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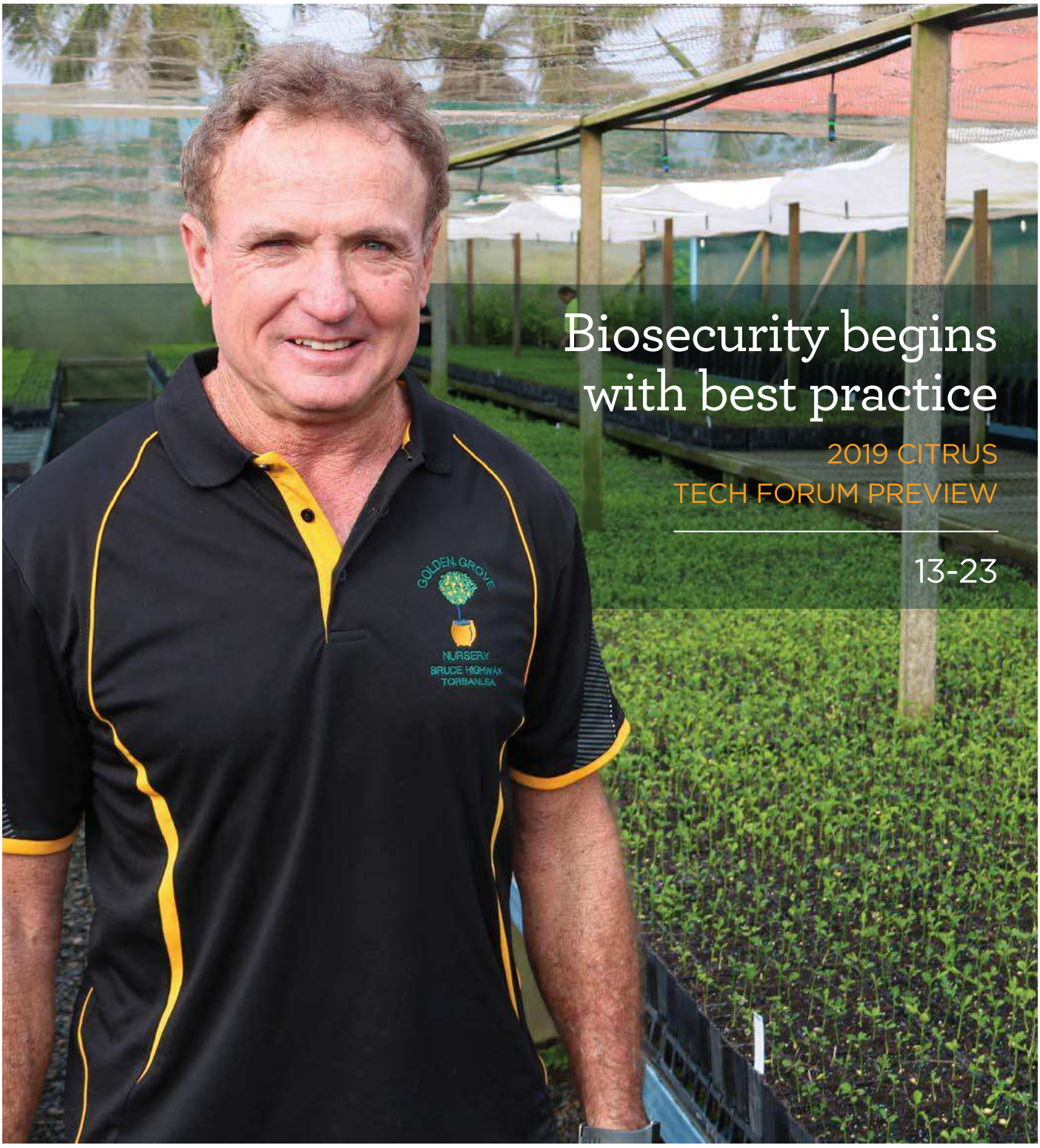

Biosecurity begins with best practice

2019 CITRUS TECH FORUM PREVIEW

13-23

Citrus Australia

Management change can reduce fruit decay

By John Golding and John Archer

The research survey of packinghouse hygiene and resistance to postharvest fungicides across Australia was continued from the previous season. This survey was part of the Horticulture Innovation Citrus Postharvest Program. The survey assessed the presence of decay-causing fungi in the different citrus packinghouses around Australia and identified if these fungi had any technical resistance to common postharvest fungicides.

Postharvest fungicides are an important method to control decay and breakdown during handling and marketing. However postharvest fungicides can sometimes fail to work due to the development of resistance by the decay fungi to the fungicide. Fungicide resistance is a serious and important postharvest problem which needs to be actively managed in the packinghouse to minimise any potential losses.

Fungicide resistance can occur in packinghouses and coolrooms with poor hygiene and the continuous use of the same postharvest fungicide. Resistance arises when a single decay fungi spore that is resistant to a fungicide multiplies. The continued selection of these resistant spores can happen when the same fungicide is used and these spores can multiply resulting in full resistance.

The survey put out agar petri dishes which contained different fungicides and then exposed them to the air in different packinghouses across Australia during the packing season, to estimate the levels of fungicide resistance present. The plates were put into the start of the packing line, the end of the packing line, and in the cool room. The postharvest fungicides assessed were thiabendazole (TBZ) (Vorlon® or Tecto®), imazalil (Magnate® or Fungaflor®) and fludioxonil (Scholar®). If decay spores in the air of the packinghouse landed on the

Table 1. *Summary table of the results from the 2018 sanitation (hygiene) and fungicide resistance packinghouse survey.*

		Untreated				TBZ				Imazalil				Fludioxonil			
	Shed	S	E	C	T	S	E	C	T	S	E	C	T	S	E	C	T
NSW	A	1	2	2	5	4	1	1	6	1	1	1	3	1	1	1	3
NSW	B	4	1	1	6	1	2	1	4	1	1	1	3	1	1	1	3
NSW	C	4	4	1	9	2	2	1	5	1	1	1	3	1	1	1	3
NSW	D	4	4	4	12	1	1	1	3	1	1	1	3	1	1	1	3
NSW	E	4	4	1	9	2	1	1	4	1	1	1	3	1	1	1	3
NSW	F	1	1		3	1	1		3	1	1		3	1	1		3
NSW	G	4	4	2	10	1	2	2	5	1	1	1	3	1	1	1	3
NSW	H	2	3	1	6	1	3	4	8	1	1	1	3	1	1	1	3
NSW	I	4	4	1	9	1	3	1	5	1	1	1	3	1	1	1	3
Average		**3**	**3**	**2**	**8**	**2**	**2**	**2**	**6**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**3**
Qld	A	4	2	2	8	2	1	1	4	1	1	1	3	1	1	1	3
Qld	B	1	1	1	3	1	1	1	3	1	1	1	3	1	1	1	3
Qld	C	4	3	2	9	4	4	4	12	1	1	1	3	1	1	1	3
Qld	D	4	4	4	12	4	2	2	8	1	1	1	3	1	1	1	3
Qld	E	3	3	2	8	2	2	1	5	1	1	1	3	1	1	1	3
Qld	F	1	1		3	1	1	1	3	1	1	1	3	1	1	1	3
Qld	G		1	1	3	1	1	1	3	1	1	1	3	1	1	1	3
Qld	H	1	1	1	3	1	1	1	3	1	1	1	3	1	1	1	3
Qld	I	1	1	1	3	2	2	3	7	1	1	1	3	1	1	1	3
Average		**2**	**2**	**2**	**6**	**2**	**2**	**2**	**6**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**3**
WA	A	4	2		7	1	1		3	1	1		3	1	1		3
WA	B	4	4	3	11	1	1	2	4	1	1	1	3	1	1	1	3
WA	C	4	3	1	8	4	3	1	8	1	1	1	3	1	1	1	3
WA	D	4	4	2	10	4	4	3	11	1	1	1	3	1	1	1	3
WA	E	4	3	1	8	4	4	1	9	1	1	1	3	1	1	1	3
Average		**4**	**3**	**2**	**9**	**3**	**3**	**2**	**8**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**3**
SA	A	3	3	4	10	1	4	3	8	1	1	1	3	1	1	1	3
SA	B	1	1	1	3	1	2	1	4	1	1	1	3	1	1	1	3
SA	C	4	3	1	8	2	2	1	5	1	1	1	3	1	1	1	3
SA	D	4	4	1	9	2	3	1	6	1	1	1	3	1	1	1	3
SA	E	4	3	2	9	4	4	4	12	1	1	1	3	1	1	1	3
SA	F	2	1	1	4	1	1	1	3	1	1	1	3	1	1	1	3
SA	G	4	1	1	6	3	3	1	7	1	1	1	3	1	1	1	3
SA	H	4	4	4	12	4	4	4	12	1	2	1	4	1	1	1	3
SA	I	3	1	1	5	1	1	1	3	1	1	1	3	1	1	1	3
SA	J	2	1	1	4	1	1	1	3	1	1	1	3	1	1	1	3
SA	K	3	3	1	7	2	2	2	6	1	2	1	4	1	1	1	3
SA	L	2	2	1	5	3	4	3	10	1	1	1	3	1	1	1	3
SA	M	3	4	3	10	4	4	4	12	2	1	1	4	1	1	1	3
SA	N	4	3	3	10	1	1	1	3	1	1	1	3	1	1	1	3
SA	O	4	3	1	8	1	3	1	5	1	1	1	3	1	1	1	3
SA	P	4	4	1	9	3	4	1	8	1	1	1	3	1	1	1	3
Average		**3**	**3**	**2**	**8**	**2**	**3**	**2**	**7**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**3**
Vic	A	3	3	1	7	2	4	1	7	2	1	1	4	1	1	1	3
Vic	B	3	1	1	5	2	2	1	5	1	1	1	3	1	1	1	3
Vic	C	1	3	2	6	2	3	2	7	2	2	1	5	1	1	1	3
Vic	D	3	3	2	8	3	3	2	8	1	2	2	5	1	1	1	3
Average		**3**	**3**	**2**	**8**	**2**	**3**	**2**	**7**	**2**	**2**	**1**	**4**	**1**	**1**	**1**	**3**

S = Start of the line
E = End of the line
C = Coolroom
T = Total score for all different packinghouse locations (S + E + C).
The maximum (worst) total score is 12. The lower the number, the better the result.

Untreated (control) plates measured hygiene, where a score of;
1 = very low spore levels,
2 = low spore levels,
3 = moderate spore levels,
4 = high spore levels.

For TBZ, imazalil and fludioxonil amended plates, a score of;
1 = very low resistance detected,
2 = low levels of resistance detected,
3 = moderate levels of resistance detected,
4 = high levels of resistance detected.

Table 2. *Comparison of the results of untreated, TBZ, imazalil and fludioxonil amended plates both before (Time 1) and after intensive sanitation (Time 2) from the same packinghouses. There were three different packinghouses (A, B and C) assess at two different sampling times (Time 1 and 2). The scores are the same as described in Table 1.*

		Untreated				TBZ				Imazalil				Fludioxonil			
Shed	Time	S	E	C	T	S	E	C	T	S	E	C	T	S	E	C	T
A	1	3	3	4	10	1	4	3	8	1	1	1	3	1	1	1	3
A	2	3	1	1	5	1	1	1	3	1	1	1	3	1	1	1	3
B	1	4	4	2	10	4	4	3	11	1	1	1	3	1	1	1	3
B	2	4	3	1	8	4	4	1	9	1	1	1	3	1	1	1	3
C	1	4	3	2	9	4	4	4	12	1	1	1	3	1	1	1	3
C	2	1	1	1	3	2	2	3	7	1	1	1	3	1	1	1	3

plates with fungicide and grew, then there was some technical resistance to that fungicide.

A summary of the results of this season's survey are presented in Table 1. The results show there were large differences in sanitation and technical resistance between the different packinghouses around Australia. Some packinghouses had excellent hygiene and sanitation with very few decay causing fungi detected, while other packinghouses had very high levels of decay causing fungi both in the packinghouse and in the coolroom. In general the highest levels of decay causing fungi were detected at the start of the line. This is not unexpected as this is where the fruit is dumped from the orchard. However it is important to improve hygiene and reduce the numbers of decay causing fungi in all areas of the packinghouse and particular attention should be made in this area, as these spores can remain in the packinghouse and coolroom and be a risk for decay and resistance development.

A comparison of the 2018 results from the 2017 season showed there had been some reductions in the levels of total decay causing spores in the packinghouses and coolrooms in 2018. This is an excellent result and shows that packers have been active in their sanitation programs, particularly in the coolrooms, where total decay causing fungi detections were significantly lower. This lower pressure in the number of decay causing spores reduces the risk of decay and development of resistance.

Technical resistance to the postharvest fungicide, TBZ was detected in most packinghouses around Australia. Over half of the samples assessed had technical resistance to TBZ, whilst over 20% of samples at the start of the packingline, had very high levels of technical resistance to TBZ (Table 1). These levels of technical resistance to TBZ are a concern and improvements in packinghouse hygiene and rotation of fungicides is recommended.

The uses of other fungicides (such as imazalil and fludioxonil) with other modes of action against green and blue mould are widely used and essential to help manage postharvest decay. However this survey also showed some packinghouses had low levels of technical resistance to imazalil in some packinglines and coolrooms. Although this was an un-common observation (<8 % samples), this is a big concern and needs to be eliminated. It is crucial to maintain the effectiveness of postharvest fungicides such as imazalil which is the mainstay of postharvest fungicides. Fortunately no technical resistance to fludioxonil was detected in this Australia-wide survey, but this was probably because this fungicide is not widely used by industry.

The management of resistance to postharvest fungicides requires a whole-of-system approach, starting from harvest through to packing and storage. Reducing the risk of fungicide resistance includes:

Optimise fruit health. Good postharvest practice to minimise physical damage to the fruit during harvest and handling.

Use best hygiene practices. Lowering the populations of decay-causing spores in the packinghouse, cool room and on the fruit are keys to a successful management program. This includes removal of rotten fruit from the packinghouse and coolrooms, the regular sanitation of equipment, coolrooms and packingline by washing (or using fogging technology).

Optimise fungicide use. Understand the way each fungicide works to develop strategies to minimise the development of resistance by using rotations and mixtures whenever possible and before resistance selection occurs.

Optimise fungicide efficacy. The correct fungicide concentration and coverage determines the efficacy of the treatment and minimises the chances of decay spores surviving following treatment.

Monitor fungicide resistance. The early detection of resistance increases the chance that its development can be managed and stopped.

An example of the efficacy of good cleaning and sanitation activities is presented in Table 2, which shows the results of different packinghouses at different sampling times. The packinghouses were sampled during the packing season (Time 1) and also after cleaning and improvements in hygiene (Time 2). The results showed a decrease in the total number of decay causing fungi and levels of technical resistance to TBZ in all packinghouses, particularly in packinghouses A and C. This shows that with both monitoring and targeted cleaning and sanitation, the risk of the failure of decay management can be minimised.

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John Golding and John Archer will discuss this at the 2019 Citrus Tech Forum on March 6-7.