Impact of Grapevine leafroll-associated virus-3 and grapevine red blotch virus on yield and berry juice quality in the American grape variety Norton/Cynthiana (Vitis aestivalis)

Cooper Adams

Introduction

- Recent studies have focused on the effects of Grapevine Red Blotch Virus (GRBV) on vine health and berry quality of Cabernet Sauvignon, Merlot, and Cabernet Franc
- Our preliminary data from last year (Fall 2020) examined the effects GRBV on berry quality
- We have continued this analysis for a second year (2021), examining the effects of GRBV, GLRaV3 on Norton

What viruses cause damage?

- Of the viruses detected in the Missouri survey, two that have been documented to cause the greatest losses are:
  - GRBV
    - Geminiviridae, monopartite gemini like virus, one single strand circular DNA
  - The grapevine leafroll-associated viruses (GLRaV-3, and to a lesser extent GLRaV-2, and GLRaV-2RG)
    - Closteroviridae, genus Ampelovirus, two sub groups, alpha virus, + strand RNA
      - GLARV-2, genus Closterovirus, separate from other leaf roll viruses

Grapevine leafroll-associated virus 3 symptoms in red Zinfandel

Symptoms

- Interveinal reddening and downward rolling of leaf margin in red cultivars

Photo taken by Ed Weber, UC Cooperative Extension

Slide provided by Jim Wolpert

Grapevine leafroll-associated virus 3 symptoms in red Zinfandel

(No distinct symptoms of GLRaV-3 have been observed in Missouri grape hybrids)

Photo taken by Ed Weber, UC Cooperative Extension

Slide provided by Jim Wolpert

Grapevine red blotch virus symptoms in Crimson Cabernet in a Missouri vineyard

Photo taken by Dean Volenberg, Oct. 25, 2017

- Symptoms:
  - Anthocyanin build up, initially in older leaves, top of the canopy in fall
  - Eventually leaf senesce from plant
  - Severity related to onset, location

Grapevine red blotch virus symptoms in Crimson Cabernet in a Missouri vineyard

GRBV symptoms have only been confirmed in Crimson Cabernet

Photo taken by Dean Volenberg, Oct. 25, 2017

Why is it hard to find GRBV and GLRaV3 in Norton?

- There are no symptoms found in Norton for GRBV and GLRaV3 which makes it near impossible to find without screening for the virus

Previous Findings

- GRBV and the grapevine leafroll-associated viruses have been documented to affect vine health and berry quality in California, and British Columbia Canada.

GRBV and GLRaV3 block grape maturation in *Vitis vinifera*

GRBV and GRLaV-3 on Cabernet Sauvignon and Merlot

- Decreasing Brix
- Decreasing pH
- Increasing TA

Girardello et al., 2020. Molecules 25, 3299; doi:10.3390/molecules25143299

Bowen et al. 2020, Am J Enol Vitic 71, 308-318

Girardello et al. 2020. J. Sci Food Agric. 100, 14361447

Estimated Economic Impact of GRBV and GLRaV-3 in *Vitis vinifera*

- GRBV causes estimated loses of:
  - $2.2k - $68.5k per hectare over a 25-year life cycle of Cabernet Sauvignon or Merlot

- GLRaV-3 causes estimated loses of:
  - $25k - $40k per hectare in Cabernet Franc in New York
  - $29k - $225k per hectare in Cabernet Sauvignon in California

What are the effects on Norton?

- Evaluate the impact of GRBV on yield and berry juice quality in Norton
- Evaluate the impact of GLRaV3 on yield and berry juice quality in Norton

2020 growing season:

Screening and selecting 5 vines of healthy and 5 vines of GRBV to sample

Collecting 4 clusters from the selected vines

Cluster weights

2020 growing season: How does GRBV effect berry cluster size and weight?

25 berries selected that were representative of the cluster

Berries individually weighed

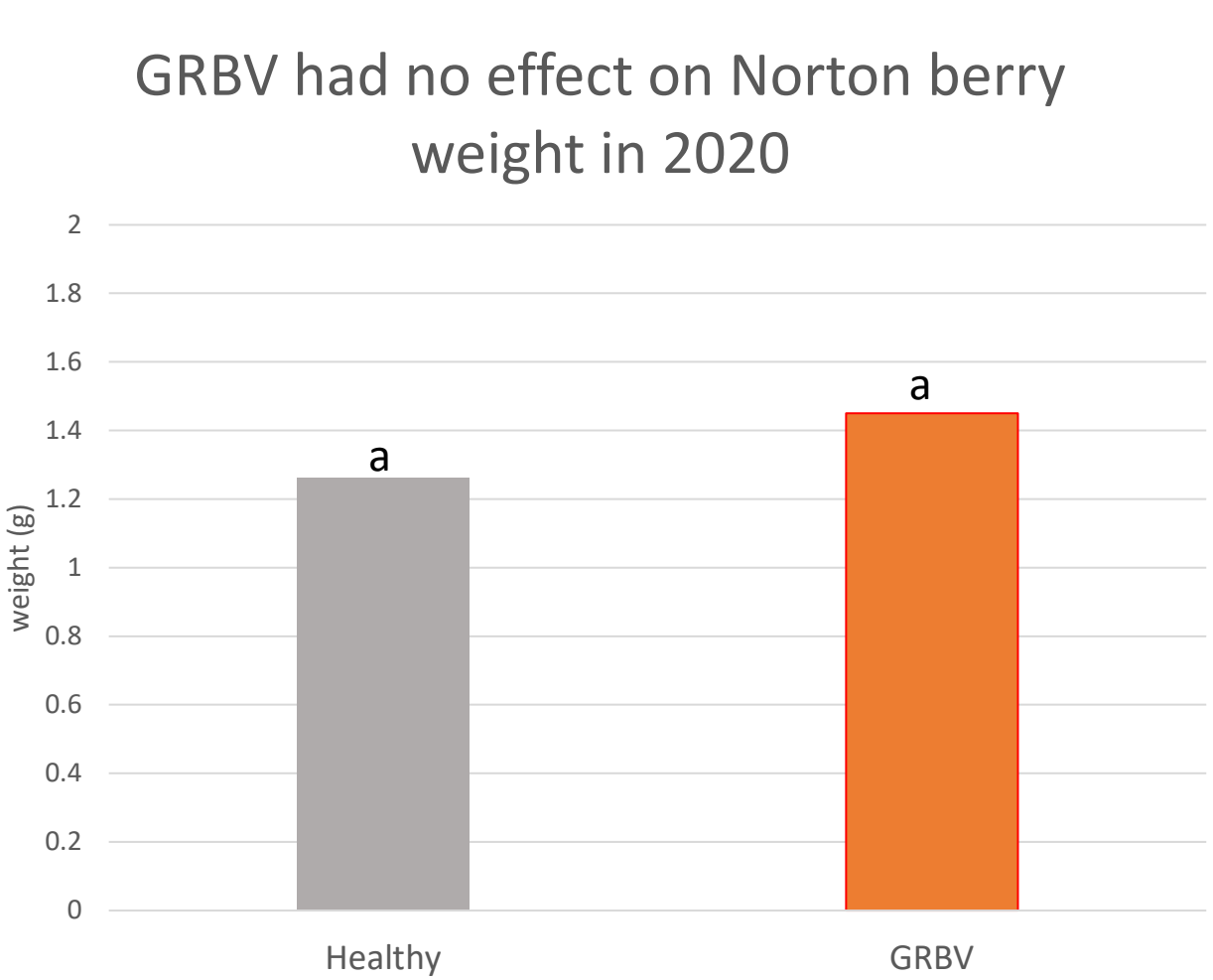
2020 growing season: How does GRBV effect berry juice quality and weight?

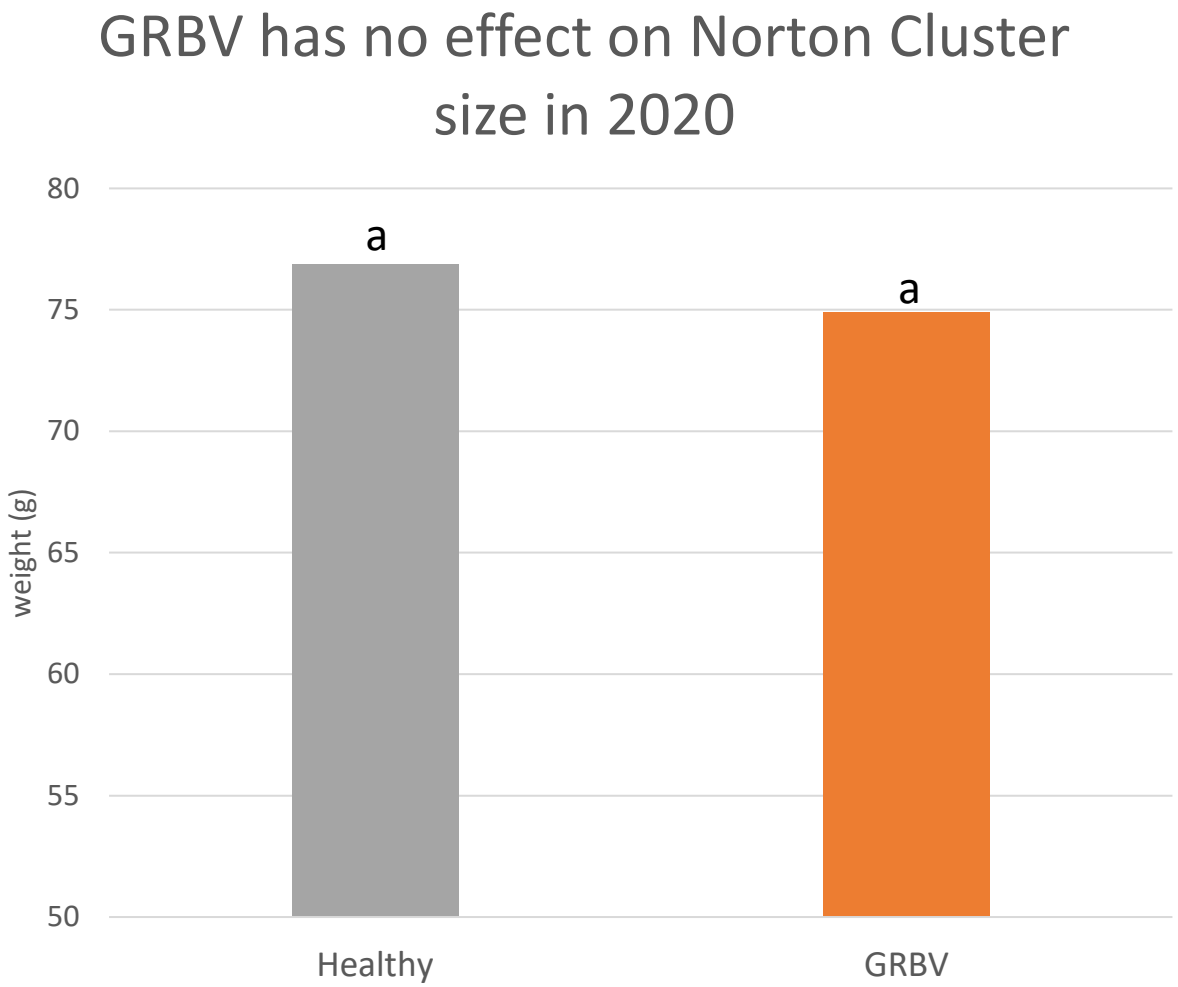
Berries hand juiced and collected in 15 ml tubes.

1ml of juice has Brix measurement done

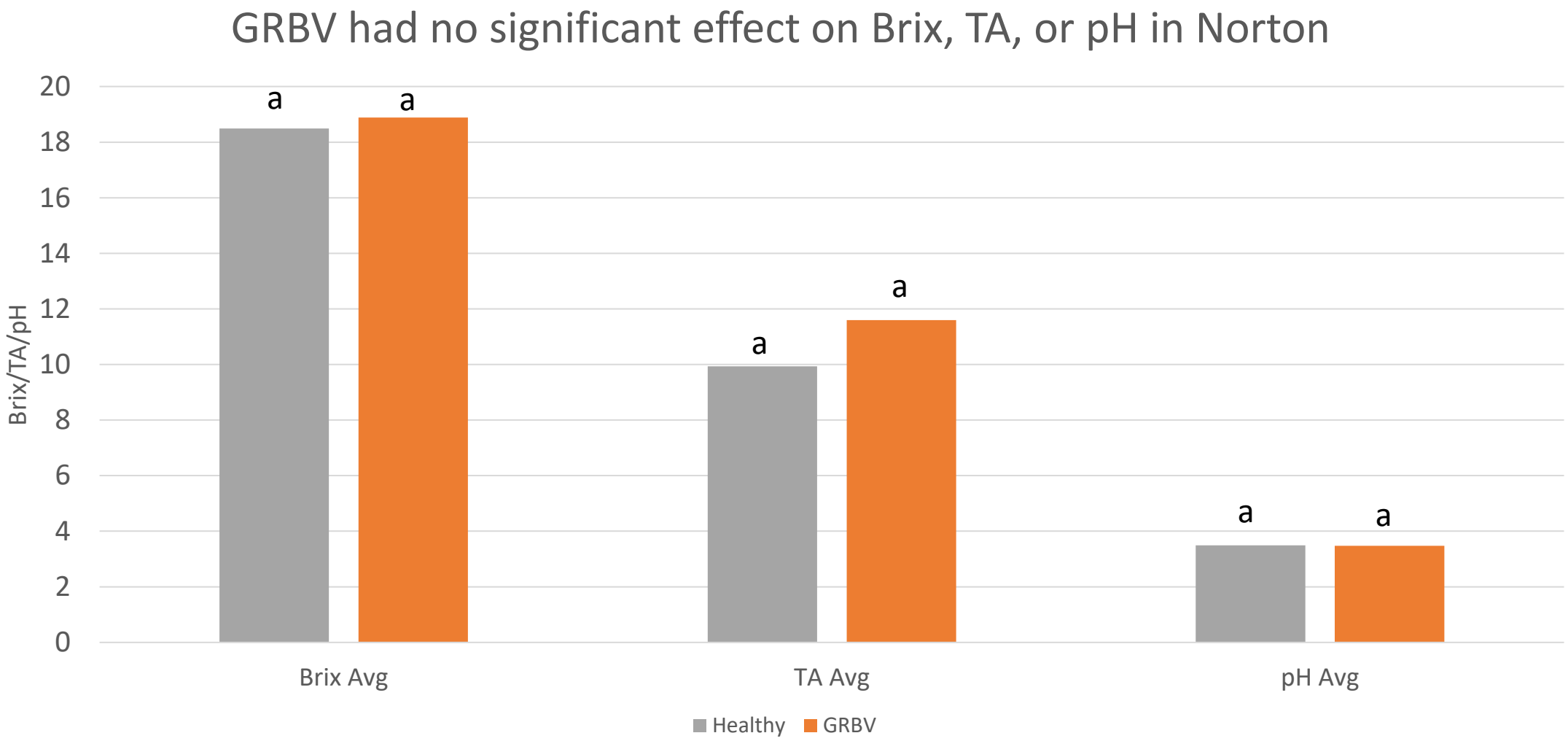
Auto titrator runs 10ml of juice through TA and pH testing.

2020: Berry and cluster size are not impacted by GRBV in Norton





2020: No significant differences in Brix, TA, or pH



Plans for year two: 2021

NEW PLANTS SCREENED THIS YEAR

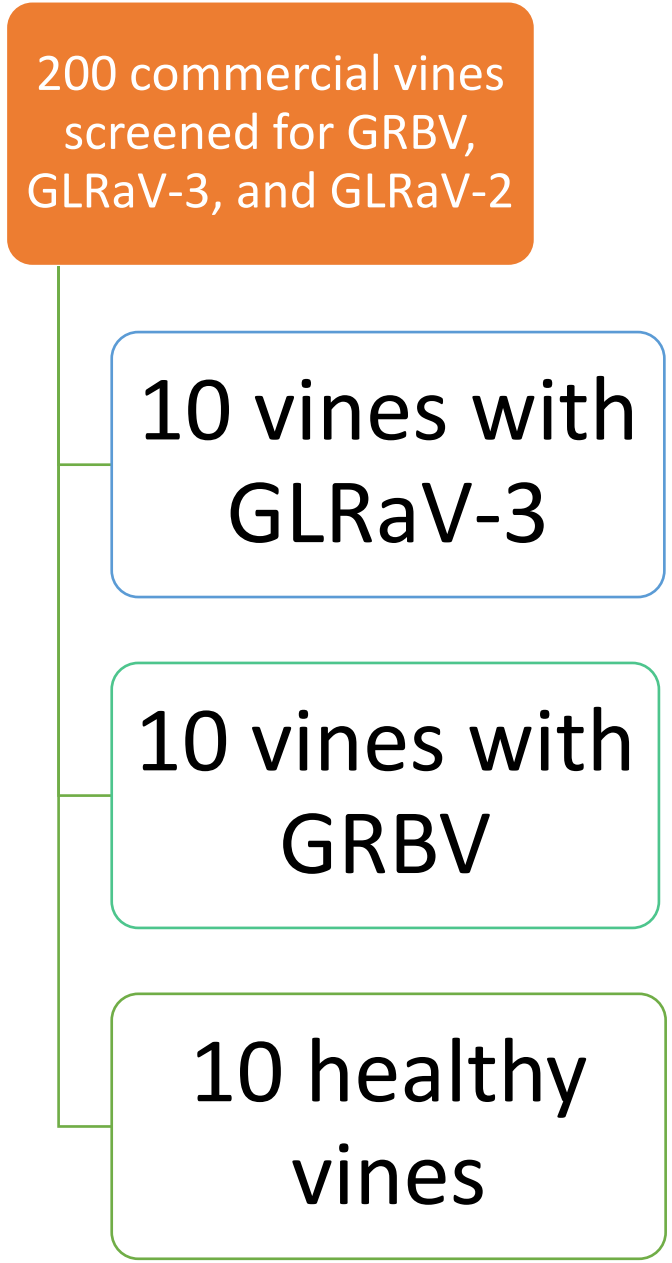
SAMPLING BERRIES MULTIPLE TIMES AS WELL AT VERASION

WE WILL TAKE BERRIES FROM THOSE PLANTS AND DO SIMILAR ANALYSIS TO LAST YEAR FOR BERRY WEIGHT, CLUSTER COUNT, PH, TA, AND BRIX. PRUNING WEIGHTS

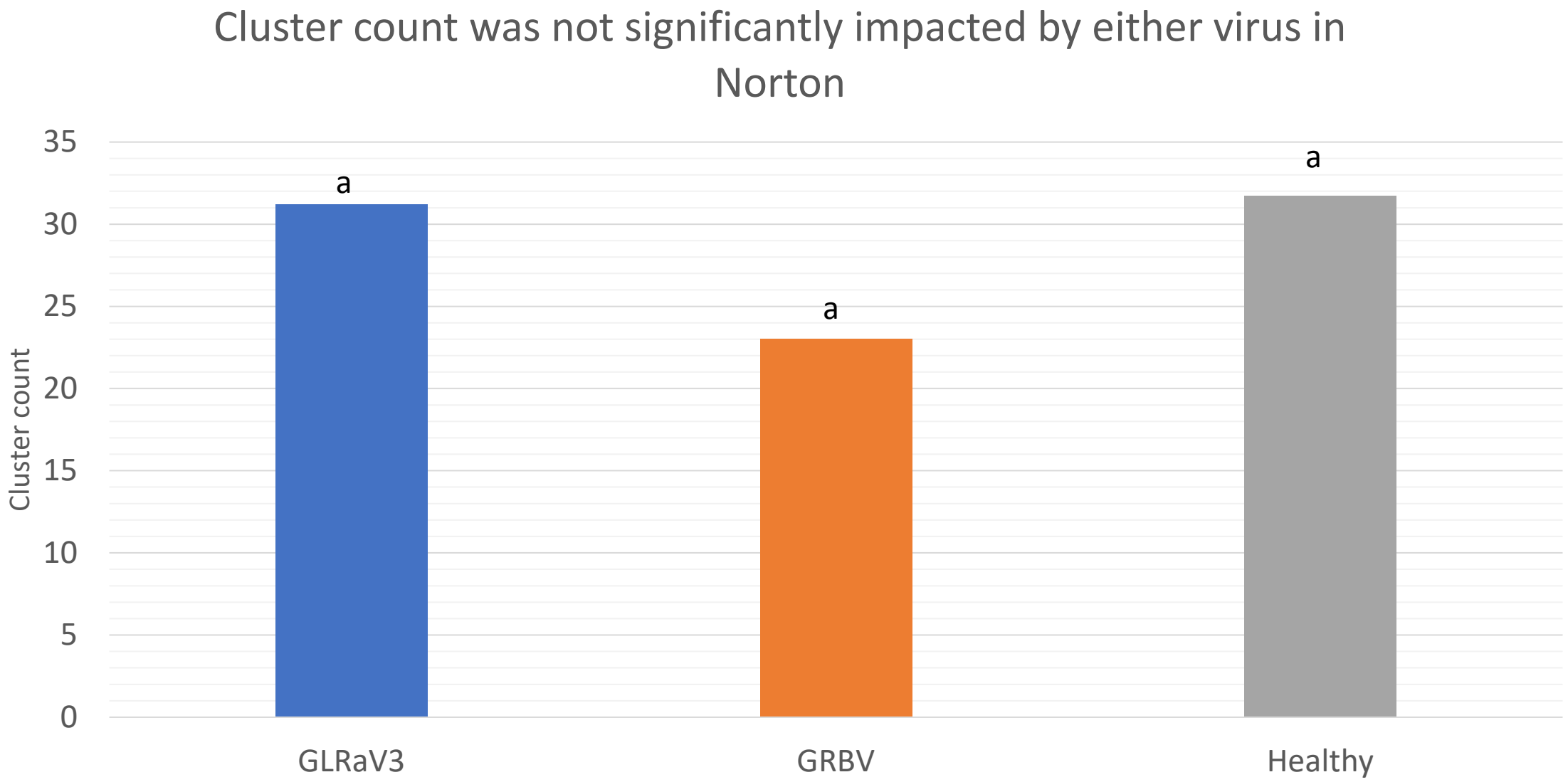
2021 Berry Sampling Procedure

- 10 vines infected with each virus were selected from screening.
- Initially cluster counts were performed at each vine.
- 25 Berries were selected from the middle of the cluster alternating from the front of the cluster to the back of the cluster.
  - In situations were there were not many clusters on the vine some were double sampled to get 25.
- These berries were then transported in ice before having analysis done on them.
  - Weight, TA, pH, and Brix
- The following week we returned to sample 25 more berries
  - Due to spray schedules sometimes, it was more or less than a week between samples

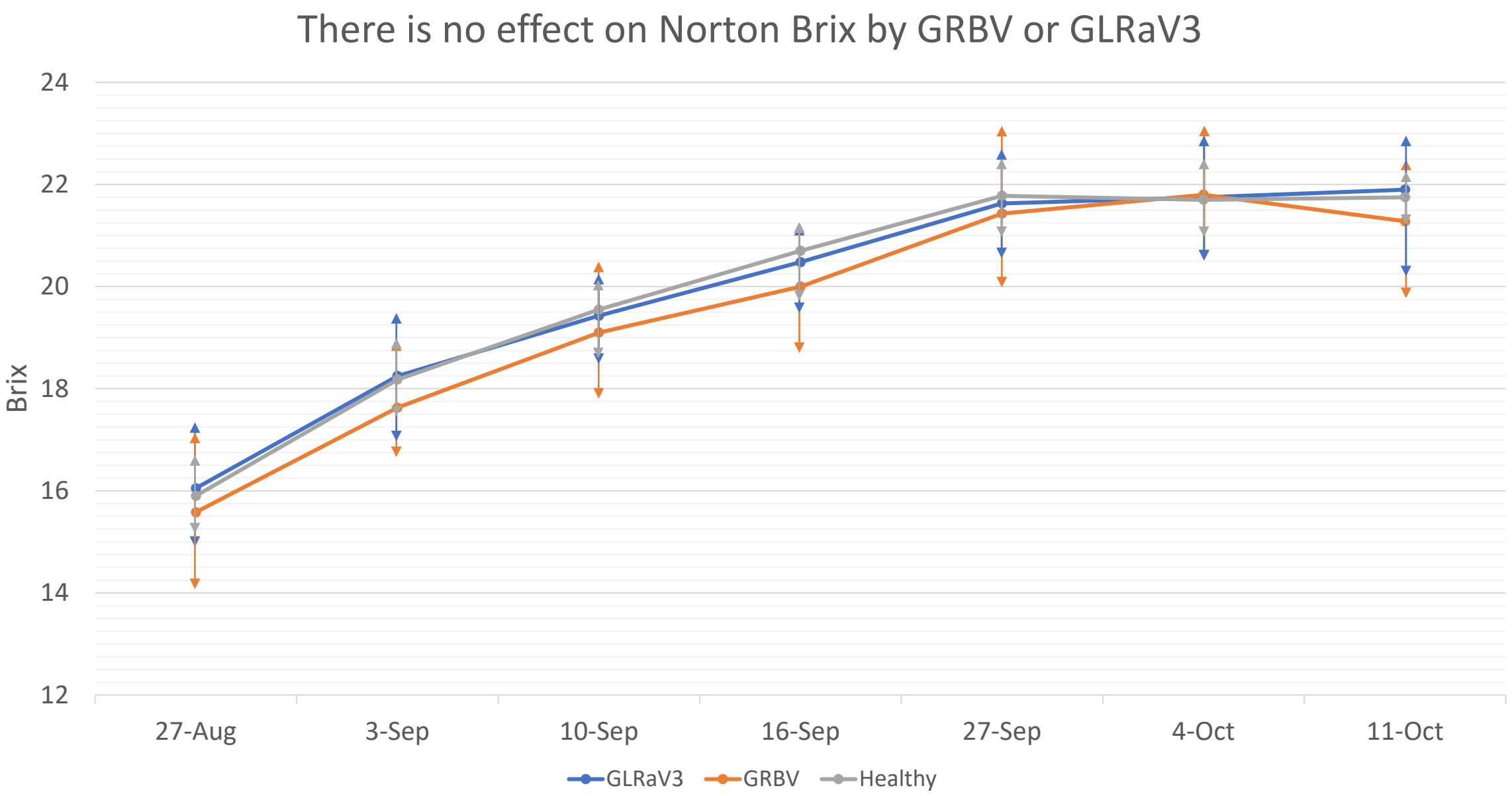
Year 2 Influence of GRBV and GLRaV-3 on yield and berry quality: Norton

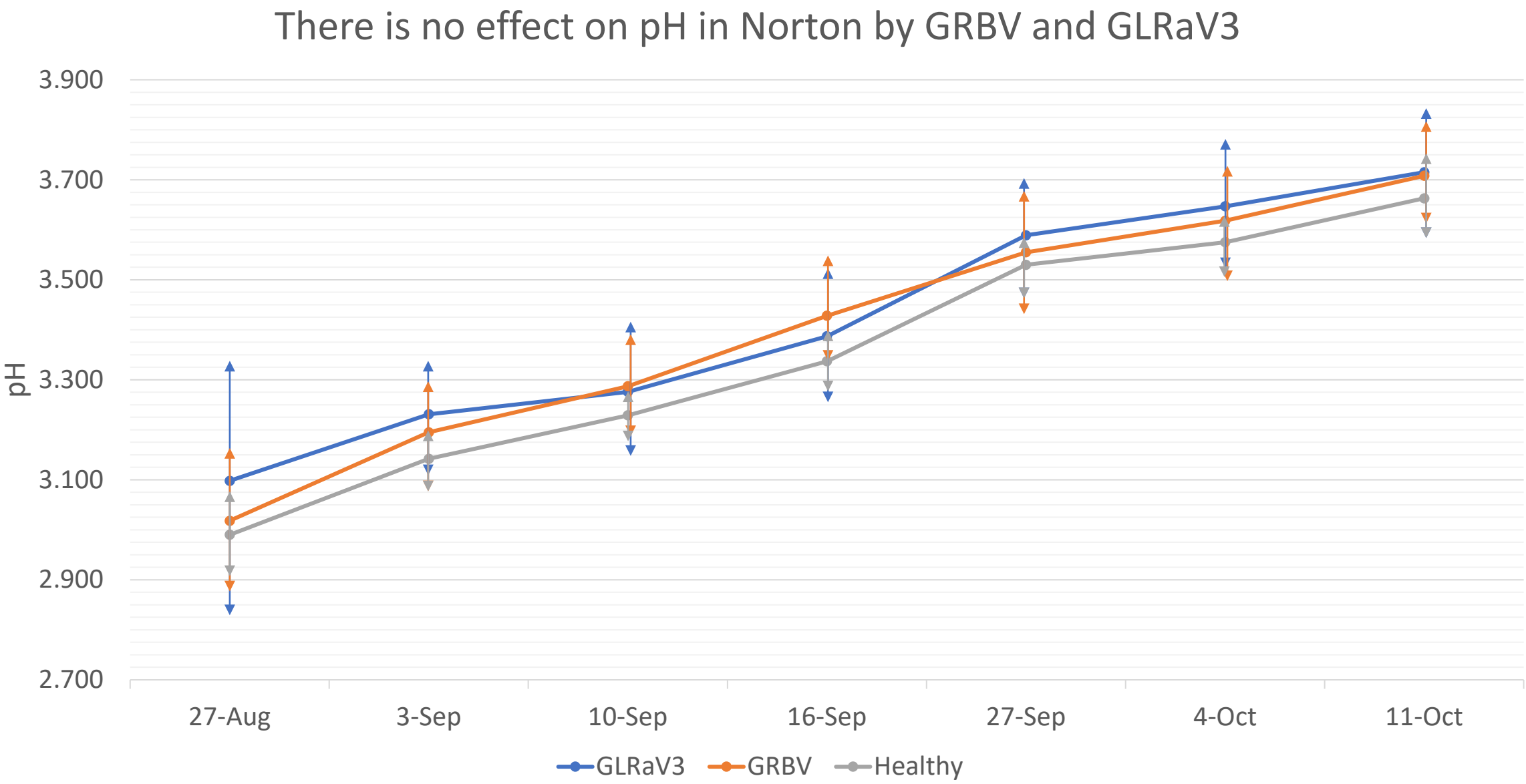


Did GRBV or GLRaV3 affect Norton cluster counts?

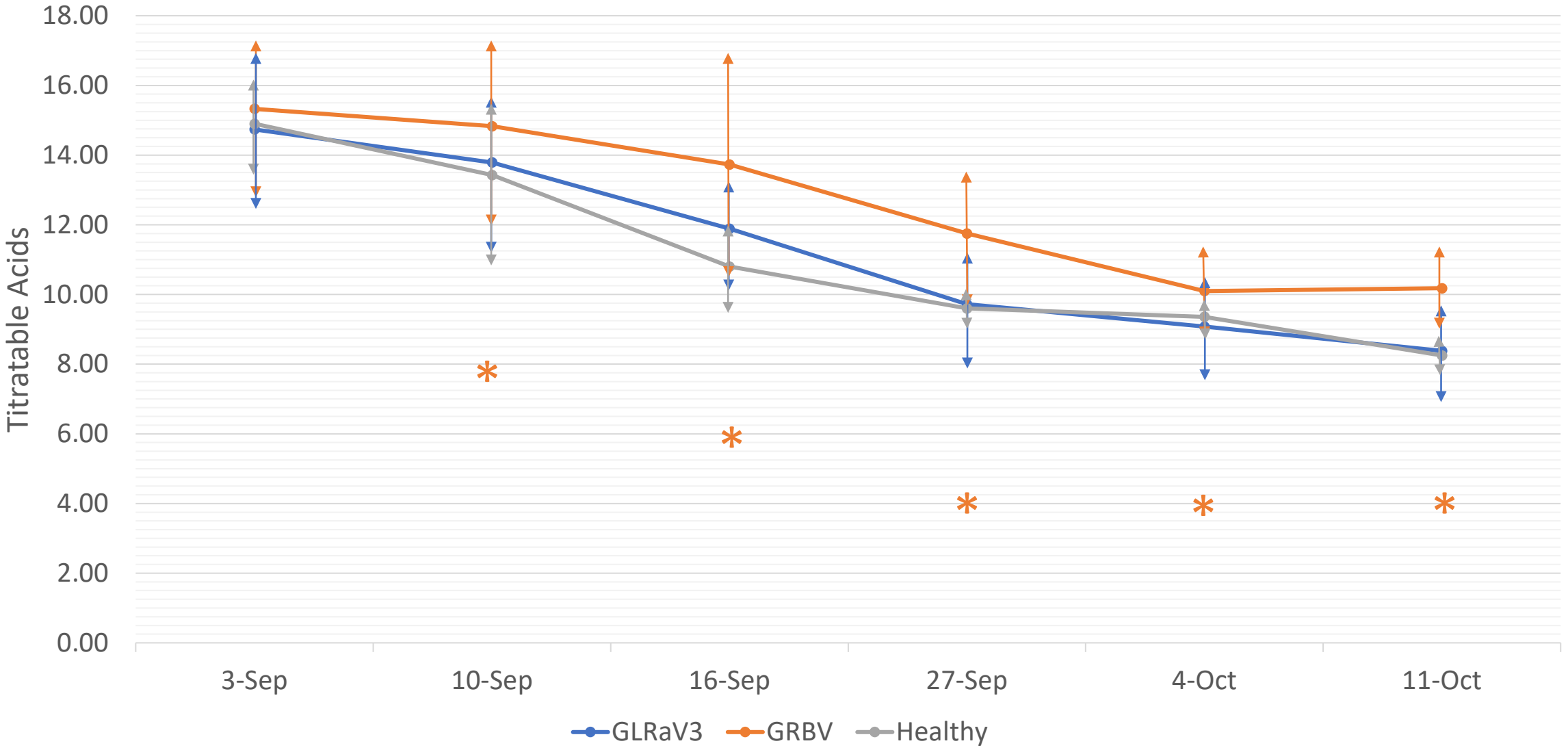


Anova done at .05 for all statistical analysis


There is no effect on Norton Brix by GRBV or GLRaV3
Brix
24
22
20
18
16
14
12
27-Aug
3-Sep
10-Sep
16-Sep
27-Sep
4-Oct
11-Oct
GLRaV3
GRBV
Healthy

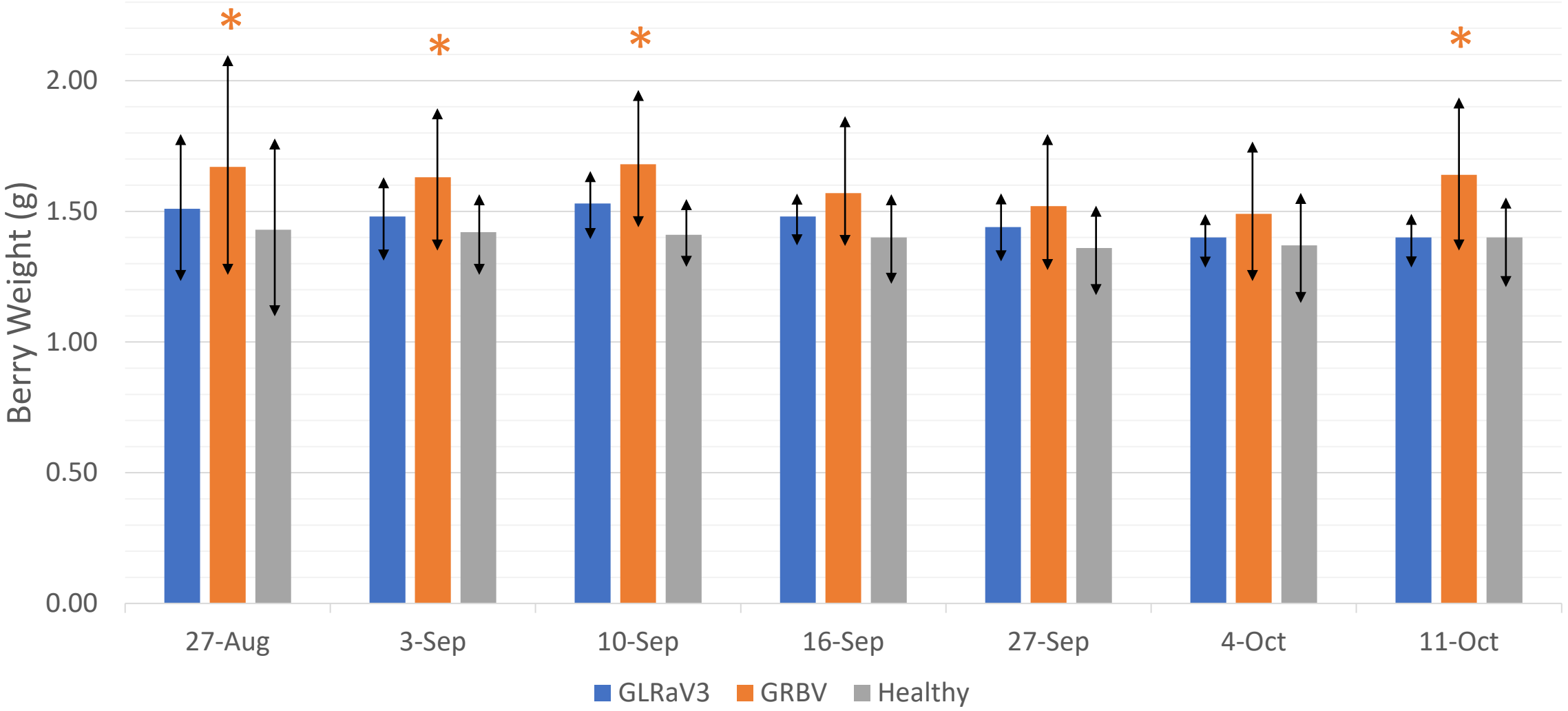

There is no effect on pH in Norton by GRBV and GLRaV3
pH
3.900
3.700
3.500
3.300
3.100
2.900
2.700
27-Aug
3-Sep
10-Sep
16-Sep
27-Sep
4-Oct
11-Oct
GLRaV3
GRBV
Healthy

Titratable acids from berries infected with GRBV are higher than those from virus-free berries



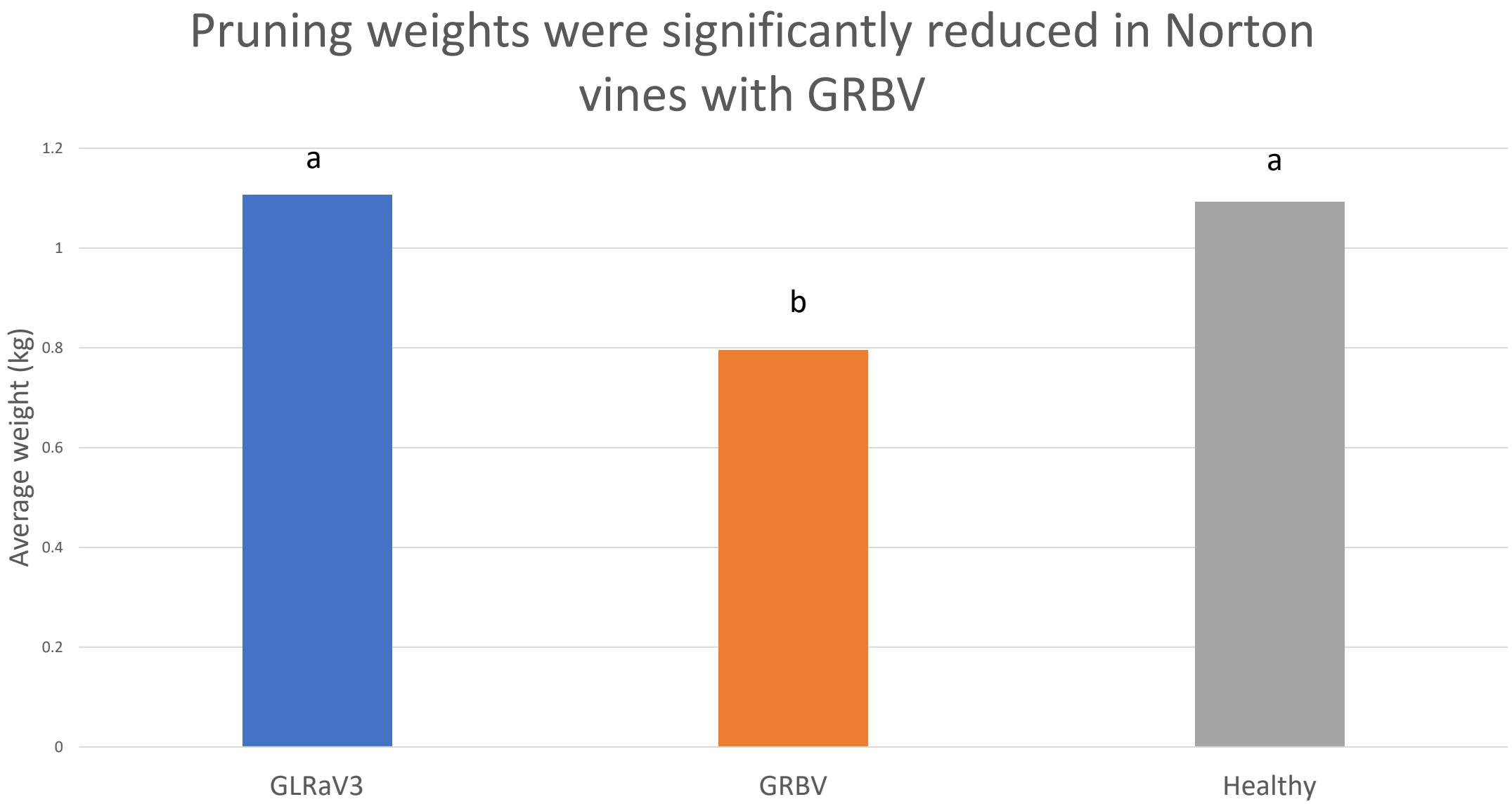
* Notes a significant difference at p < .05

Norton Berry weights from vines infected with GRBV were significantly higher than those from healthy vines



* Notes a significant difference at p < .05

Were pruning weights impacted?



Comparison of virus titers in Norton (*Vitis aestivalis*) to Kishmish Vatkana (*Vitis vinifera)*

Overall virus load is lower in Norton than in Kishmish Vatkana

The titer of the leafroll viruses (GLRaV-1, GLRaV-2, GLRaV3) was significantly lower in Norton than in Kishmish Vatkana

Howard et al., 2021, Phytobiomes 5, 432-441

Norton is tolerant to GLRaV-3

- *Vitis vinifera*
  - Brix ↓
  - pH ↓
  - TA ↑
  - Berry weight ↑
  - Pruning weight ↓
  - Clusters/vine ↓
  - Berries/cluster ↓
- Norton (*Vitis aestivalis*)
  - Brix ↔
  - pH ↔
  - TA ↔
  - Berry weight ↔
  - Pruning weight ↔
  - Clusters/vine ↔
  - Berries/cluster?

Norton may have some degree of tolerance to GRBV

- *Vitis vinifera*
  - Brix ↓
  - pH ↓
  - TA ↑
  - Berry weight ↑
  - Pruning weight ↓
  - Clusters/vine ↓
  - Berries/cluster
- Norton (*Vitis aestivalis*)
  - Brix ↔
  - pH ↔
  - TA ↑
  - Berry weight ↑
  - Pruning weight ↓
  - Clusters/vine ↔
  - Berries/cluster?

Conclusions for study and what is left to do?

- Norton is tolerant to GLRaV3
- Norton has some tolerance to GRBV compared to *Vitis vinifera*
- Norton is an American species *Vitis aestivalis*
  - May be more adapted to both GLRaV-3 and GRBV
  - To further investigate phenolics and comparison of juices need to be done

Acknowledgments

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Questions?