

Prevention of kiwifruit storage diseases with post-harvest application of a fermentation extracts and *Bacillus amyloliquefaciens* BS-1b

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Key words

Bacillus amyloliquefaciens BS-1b, Kiwifruit, Hayward, *Botrytis cinerea*, *Penicillium*, *Fusarium*

Overview

Spores of various fungal and bacterial pathogens are present on the fruit's surface at the time of picking. Cool storage shuts down many of these pathogens but as the fruit is removed from cool storage many of these pathogens reignite and lead to fruit spoilage.

The stem wound at picking offers an easy entry point for *Botrytis cinerea* (Grey Mould). A post picking application of a BioFungicide containing a fermentation base and *Bacillus amyloliquefaciens* BS-1b from BioStart was trialled to assess its ability to reducing instances of post cool storage *Botrytis c.*

The trial involved count 30 Hayward fruit being subjected to two lengths of cool storage, 15 weeks and 24 weeks. For each length of cool storage there was a control and treatment group of 12 trays with 18 fruit per tray. After the fruit was removed from cool storage it was assessed at 3 intervals over a 16 day period.

The results showed that for the fruit, which had been in storage for 15 weeks, the treatment had reduced the instances of both *Botrytis c.* and *Penicillium*. There was also less soft and over ripe fruit after two weeks at room temperature. For fruit that had been in storage for 24 weeks the treatment gave no advantage. All of the fruit in this group showed advanced breakdown and was unsuitable for sale.

Future work will be carried out on assessing fruit sprayed with the BioFungicide in the orchard prior to picking.



Trial Location

KiwiHeights Orchard Roderick Lane No1 Rd Te Puke Bay Of Plenty. This orchard has a high risk history of Botrytis, 2008 harvest season (May) was also very wet.

Pre-Harvest

The fruit had an application of Hyglo (waterstain remover) latic acid based product prior to harvesting. No fungicides were applied.

Trial set up

4 replicates of 12 trays (total 48 trays) were picked directly into a standard Zespri export trays (count 30 plix). The fruit was dry prior to picking. Maturity clearance was under Main Pack specs. Only export fruit was picked and placed into plix (Zespri Export Standards).

The calyx end of the fruit had the BioFungicide applied to it as a fine mist by a hand applicator at a rate of 1:200. Product was applied to achieve complete coverage of the picking stalk wound and surrounding area. Treatment was then allowed to dry before closing up the trays. Trays were then stacked onto pallet and put into cool storage at DMS Pukepack within 1 hour of finishing.



Coolstorage

Fruit was stored in static storage at standard industry specs. Main packed fruit is kept at temperature -1.1 °C. Typically fruit is stored in the industry until the end of November depending on the crop volume.

Assessment

Fruit was transported to BioCult laboratory in Cambridge for assessment. Fruit in storage for 15 weeks was removed from cool storage on the 04 August 2009 (ISO week 36). Fruit in storage for 24 weeks was removed from cool storage on the 04 November 2009 (ISO week 45).

Once out of cool storage the fruit was left at room temperature and assessed at 2, 7 and 16 days after being removed from cool storage.

Results

Fruit in storage for 15 weeks

	Day 2 assessment		Day 7 assessment		Day 16 assessment	
	Treated	Untreated	Treated	Untreated	Treated	Untreated
Early <i>Botrytis</i>	0	6	0	5	3	3
Advanced <i>Botrytis</i>	0	1	0	1	1	1
<i>Penicillium</i>	1	4	2	3	1	11
<i>Fusarium</i>	0	0	0	0	0	0
Bacterial rot	0	0	0	0	0	0
Small lesion	0	1	0	9	1	2
Soft fruit	0	0	2	12	38	72
Over ripe fruit	0	0	0	0	10	15

Comments

After 2 days at room temperature the data shows a clear advantage for the treated fruit.

After 7 days at room temperature the data shows a clear advantage for the treated fruit.

After 14 days at room temperature the data shows a clear advantage for the treated fruit. The Untreated fruit have ripened quicker than the Treated fruit. Overall an unacceptable proportion of the untreated fruit is now unsaleable.

Some of the early mycelium growth initially identified as *Botrytis* developed into *Fusarium*.

Some of the early *Botrytis* cleared up over 16 days.

The bacterial rot was mostly on the side of the fruit in contact with the plix, the *Fusarium* was generally on the topside of the fruit.

For full assessment results see appendix 1

Fungal infection examples

***Botrytis c.* in Untreated fruit.**



Early stages



Advanced stages

***Penicillium spec.* in Untreated fruit.**



Early stages



Advanced stages

Fruit in storage for 24 weeks

	Day 1 assessment		Day 8 assessment		Day 15 assessment	
	Treated	Untreated	Treated	Untreated	Treated	Untreated
Early <i>Botrytis</i>	0	0	0	0	5	0
Advanced <i>Botrytis</i>	0	1	0	1	4	0
<i>Penicillium</i>	3	0	3	0	8	9
<i>Fusarium</i>	0	0	13	10	1	
Bacterial rot	0	0	1	0	40	40
Small lesion	0	0	0	0	0	
Soft fruit	48	46	52	43	31	34
Over ripe fruit	22	30	58	66	73	80

Comments

After 1 day at room temperature the data shows no advantage for the treated fruit. There are similar numbers of soft and over ripe fruit in each treatment.

After 8 days at room temperature the data shows no advantage for the treated fruit. There are similar numbers of soft and over ripe fruit from both treatments.

After 15 days at room temperature the data shows no advantage for the treated fruit. There are similar numbers of soft and over ripe fruit from both treatments. Although these test data suggest that there were still a number of good fruit left in the trays, the reality is quite different: A number of fruit that appeared still good and firm to the touch, "saleable quality" were cut up after the assessments. All of these were truly gone, the flesh looking partially glassy, tasting bad and containing high levels of alcohol. In contrast to this, the remaining saleable fruit from the "Early" set were still edible, and tasting well.

For full assessment results see appendix 2

Conclusion

1. The treated fruit in storage for 15 weeks showed less instances for disease and fewer soft and over ripe fruit.
2. There was no difference in the treated and untreated fruit in storage for 24 weeks
3. The treatment was only applied to the calyx end of the fruit, further trials need to be carried out on applying the treatment to the whole fruit, possibly before harvest as an orchard spray.

Third assessment 16 Days after Taking Fruit out of Cool Storage

Treated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>					3								3
Advanced <i>Botrytis</i>										1			1
<i>Penicillium</i>	1												1
<i>Fusarium</i>													0
Bacterial rot													0
Small lesion										1			1
Soft fruit	2	10		5		1	13	1		5	1		38
Over ripe		1		1						8			10

Untreated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>					2	1							3
Advanced <i>Botrytis</i>					1								1
<i>Penicillium</i>	1			1	1	7			1				11
<i>Fusarium</i>													0
Bacterial rot													0
Small lesion							1	1					2
Soft fruit	2	11	1	3	4	10	6	3	13	8	6	5	72
Over ripe fruit					1		3	2		1	3	5	15

Appendix 2

Fruit in storage for 24 weeks

First assessment 1 day after taking fruit out of cool storage

Treated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>													0
Advanced <i>Botrytis</i>													0
<i>Penicillium</i>	1			1								1	3
<i>Fusarium</i>													0
Bacterial rot													0
Small lesion													0
Soft fruit	7	3	2	1	2	5	3	1	10	1	6	7	48
Over ripe fruit	2			1	2		3	2	3	1	2	6	22

Untreated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>													0
Advanced <i>Botrytis</i>					1								1
<i>Penicillium</i>													0
<i>Fusarium</i>													0
Bacterial rot													0
Small lesion													0
Soft fruit	2	3	1	1	9	8	6	1	2	6	1	6	46
Over ripe fruit		1	2		1	3	3	10	2	3	1	4	30

Second assessment 8 days after taking fruit out of cool storage

Treated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>													0
Advanced <i>Botrytis</i>													0
<i>Penicillium</i>	1			1								1	3
<i>Fusarium</i>							5	1				7	13
Bacterial rot					1								1
Small lesion													0
Soft fruit	2	3	3	4	4	2	9	6	6	2	5	6	52
Over ripe fruit	8		4	2	5	3	5	4	7	4	8	8	58

Untreated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>													0
Advanced <i>Botrytis</i>					1								1
<i>Penicillium</i>													0
<i>Fusarium</i>							4	1	2	1	1	1	10
Bacterial rot													0
Small lesion													0
Soft fruit	5	2	3	4	6	1	3	7	3	4	1	4	43
Over ripe fruit	1	7	4	5	7	10	6	7	3	3	5	8	66

Third assessment 15 days after taking fruit out of cool storage

Treated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>			1	1		2		1					5
Advanced <i>Botrytis</i>							4						4
<i>Penicillium</i>	2			1	2	1					1	1	8
<i>Fusarium</i>								1					1
Bacterial rot	4	2		1	3	5	4	2	8	1	7	3	40
Small lesion													0
Soft fruit	4	9	3	2		4	3	1	1	1	1	2	31
Over ripe fruit	6	6	7	4	7	2	5	7	5	8	5	11	73

Untreated

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Early <i>Botrytis</i>													0
Advanced <i>Botrytis</i>													0
<i>Penicillium</i>					1	2	1	2		1	2		9
<i>Fusarium</i>													
Bacterial rot		4	2	2	3	3	5	3	3	6	2	7	40
Small lesion													
Soft fruit	3	4	6	3	2	3	3		3		5	2	34
Over ripe fruit	7	4	4	6	12	7	5	11	6	6	6	6	80