Establishing a workflow for accurate prediction of total soluble sugars of table grape berries using near-infrared spectroscopy

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Introduction
Problem statement and Project Aim

Determining optimum harvest maturity

- major challenge faced by table grape producers:
  - determining optimum harvest maturity, linked to the “best” eating quality
- minimum concentration of total soluble solids (TSS) must be met before grapes can be harvested
- current methods for determining TSS of grapes are destructive and time-consuming

To establish optimum TSS level linked to the “best” eating quality:

- Berries for sensory evaluation must be allocated in known TSS classes,
  using non-destructive methods
- Non-destructive methods to assess/predict table grape quality parameters include near-infrared spectroscopy

Project Aim: Establish a workflow for accurate prediction of TSS and optimal harvest maturity of intact table grape berries, using near-infrared (NIR)spectroscopy and sensory evaluation

Material and methods
Experimental cultivar

- Joybells was selected as experimental cultivar

- When Joybells, a red seedless cultivar of ARC Infruitec-Nietvoorbij, was released in 2018, its standards for optimum harvest maturity has not yet been established.

- Joybells has the following outstanding characteristics:
  - exceptionally high inherent acidity
  - unique fruity flavour
  - crunchy firm flesh

Material and methods
Experimental vineyard and sampling

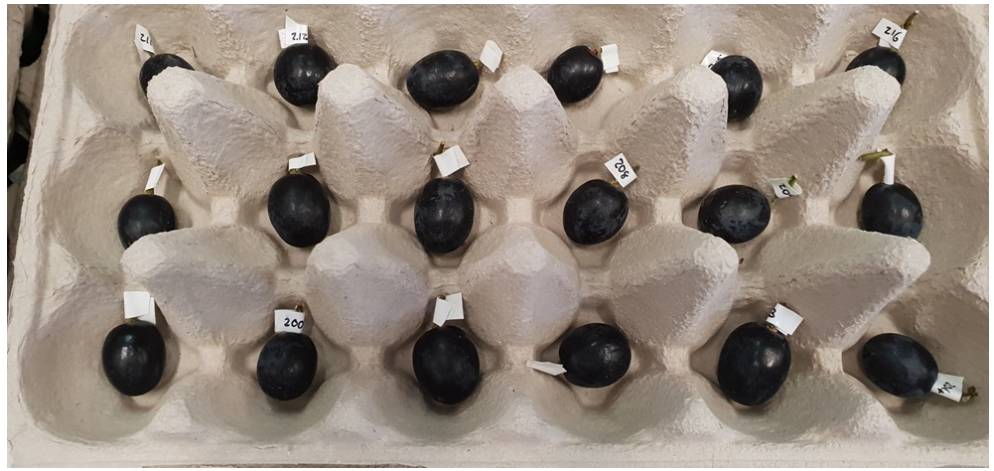
Grapes from an experimental vineyard at Hex River Valley experiment farm were harvested over four harvest dates (18/1, 25/1, 8/2, 15/2).

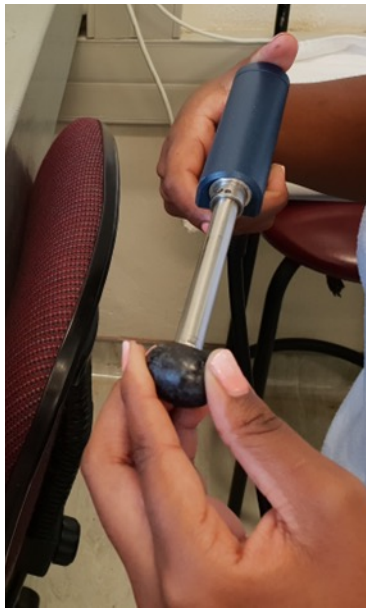
At each harvest date, two cartons of 4,5kg grapes were packed according to export protocol and stored in a cold room at -0.5^{o}C until instrumental measurements and sensory evaluations were done.

From the sampled bunches, 500 berries were randomly selected for the near-infrared scans

Material and methods
NIR spectroscopy

- After each single whole berry was scanned with the solid probe of the NIR spectrometer to obtain spectra, the berry's TSS was determined with a hand-held digital refractometer.
- A calibration for non-destructive prediction of TSS was established.
- For sensory evaluation, berries were separated into classes according to TSS concentration ranging from 18 to 27 ˚Brix, using the solid probe of the NIR spectrometer.





Material and methods
Sensory evaluation

- panel of 9 trained persons, 3 tasting sessions on one day
- each person tasted 27 berries per session
- 9 berries (one per TSS class) x 3 repetitions

- scoring (0-6) of main descriptors:

skin colour	green flavour
firmness	acidity (sourness)
sweetness	astringency
fruitiness	overall liking

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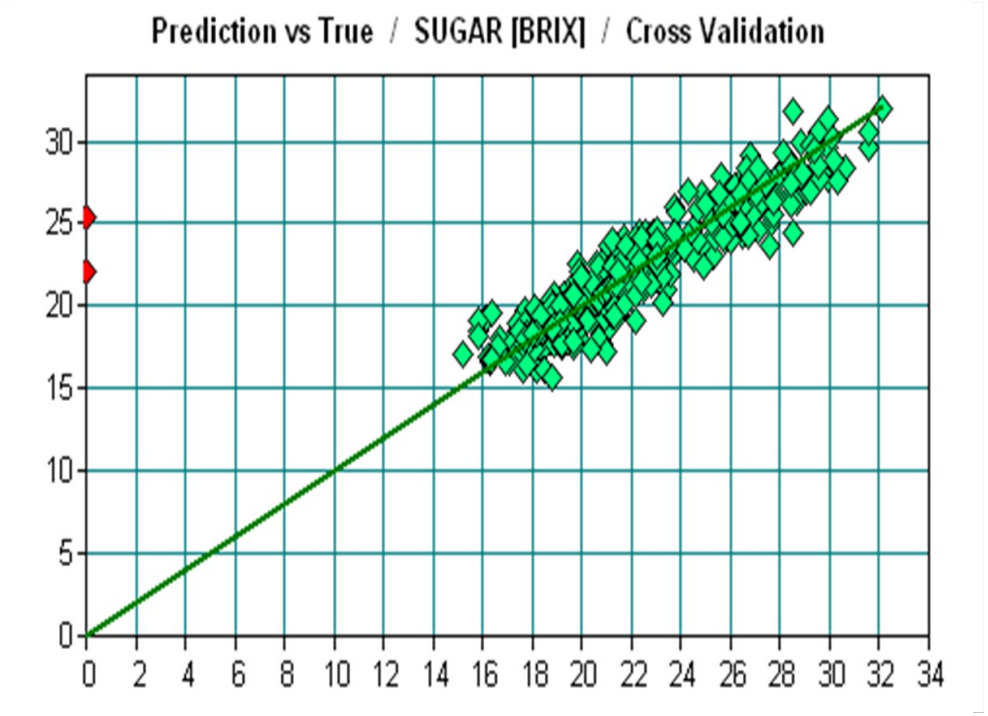
Results

Callibration for non-destructive prediction of TSS

Sugar groups and actual TSS,TA, pH, sugar: acid ratio of grouped samples

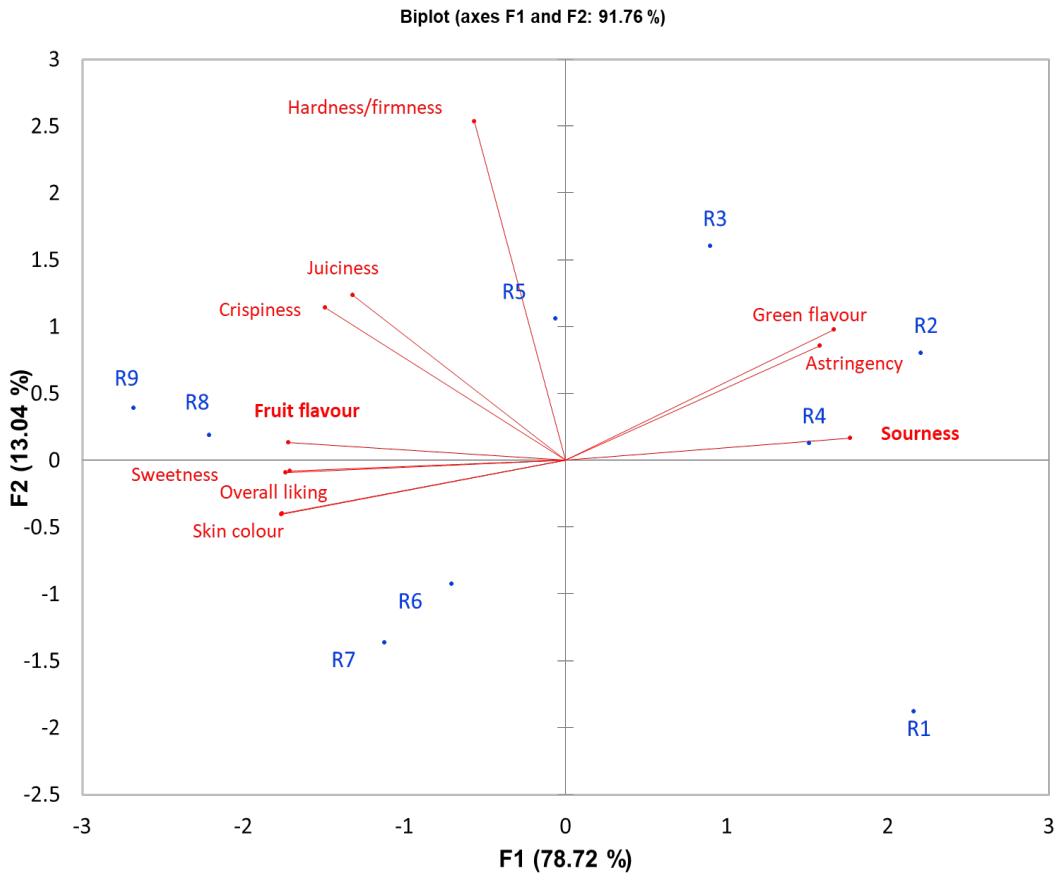
Ripening stage	Sugar groups	TSS (°Brix)	TA ($g.L^{-1}$)	pH	Sugar:acid ratio
R1	20-20.9	20.20	6.05	3.82	33.39
R2	21-21.9	21.70	5.22	4.08	41.57
R3	22-22.9	22.60	4.97	4.23	45.47
R4	23-23.9	23.50	4.94	4.40	47.57
R5	24-24.9	24.80	3.82	4.85	64.92
R6	25-25.9	25.90	3.80	4.85	68.16
R7	26-26.9	27.10	3.72	4.73	72.85
R8	27-27.9	27.80	3.55	4.92	78.31
R9	28-28.9	28.80	3.31	5.39	87.01



Predicted TSS versus True TSS (R^2 = 74.76%)

NIR spectroscopy can be used to predict TSS accurately for Joybells

Results
PCA biplot of sensory variables for Joybells



PCA biplot of sensory (taste) variables for Joybells

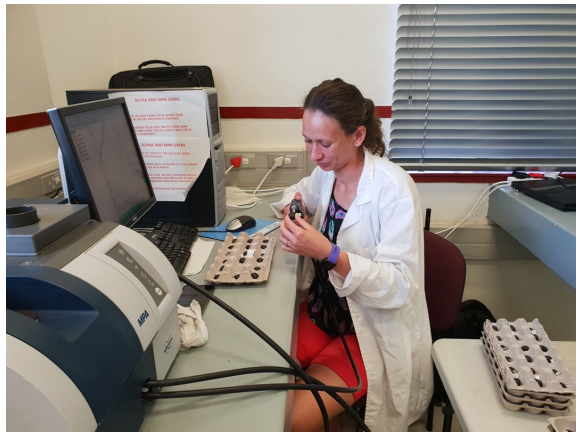
sweetness, fruitiness and sourness contributed most to the intensity score.

Conclusion and recommendations

- NIR spectroscopy can be used to predict TSS of Joybells accurately.
- No TSS categories were unacceptable (no score < 3).
- To limit risks (regarding pre and postharvest quality), grapes should be harvested at the lowest acceptable TSS for the consumer.
- Samples with lower TSS levels should be included in further evaluations to set standards for minimum and optimum harvest maturity of Joybells.
- Calibrations should be established for more table grape cultivars

Further research… following on this study..

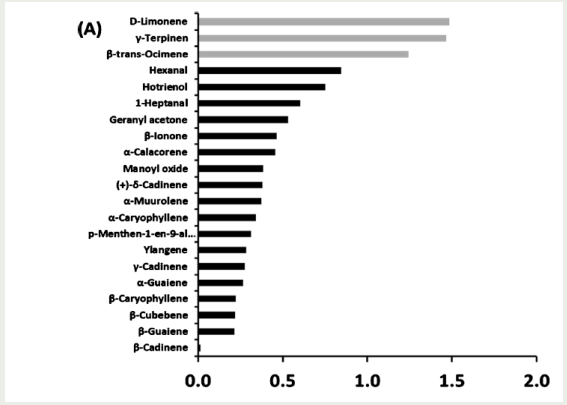
- The TSS calibration range for Joybells® was expanded in the next two seasons
- Calibrations for Sable Seedless® were established over three seasons (2019/20 – 2021/2022)
- Workflow developed and the Sable Seedless® calibrations established are applied in a current Ph.D. study "Chemosensory profiling of Sable Seedless® through berry ripening"



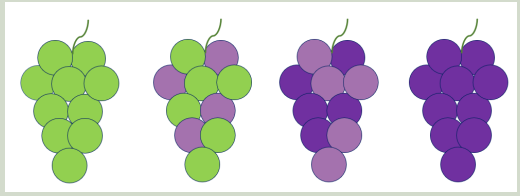
- The workflow, prediction models and calibrations developed through this study, contribute to establishing reliable, robust and non-destructive methods for TSS quantification and determining the harvest maturity of table grapes.

Expected Outcomes of PhD study of N. Viljoen

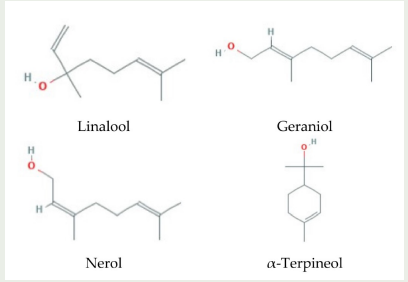
“Chemosensory profiling of Sable Seedless® through berry ripening”

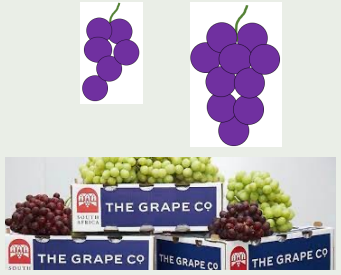


Chemosensory profile for Sable Seedless



Sensory profiles at different TSS levels





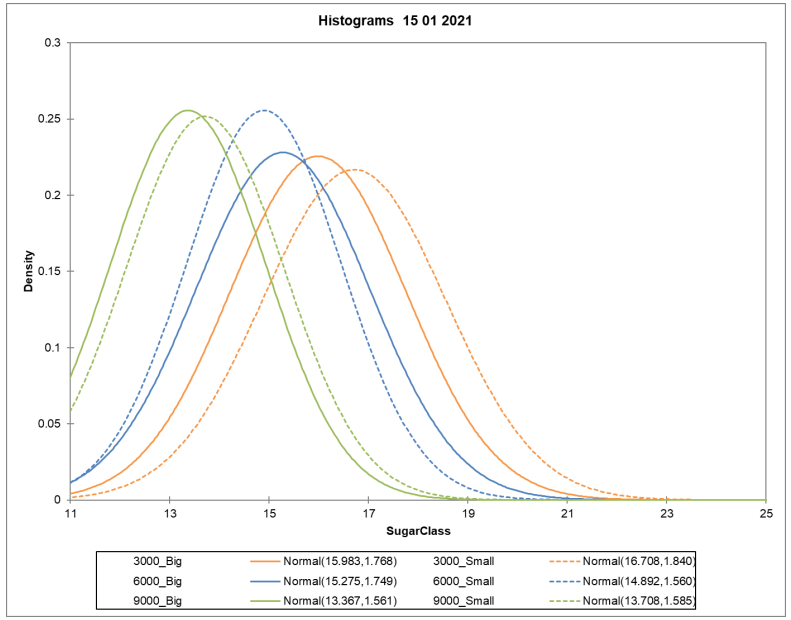
Verify whether relationship exist:

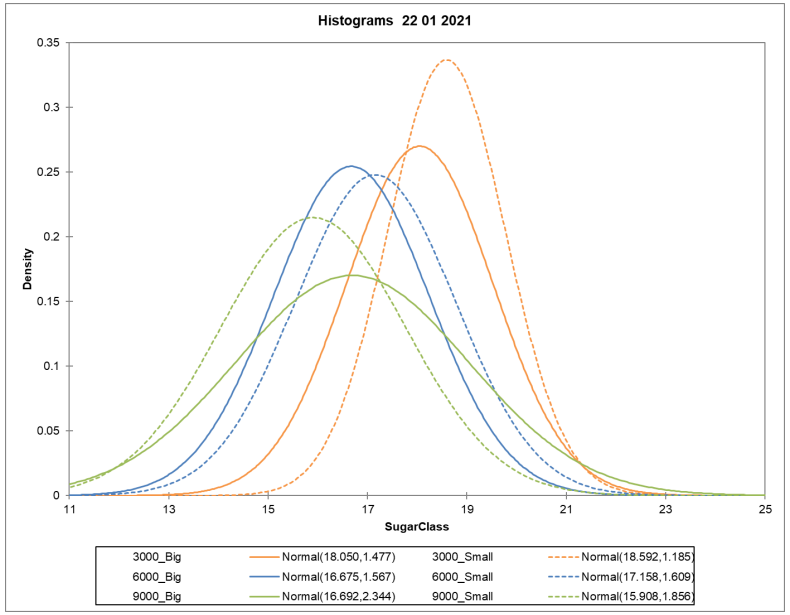
- crop load, bunch size and chemical composition
- crop load, bunch size and flavour

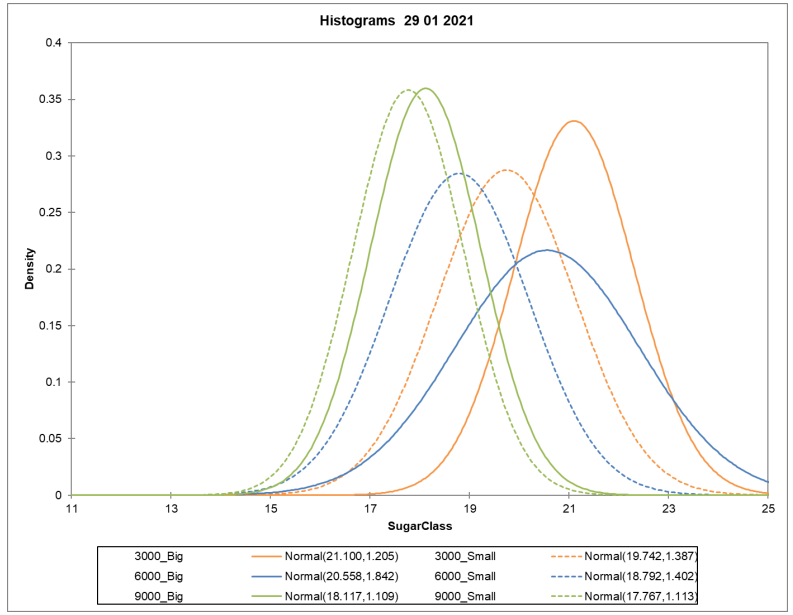
Results from PhD study of N.Viljoen:

Sable Seedless® 2020/2021:

Crop load affected frequency of TSS classes at 3 sampling (tasting) dates







4 Jan | 11 Jan | 18 Jan

NIR solid probe calibration obtained in 2020 was used to separate berries into TSS classes for sensory evaluation.

Distinct differences between crop loads:

- TSS
- unique Sable taste

3000 cart/ha (orange lines

6000 cart/ha (blue lines)

9000 cart/ha (green lines)

Acknowledgements

Student Bursary funding

- SATI

Technical support and inputs

- Stephan Badenhorst and his team of The GrapeCo
- Wouter Beukes, Breyten Bronkhorst, Hannes du Toit and the Roodezand Farm team
- SAGWRI Table Grape research group

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

SAGWRI South African Grape and Wine Research Institute

Thank you
Enkosi
Dankie

AgriSciences · EyeNzululwazi ngeZolimo · AgriWetenskappe

Photo by Stefan Els