Assessing the harvest quality of organic bananas

Project no. SMP24019, final presentation

11-12-2024, Dr. Leo Lukasse

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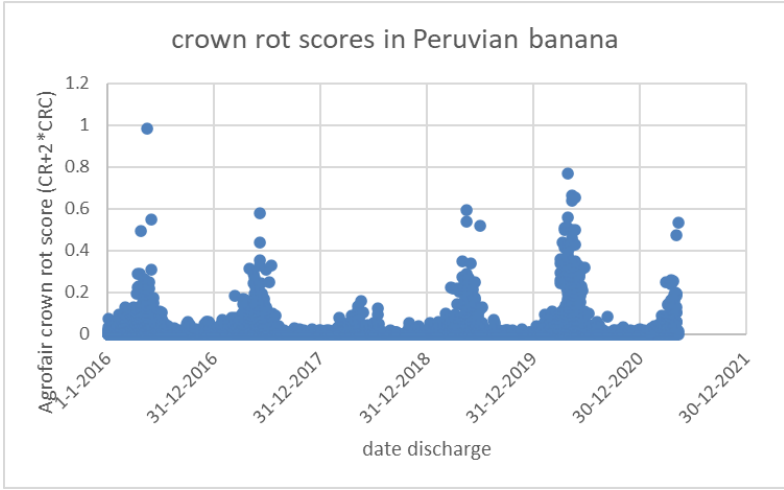
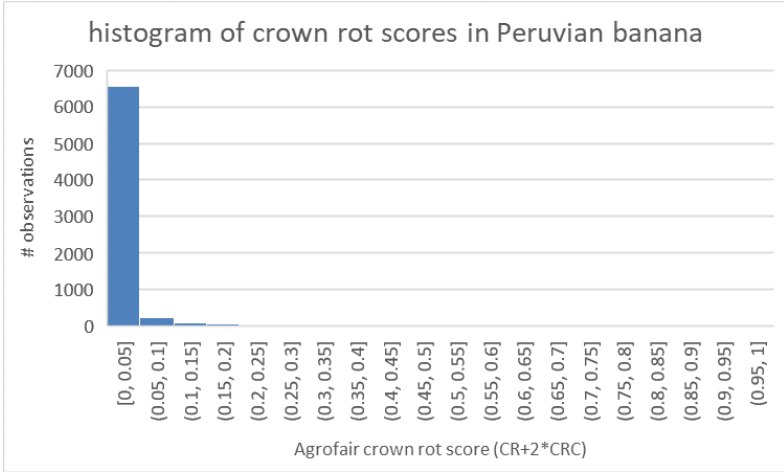
Idea

- Aim: better measure/estimate initial quality of organic bananas
- Consortium: Agrofair, Maersk, Tulipan Naranja, WR
- Approach: literature study, interviews, stakeholder discussions, field visits, field tests

Results

- Crown Rot is seasonal
- Big difference between years. Why?
- Within season there is big difference between batches. Why?





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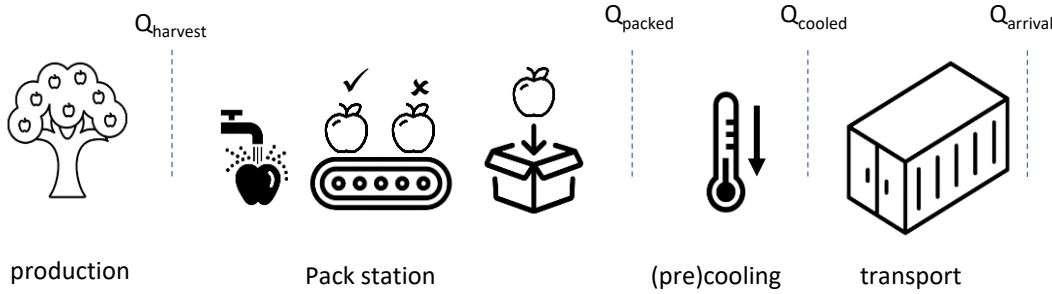
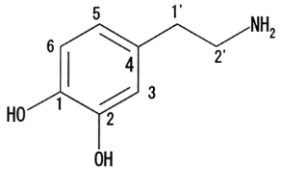
Results



- "Initial" quality is too simple
- Harvest quality – literature study
- Packed quality – brain storm sessions, experiment plan
- Cooled quality - experiment plan

Harvest quality – literature study

- Harvest maturity indictors
  - Weather pattern indicative of fungal growth (~30-40 days before harvest)
  - Orchard/plantation management (angularity, internal colour, days from full bloom)
- Measuring ethylene production early in the chain (new ethylene sensors development)
  - Ethylene production of fruit is linked to days to ripen (Chillet et al., 2005)
  - Indictor of fungal growth (*Colletotrichum)* (Mitcham et al., 2024)
  - Ethylene attenuates chilling injury (Zhou et al., 2022)
- Measure fungal resistance of fruits over the season (link with dry and wet period)
  - Dopamine (in the green peel) inhibits *Colletotrichum* (Muirheid, and Deverall, 1984)
  - Dopamine also ameliorates chilling injury (Ali et al., 2023)



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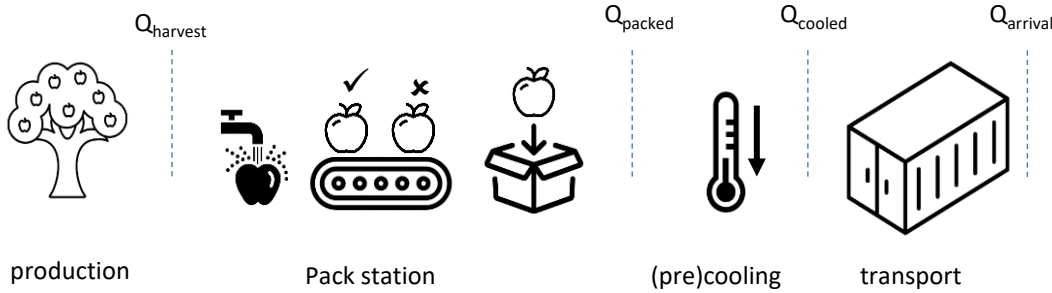
Packed quality

- Possible factors:
    - Is knife, used for cutting from bunch, clean?
    - Is water in bleeding basin clean?
    - Post-bleeding washing/spraying/cleaning steps
- Field experiment design written (too late): in 1 pack station apply different treatments, mark cartons, evaluate differences after arrival in NL.
- Field experiment should be executed in April.
- Options for monitoring bleeding basin water quality explored

Cooled quality

- Possible factor:
    - duration between packing and reaching optimal storage temperature
- Field experiment design available: apply different treatments (fast/slow cooling), mark cartons, evaluate differences after arrival in NL.
- Field experiment should be executed in April.

Main conclusions



- "Initial" quality is too simple
- Harvest quality
  - Dopamine as indicator of banana resistance?
- Investigate packhouse hygiene
  - Idea 1: field experiments
  - Idea 2: monitor washing water turbidity
- Precooling effects
  - Field experiments

Next steps

- Follow up: PPP IQ4DT submitted Aug. 2024. Rejected. 
- Consortium: Agrofair, Compagnie Fruitière, Maersk, Westfalia, Driscoll’s, Hemdahl, SmartSense, Vertigo
- Follow-up instruments
    - ~~plan A, PPP 2024~~
    - plan B, PPP 2025 or ????

Does Controlled Atmosphere Reduce Crown Rot in Organic Bananas?

Johannes W.H. van der Waal, BEng., MSc
AgroFair Europe B.V. , Barendrecht, Netherlands

Conclusions

1. Crown rot (CR) susceptibility is related to **fruit age** – accumulated degree.days
2. A higher **pulp temperature (PT)** at arrival and a longer **transit time** are related to increased crown rot incidence. PT cause or effect? Or both?
3. Not using **Controlled Atmosphere (CA)** increases the incidence risk by 1.66 / 1.99 for mild and severe crown rot.
4. CA is useful in situations with **add** and **transit** times in **highest quartiles**.
5. Further research: Extend to other countries, predict CR with **machine learning** models.

Introduction

1. Organic bananas are an important fruit category.
2. No synthetic chemicals – post-harvest anti-fungal protection of the crown is a challenge
3. Organic post-harvest products are prone to fraud (adulteration with quaternary ammonium compounds).
4. CA is reported to reduce crown rot in tests, but does it work on a commercial scale? Is it worth the additional cost?

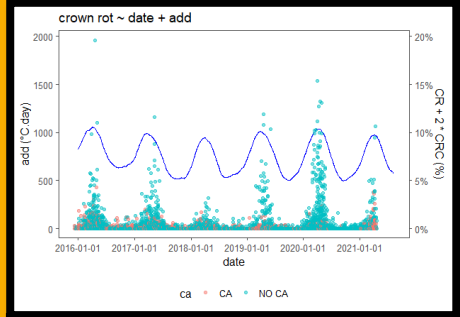
Experimental design

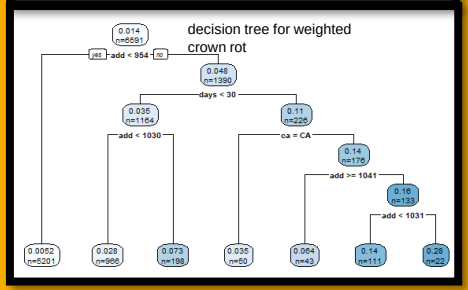
1. A data set of **6591 container shipments** of organic bananas from Peru to Europe, 540 with CA, 6051 without CA.
2. Crown rot assessment according to **industry protocol**, with and without CA.
3. Weather data are retrieved from **meteostat.net** API, for Piura, Peru
4. **Accumulated degree days** (add) computed on a 77 day growing cycle with 13.5°C cut-off.
5. Many zero values in dependent variable : **hurdle regression**, a combination of a binomial model for the zeros and a zero-truncated negative binomial count model. (library *pscl*).
6. **Decision tree** on weighted variable (C = CR + 2* CRC), (library *rpart*).

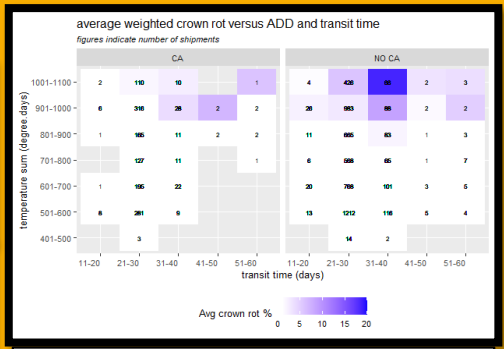

```
add             : accumulated degree days > 13.5°C
ADD             : add/100
ca              : dummy variable for CA
days            : transit time between pack and discharge
avggrade        : average gride (girth) of the fruit
maxtemp         : maximum pulp temperature on arrival
season          : dummy variable for crown rot season (wk 8-25)
Mild CR/ CR:    <20% of crown affected
Severe CR  / CRC:    > 20 % of crown affected
C               : weighted crown rot (CR + 2 * CRC)
theta = probability of drawing 0
```

Results and discussion

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 75	Max
CR	6591	0.007	0.024	0	0	0	0.43
CRC	6591	0.004	0.017	0	0	0	0.416
C	6591	0.014	0.052	0	0	0	0.98
add	6591	766.477	176.113	498.7	597.484	935.423	1054.981
ca	6591						
... CA	1316	20%					
... NO CA	5275	80%					
days	6591	27.424	3.488	18	26	29	60
maxtemp	6591	14.826	0.562	0	14.5	15.1	23.5





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HURDLE REGRESSION OUTCOMES  ========================
                                mild CR        severe CR
-------------------------------------------------------
Count model: (Intercept)     -11.29 ***     -11.37 ***
                               (1.18)         (1.59)
Count model: ADD               0.34 ***       0.41 ***
                               (0.02)         (0.04)
Count model: caNO CA           0.51 ***       0.69 ***
                               (0.07)         (0.12)
Count model: days              0.05 ***       0.02 *
                               (0.01)         (0.01)
Count model: avggrade          0.03           0.03
                               (0.02)         (0.03)
Count model: maxtemp           0.46 ***       0.42 ***
                               (0.04)         (0.06)
Count model: Log(theta)        0.41 ***       0.32 **
                               (0.07)         (0.10)
Zero model: (Intercept)       -4.23 ***      -5.61 ***
                               (0.25)         (0.30)
Zero model: season1            1.97 ***       2.31 ***
                               (0.07)         (0.09)
Zero model: days               0.08 ***       0.09 ***
                               (0.01)         (0.01)
-------------------------------------------------------
AIC                         13568.10        7719.22
Log Likelihood              -6774.05       -3849.61
Num. obs.                    6591           6591
=======================================================
*** p < 0.001; ** p < 0.01; * p < 0.05 std.er in  ()
```

Thank you

Leo Lukasse

Leo.Lukasse@wur.nl

Tel.: +31 317 480201