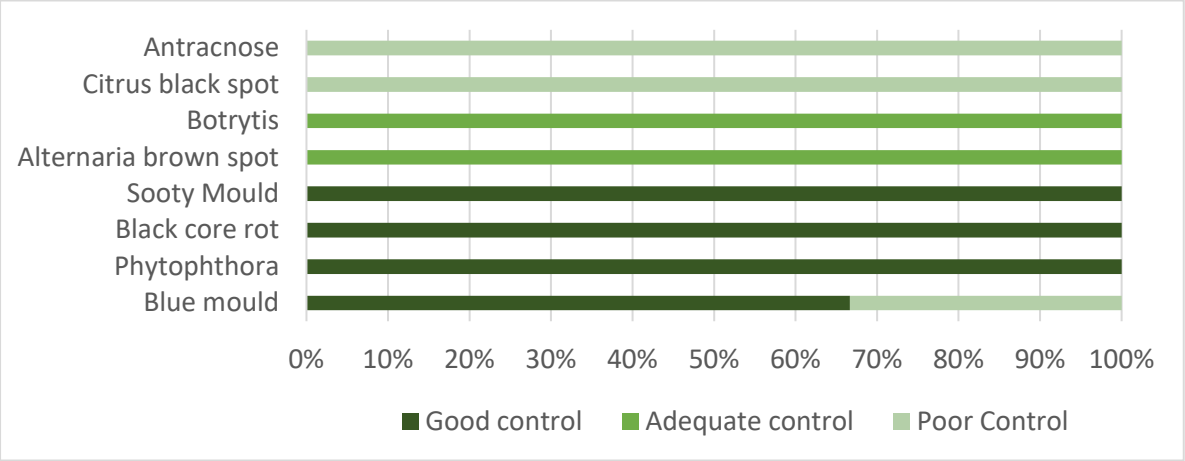


Figure 29. Level of control of the main diseases of concern for WA participants.

Knowledge of pests and disease

Knowledge of pests and diseases was quite varied for the survey group (Figure 29). All participants had a sound knowledge of red scale and Mediterranean fruit fly. Participants were less confident of their knowledge of Fuller's rose weevil, LBAM, citrus bud mite, Anthracnose, mealybug and citrus gall wasp (noting that citrus gall wasp is not yet an issue for WA orchards).

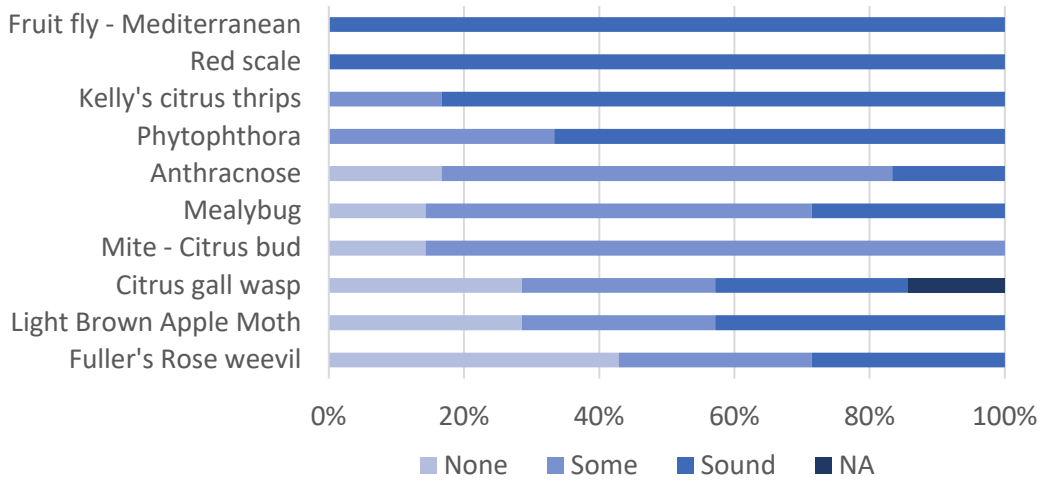


Figure 30. Participants' level of knowledge of pests and diseases.

Biological and cultural practices

All participants prune trees for spray penetration and airflow (Figure 30). Only 57% remove decaying fruit from the orchard and 71% bait spray to control fruit fly. No orchards are currently using mating disruption. Only 43% are releasing beneficial insects and 14% manage the inter-row for beneficials. Seventy-one per cent of participants said they monitored to a protocol for pests and 57% monitored to a protocol for diseases.

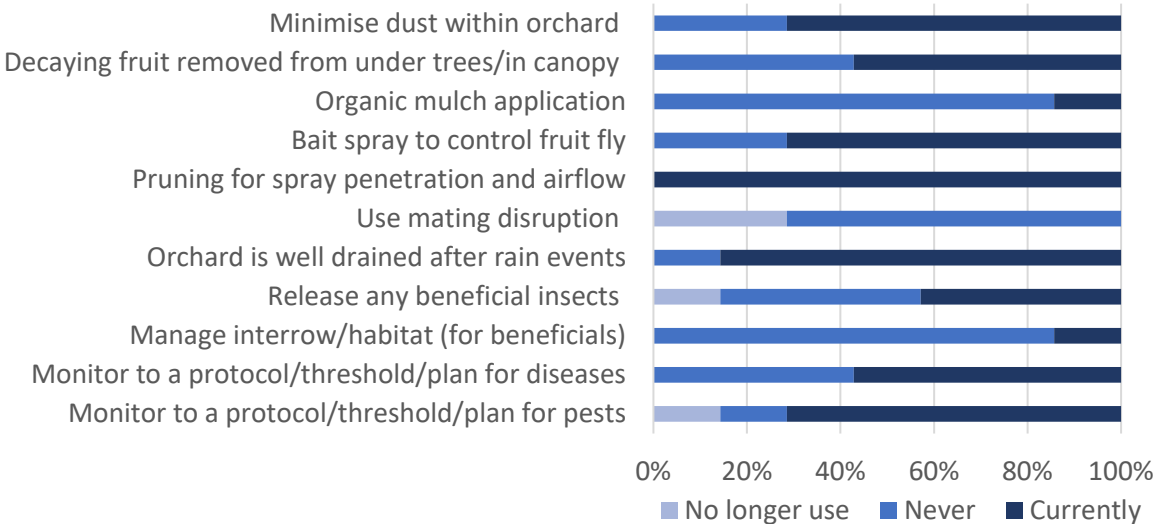


Figure 31. Percentage of WA participants currently using IPDM practices.

Spray practices

Decision-making for spraying for pests and diseases was based on both monitoring and experience for all participants (Figure 31). However, 57% spray on a calendar for pests and 71% for disease. Most orchards selectively spray for pests and rotate between chemical groups (86%). All participants indicated they use insecticides with a low effect on beneficials, however, 57% use broad-spectrum insecticides.

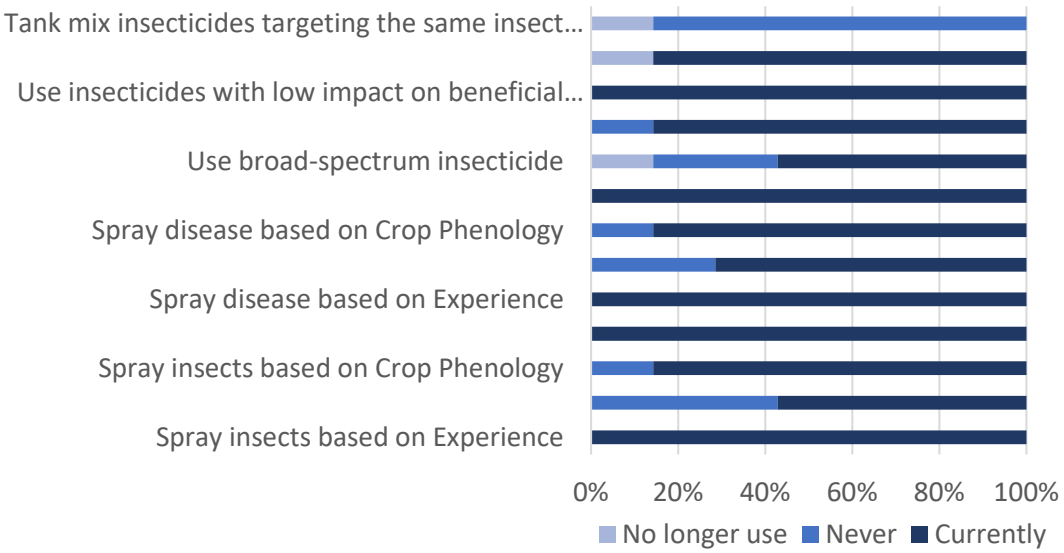


Figure 32. Percentage of WA participants currently using IPDM practices related to spraying.

Recent chemistry use

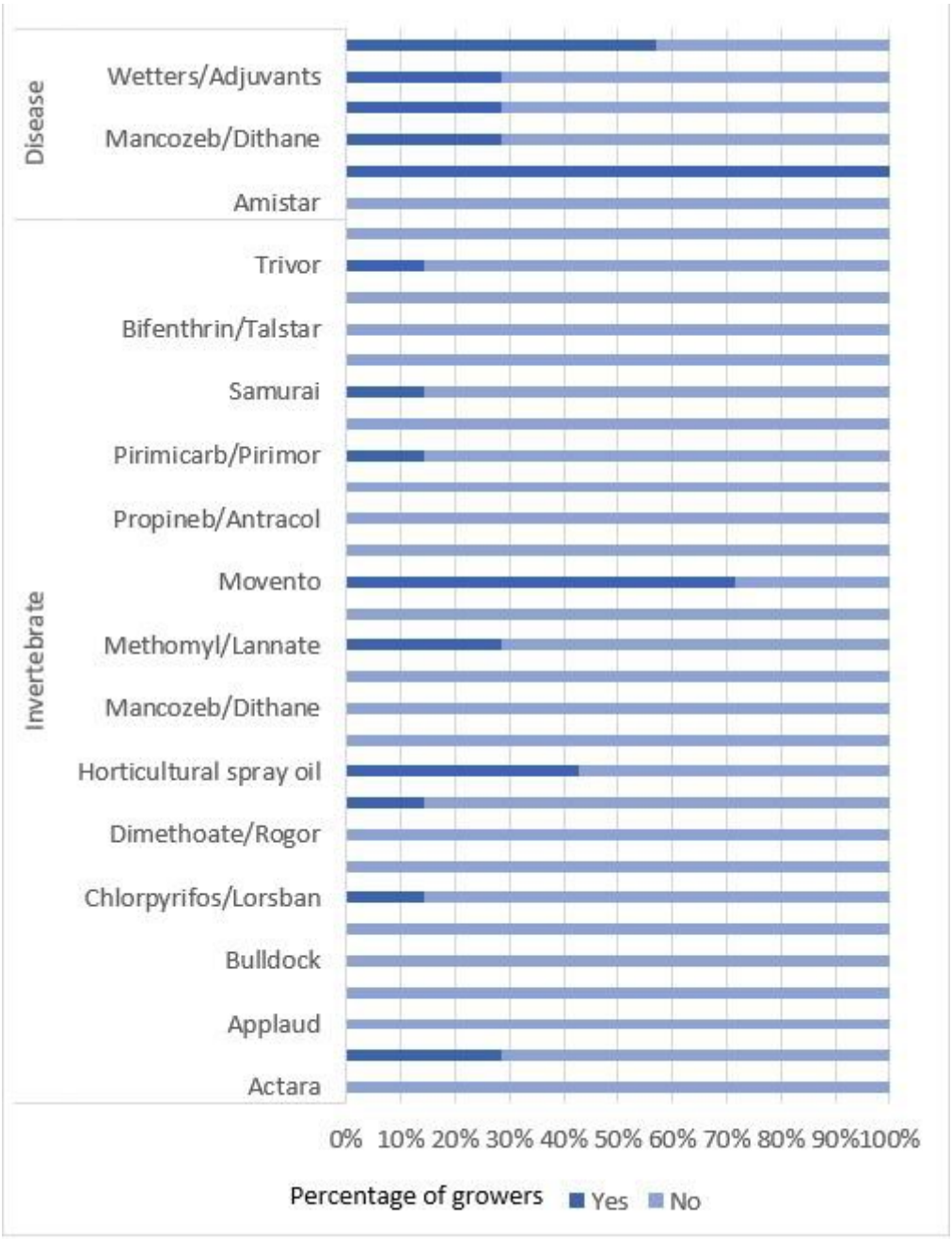


Figure 33. Chemicals used in the 2021–22 season for the 7 IPDM practice survey participants from Western Australia. Each participant reported chemical use for a representative block on their orchard, based upon their focus citrus variety.