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DETECTION OF INTERNAL HEAT DAMAGE AND IDENTIFICATION OF TECHNIQUES TO PREVENT THE EXPRESSION OF THE DISORDER IN PLUMS

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Heat damage on Laetitia plums

Introduction

- Fruit of certain plum cultivars subjected to extremely high air temperatures in the week or two before harvest may develop heat damage in different forms:

  - External heat damage
    - Typically caused by direct sunlight
    - Easily identifiable as “discoloured” sunken area on surface of the skin
    - Usually visible on fruit at packing and can therefore be removed from the commercial consignment

Heat damage on Laetitia plums

Introduction

- Internal heat damage
  - It's difficult to identify since its not visible
  - Usually not present at harvest
  - Reportedly caused by high ambient temperatures, rather than direct sun, but the exact causal mechanism is uncertain.
  - Fruit pulp temperature escalates higher than the ambient air temperature, resulting in the damage of cells

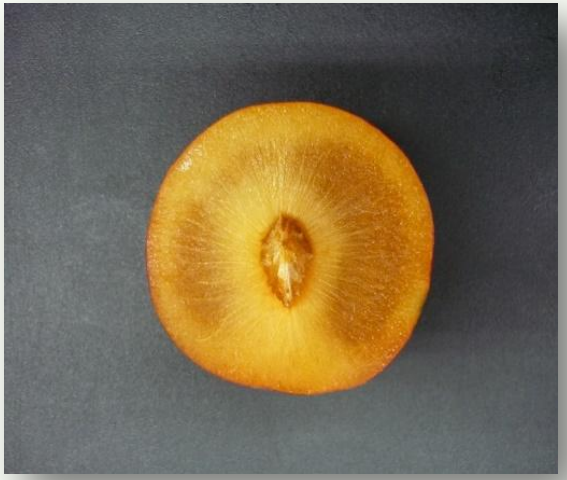
Heat damage on Laetitia plums

Introduction

- Heat wave conditions that may cause internal heat damage in plums are air temperatures:
  - above 35 ˚C for 3 consecutive days
  - 38 ˚C for two days
  - or 40 °C for a day

Internal Heat Damage

- Development of the disorder is progressive since it escalates inside the fruit over cold storage time
- It is characterised as breakdown of the plum flesh tissue at different locations, most typically between the stone and the epidermis



- Damage is also known to occur at the shoulders or as random brown spots in the mesocarp

Internal Heat Damage - continues

- Another internal disorder known to develop after heat waves is pit burn
  - Manifests as a dark discolouration around the stone
- This study was conducted to generate information to assist risk management of internal heat damage in Laetitia plums, which is a recurring problem

Objectives

- To develop a risk assessment method to establish the likelihood of internal heat damage in the fruit prior to export
- To reconfirm if slow cooling of Laetitia plums after harvest would reduce internal heat damage compared to rapid cooling [previously reported by De Kock, Khumalo, Davids and Jooste (2006)]
- An additional requirement was to ascertain the effect of using 1-MCP in combination with cooling rate manipulation on plum fruit quality after cold storage

Materials and methods – Part 1

Risk assessment for internal heat damage

- Maturity indexing was conducted for each population

Temperature methods tested to force development of internal heat damage in susceptible Laetitia plums to enable risk assessment:

Treatment Number	Cooling rate[1] (Ambient to -0.5 °C)	Holding at -0.5 °C (After cooling)	Ripening at 20 °C
1	24 hours	2 days	0 days
2	24 hours	2 days	2 days
3	6 hours	3 days	0 days
4	6 hours	3 days	2 days

Materials and methods - Part 2

Effect of cooling rate and 1-MCP on the development of internal heat damage

Treatment [1]	1-MCP Application	Cooling rates
1 (24h + 1-MCP)	Yes	24 hours
2 (24h – 1-MCP)	No	24 hours
3 (48h +1-MCP)	Yes	48 hours
4 (48h –1-MCP)	No	48 hours
5 (72h +1-MCP)	Yes	72 hours
6 (72h –1-MCP)	No	72 hours
7 (6h –1-MCP)	No	6 hours

Results and discussion

Risk assessment

Internal heat damage (%)								
Year	Cooling rate (Hours) (Factor A)	Ripening days (Days) (Factor B)		Cooling rate (Hours) (Factor A)		Prob > F [1]		
		0 day after cooling	2 days after cooling	6H	24H	A	B	A x B
2020	-	6.0a	13.3b	14.0b	5.3a	0.0149	0.0053	0.4675
2021	6H	0.0a	9.2b	-	-	0.0000	0.0000	0.0000
	24H	0.0a	0.5a	-	-			

Results and discussion

Risk assessment

T4: 6h FAC; 3d @ -0.5 °C; 2d @ 20 °C

Results and discussion

Effect of cooling rate and 1-MCP (2020 after PD7 shelf life)

Treatment[3]	Examination Parameters[1]							
	Flesh firmness (kg)	Shrivel (%)	Decay (%)	Skin cracks (%)	Internal heat damage (%)	Gel break-down (%)	Overripe-ness (%)	Total internal disorders (%)
1 (24h + 1-MCP)	2.7a	21.1a	1.6	28.9ab	23.0b	0.0a	3.0	26.0abc
2 (24h – 1-MCP)	2.4b	22.6a	0.8	61.2c	19.0b	9.0bc	8.0	36.0c
3 (48h +1-MCP)	2.8a	40.2ab	3.2	26.8a	0.0a	8.0abc	6.0	14.0ab
4 (48h –1-MCP)	2.1bc	46.8b	0.0	49.1c	2.0a	15.0cd	11.0	28.0bc
5 (72h +1-MCP)	2.9a	51.9b	0.8	19.7a	1.0a	6.0ab	5.0	12.0a
6 (72h –1-MCP)	2.1bc	49.5b	1.5	48.4bc	1.0a	23.0d	7.0	31.0c
7 (6h –1-MCP)	2.0c	33.1ab	0.0	47.3bc	23.0b	12.0bc	4.0	39.0c
Prob.>F[2]	0.0000	0.0443	0.2725	0.0016	0.0000	0.0002	0.3730	0.0044

Results and discussion

Effect of cooling rate and 1-MCP (2021 after PD7 cold storage)

Treatment[3]	Examination Parameters[1]							
	Flesh firmness (kg)	Shrivel (%)	Decay (%)	Skin cracks (%)	Internal heat damage (%)	Gel break-down (%)	Overripe-ness (%)	Total internal disorders (%)
1 (24h + 1-MCP)	4.8ab	12.8a	0.0	0.0	12.0b	0.0	0.0a	12.0b
2 (24h – 1-MCP)	4.1bc	12.6a	0.6	0.0	12.0b	0.0	0.0a	12.0b
3 (48h +1-MCP)	5.1a	17.8a	0.0	0.0	0.0a	0.0	0.0a	0.0a
4 (48h –1-MCP)	3.4c	38.2c	0.6	0.0	3.0ab	0.0	0.0a	3.0ab
5 (72h +1-MCP)	4.8ab	23.5ab	0.0	0.0	0.0a	0.0	0.0a	0.0a
6 (72h –1-MCP)	4.1bc	30.9bc	0.6	0.0	0.0a	0.0	2.0b	2.0a
7 (6h –1-MCP)	4.8ab	15.0a	0.0	0.0	59.0c	0.0	0.0a	59.0c
Prob.>F[2]	0.0027	0.0003	0.6771	NS	0.0000	NS	0.0357	0.0000

Conclusions

- For risk assessment of internal heat damage during cold storage of Laetitia plums, caused by high ambient temperatures near to the commercial harvest date, a useful method was formulated to force development of the disorder, namely: 6h FAC; 3d @ -0.5 °C; 2d @ 20 °C
- Presence of internal heat damage after exposure to this regime, provides a YES/NO indication
- It does not indicate severity of the problem
- Cooling in 48 to 72 hours gave significantly lower levels of internal heat damage compared to plums cooled faster than 24 hours (↑Flesh firmness, shrivel [72h] &↓skin cracks and GB)

Recommendations

- After a heat wave event in the week or two before harvest of Laetitia plums, slower cooling (48h) should be implemented as a matter of urgency
- 1-MCP can be used to retard fruit softening during the slow cooling and subsequent 42 days dual-temperature storage
- In addition, a sample comprising no less than 250 fruits should be drawn for risk assessment of internal heat damage (6h FAC; 3d @ -0.5 °C; 2d @ 20 °C)
- Use shortest cold storage possible – since internal heat damage is progressive

Recommendations - continues

- Relative humidity control during the FAC (48 hours) will be critical to reduce shrivel levels
- Optimum soil moisture will also be critical to reduce the possible heat damage underneath the shoulder of the plums
- Good foliar management
- The use of nets (permanent or drape) can be tested to measure the effect on fruit temperature and micro climate

Thank You!

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