

# Viticultural Practices to Improve Fruit Quality in Hybrid Grapevines and The NDSU Grape Breeding Program



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Razi Ibrahim, Ikbal Tatar, Harlene Hatterman-Valenti

# Sweet Home Alabama; Chilton County Peaches



# Sweet Home Alabama





# Sweet Home Alabama



# Sweet Home Alabama



# Sweet Home Alabama



# Sweet Home Alabama





# Sweet Home Alabama





Healthy Grapes Grow Even in the Most Challenging Climates  
when you pair the right vine with the right management.



# North Dakota has Serious Viticultural Problems

Few Frost Free Days  
Few Growing Degree Days  
Limited Cultivar Options





# Fruit Ripening

Frontenac

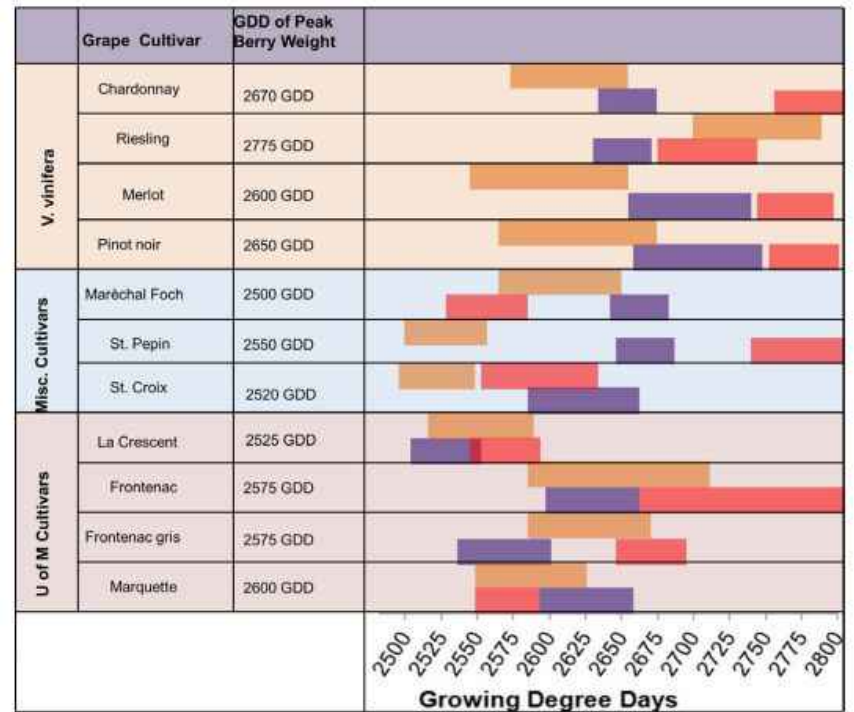
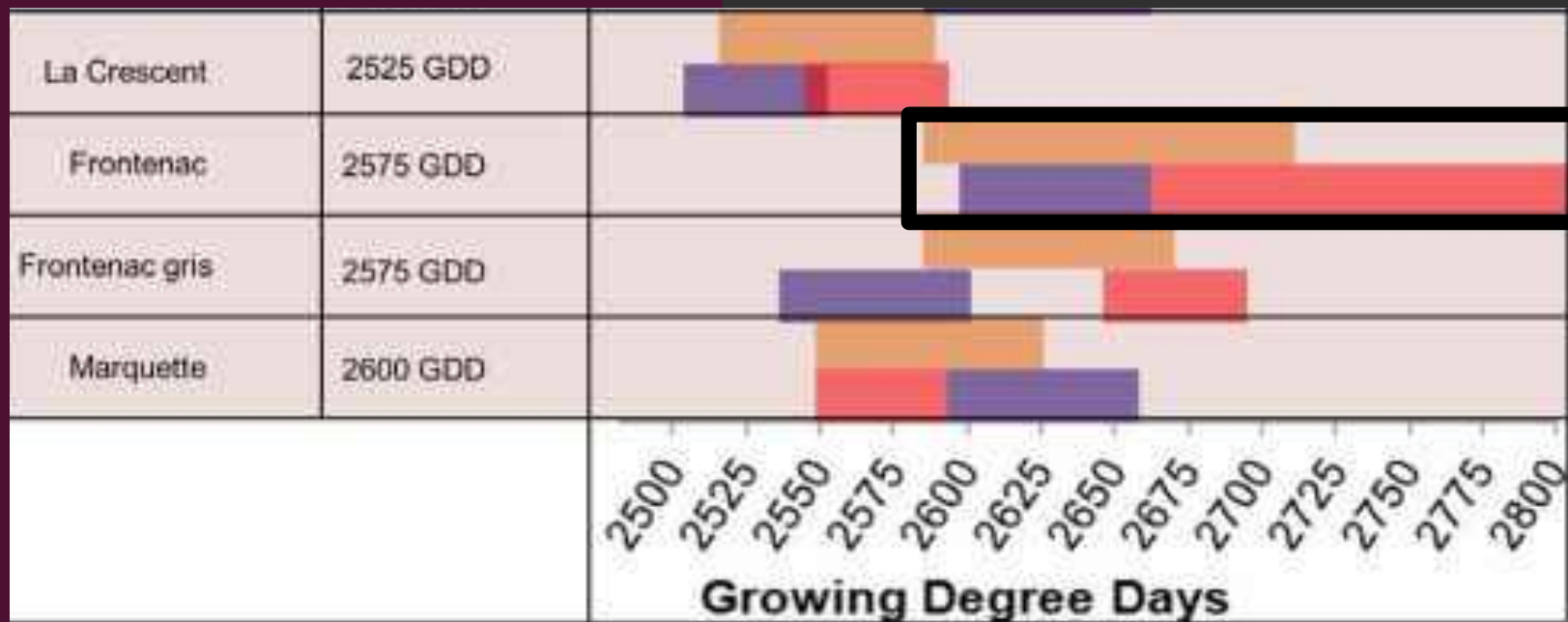
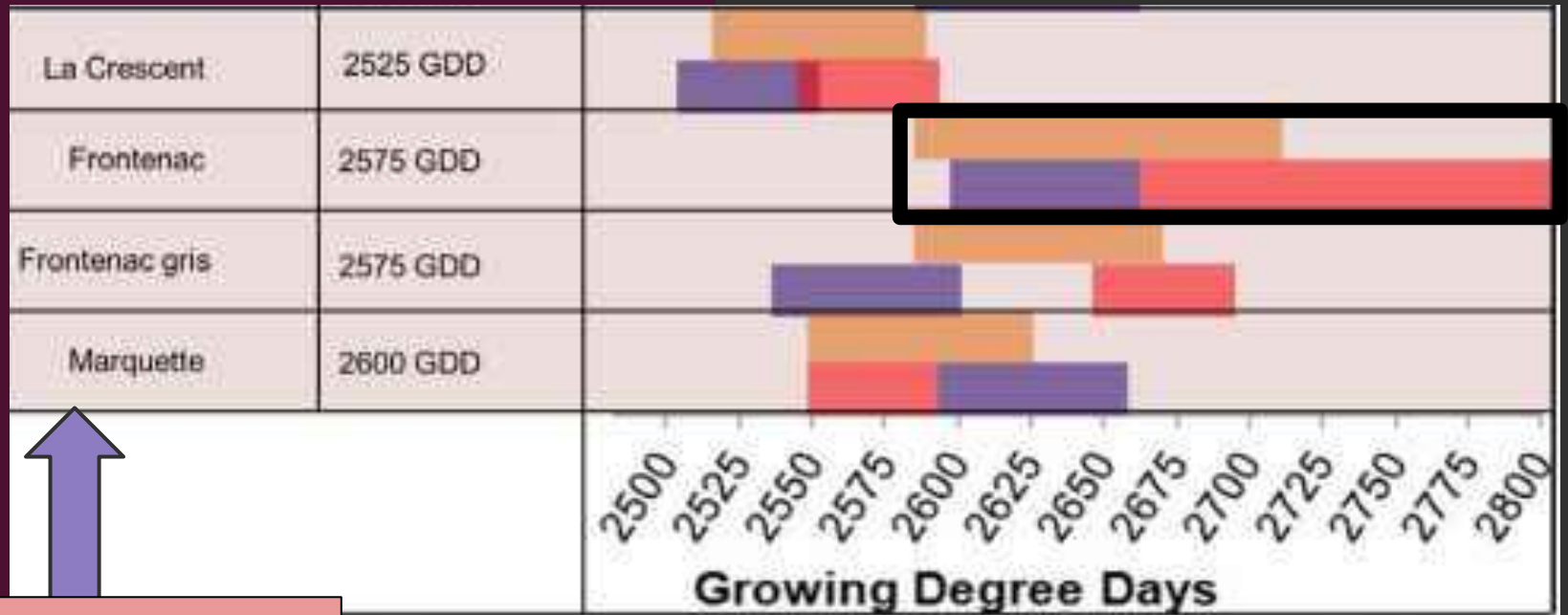


Table 1. Colored boxes indicate when there is no longer a significant change in °Brix, pH, and TA in respect to GDD, highlighting the range of peak maturity for each trait in grapes grown in Chaska, MN. Peak weight is the maximum weight achieved during the harvest season.

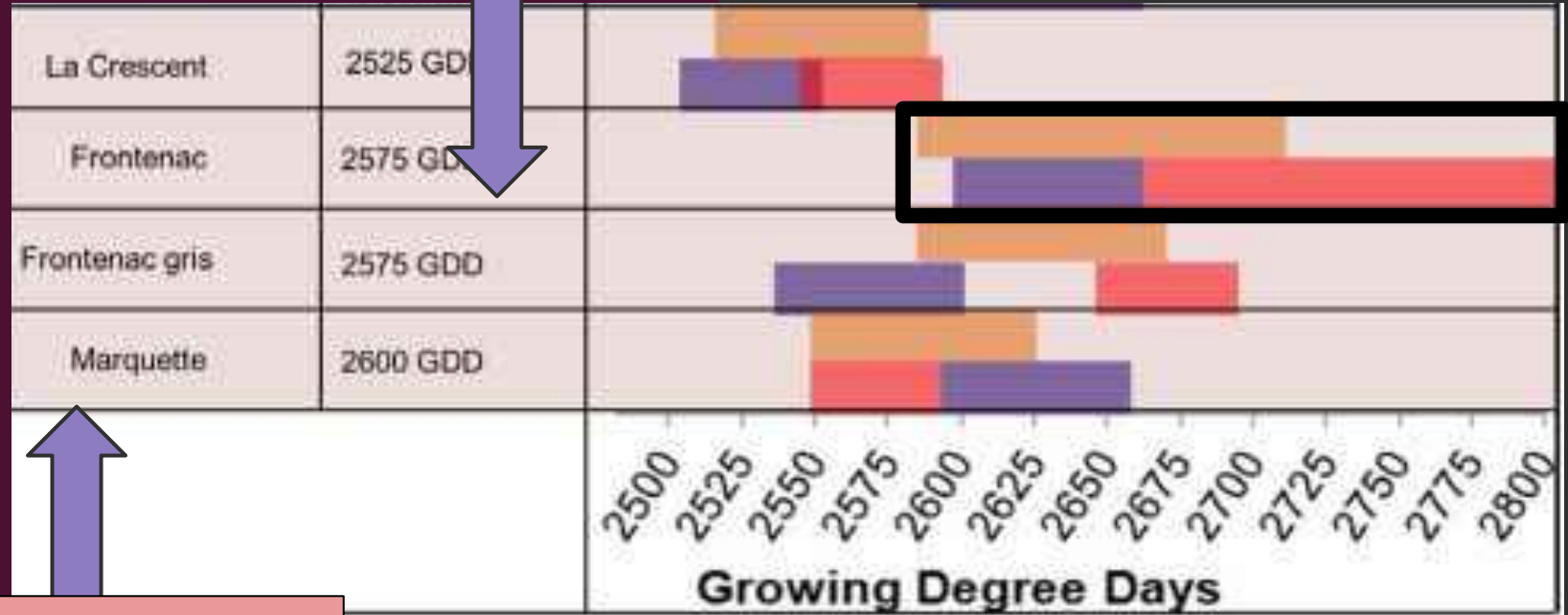






2309 GDD,  
2017

2448 GDD,  
2018



2309 GDD,  
2017



**In North Dakota, we try a lot of  
methods to overcome nature.**

Leaf Removal

Shoot-thinning

Trellis System

Mulches

Shoot-Positioning

Cluster Thinning



**Unfortunately....**

There is no viticultural  
silver bullet.

Proper management  
requires a comprehensive  
approach, acknowledging  
the absence of a panacea.

Know *your* goals going  
into planting.



# Research Goals

Investigate Methods to  
Increase Producer Profitability

- Increase Quality
  - Reduce Acidity
  - Increase Sugars
- Increase Yield



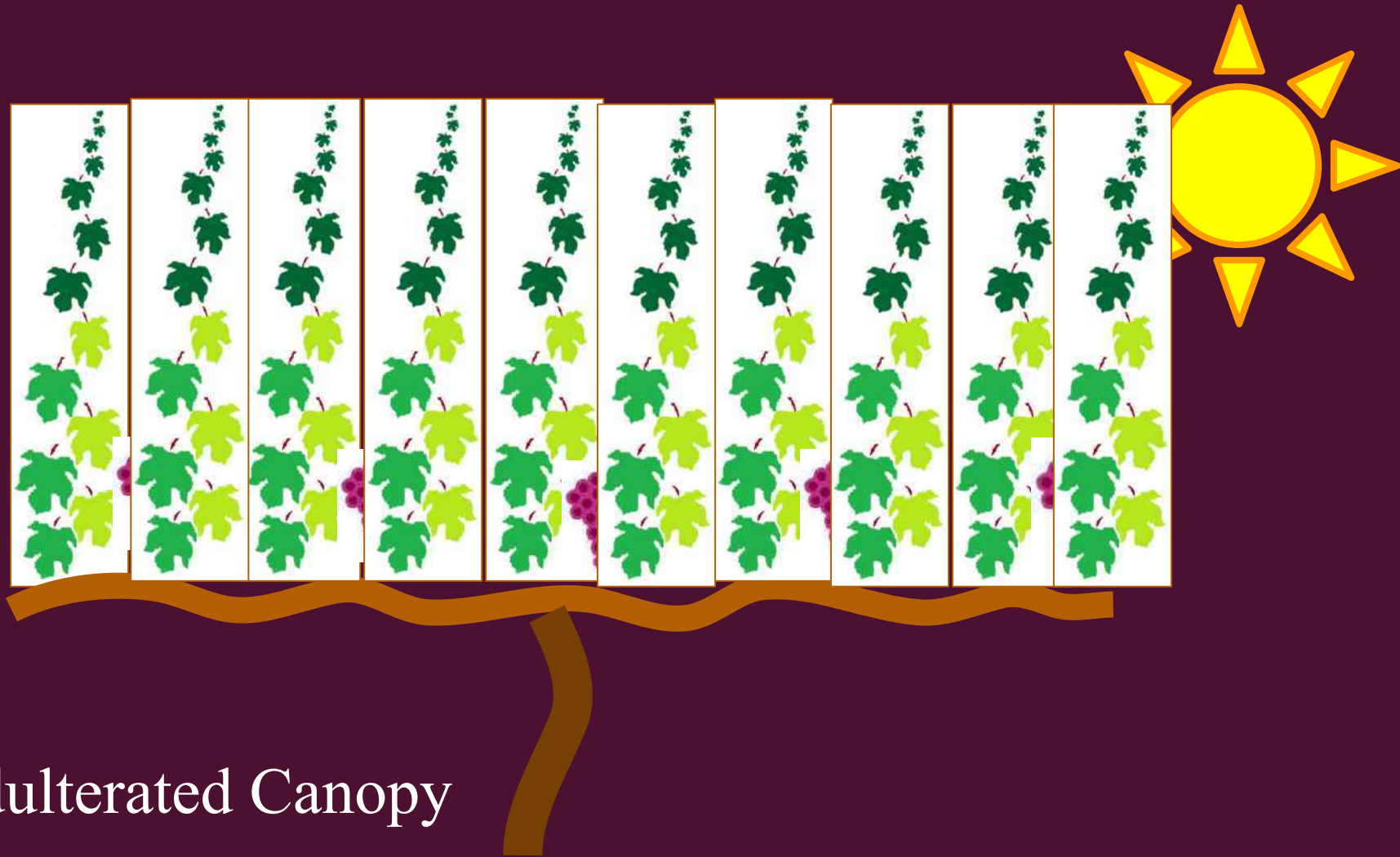


# Research Goals

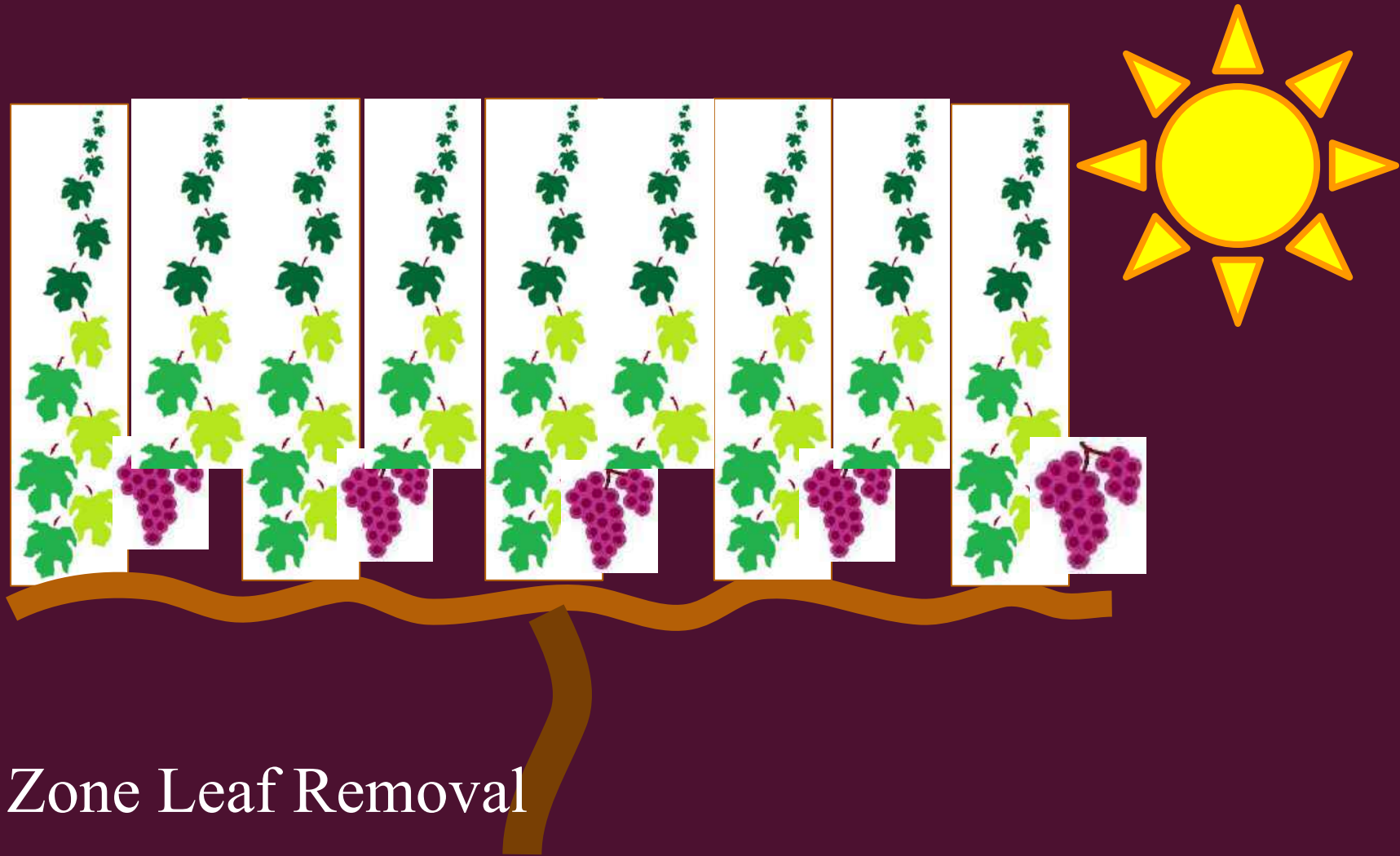
Investigate Methods to  
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- **Increase Quality**
  - Reduce Acidity
  - Increase Sugars
- Increase Yield





Unadulterated Canopy



Fruit Zone Leaf Removal





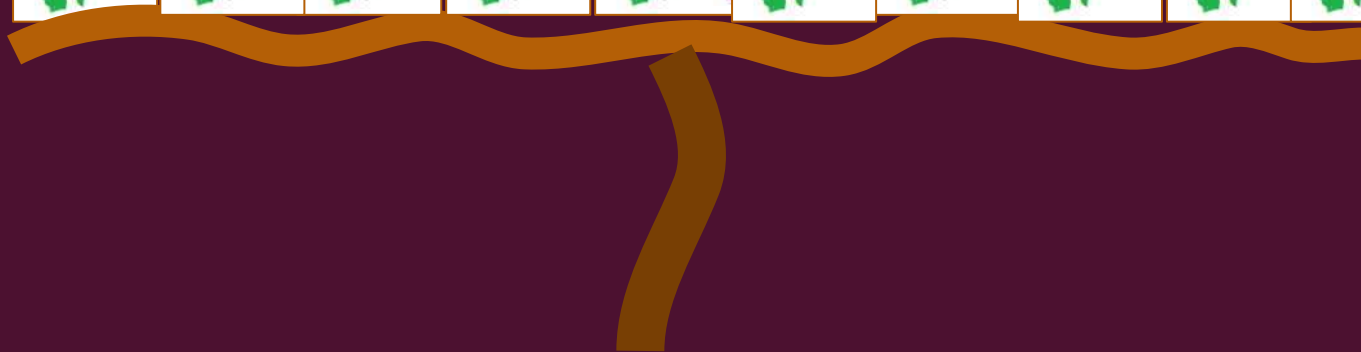
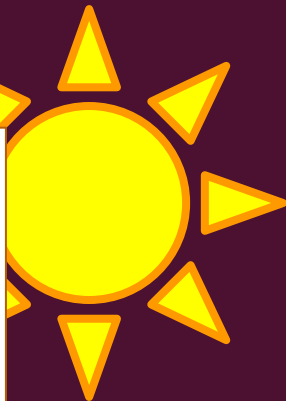
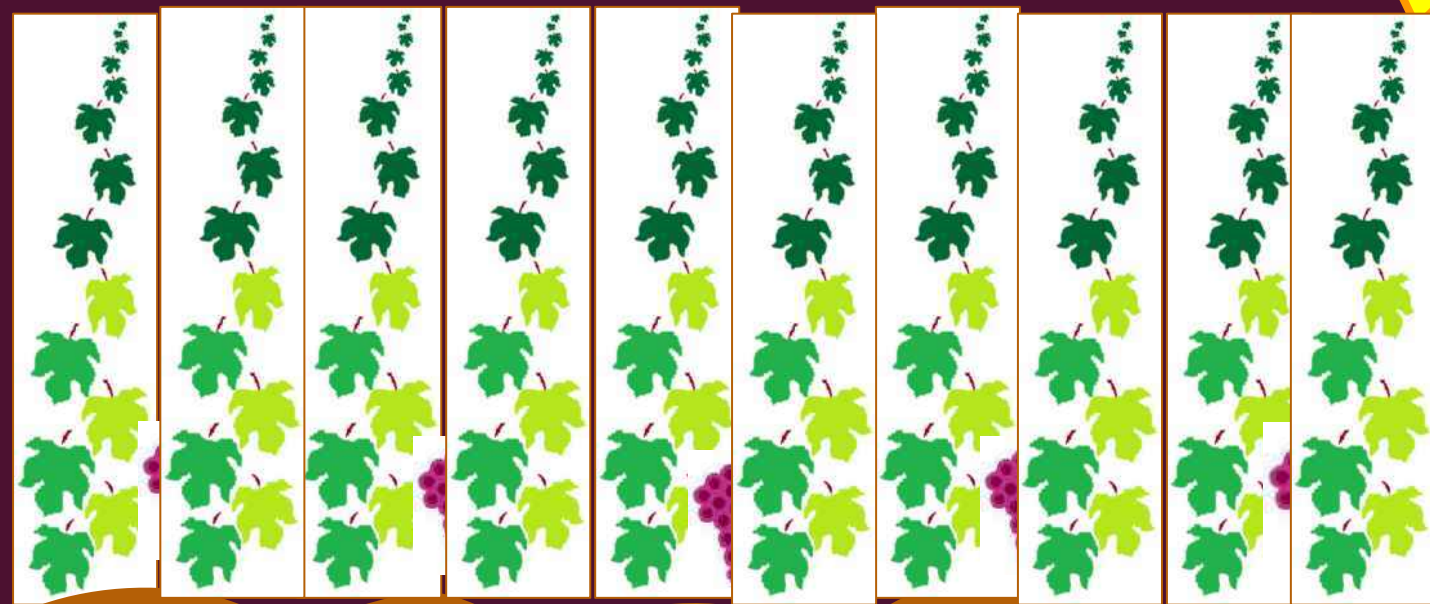
Shoot-Thinning

# Research Goals

Investigate Methods to  
Increase Producer Profitability

- Increase Quality
  - Reduce Acidity
  - Increase Sugars
- **Increase Yield**









Find a way to get more fruit from a single vine.

# Viticultural Management Practices

Leaf Thinning

Shoot Thinning

Cluster Thinning

Trellis Choice

Soil and Cover Crop Management

Irrigation Management



# Viticultural Management Practices

Leaf Thinning  
Shoot Thinning  
Cluster Thinning  
Trellis Choice

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Irrigation Management





# Viticultural Management Practices

Leaf Thinning  
Shoot Thinning  
Cluster Thinning  
Trellis Choice

Soil and Cover Crop Management  
Irrigation Management



# North Dakota Viticulture Told in Three Experiments

Yield: 'Prairie Star'

Yield: 'Frontenac'

Quality: 'Marquette'



# North Dakota Viticulture Told in Three Experiments

Yield: 'Prairie Star'

Yield: 'Frontenac'

Quality: 'Marquette'







**'Prairie Star' Pruning and Trellis Modifications**



**Watson Trellis- 'Blanc du Bois' Catsprings, TX**



**Watson Trellis- 'Blanc du Bois' Catsprings, TX**





Watson Trellis- 'Blanc du Bois' Catsprings, TX



Watson Trellis- 'Blanc du Bois' Catsprings, TX



T-Bar to Pergola- 'AU Golden Dragon' Clanton, AL





T-Bar to Pergola- 'AU Golden Dragon' Clanton, AL





T-Bar to Pergola- 'AU Golden Dragon' Clanton, AL



**Pruning Treatment:**  
**Spur Pruning + Additional Long Canes**



**Pruning Treatment:**  
**Spur Pruning + Additional Long Canes + Additional T-Bar Wire Support**





**Pruning Treatment:**  
**Spur Pruning + Additional Long Canes + Additional T-Bar Wire Support**





**Pruning Treatment:**  
**Spur Pruning + Additional Long Canes + Additional T-Bar Wire Support**

Pruning Method/ Yield Adjustment	Berry Size	Cluster Size	Cluster Number	Yield	Sugars	Acids	Vine Size
(A) Spur	+	+			+		+
(B) Spur + Canes			+	+		+	





# North Dakota Viticulture Told in Three Experiments

Yield: 'Prairie Star'

Yield: 'Frontenac'

Quality: 'Marquette'



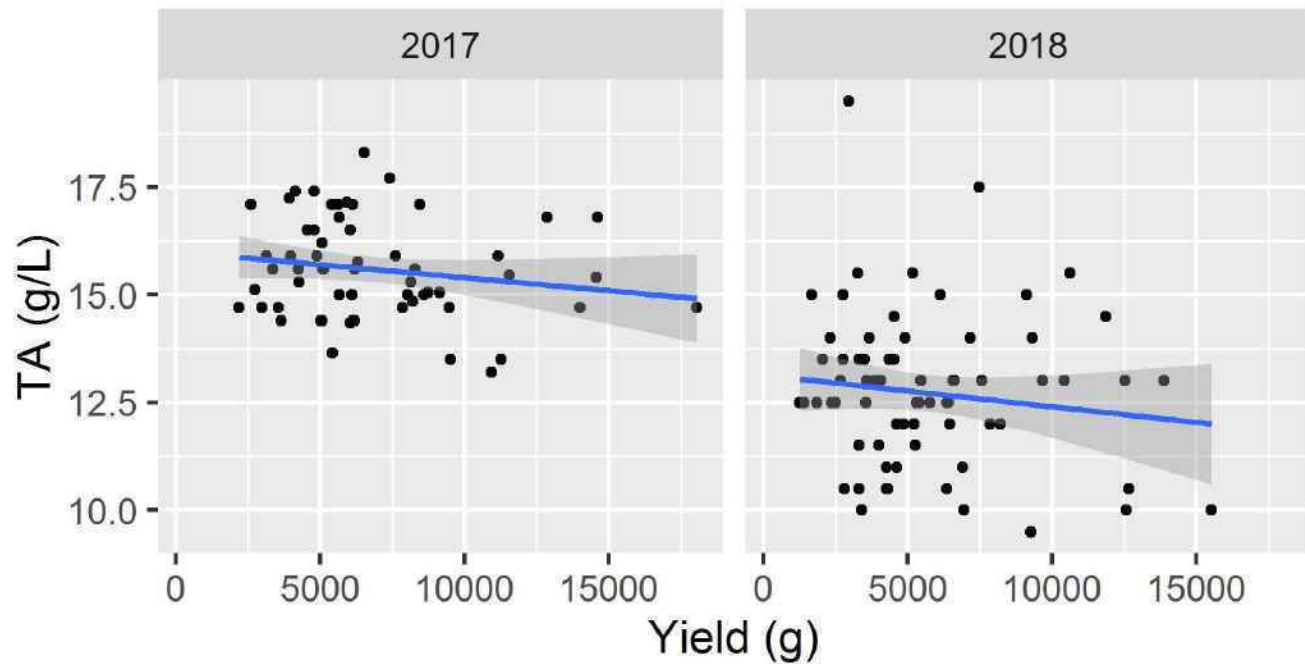
# Shoot-thinning 'Frontenac'

A gradient of commercial yields  
were enforced via manual shoot  
thinning on mature, dryland farmed  
'Frontenac' grapevines in a previously  
established planting.  
(~2.0 to 18.0 kg/vine)  
[2.7 to 24.2 tons/ha]

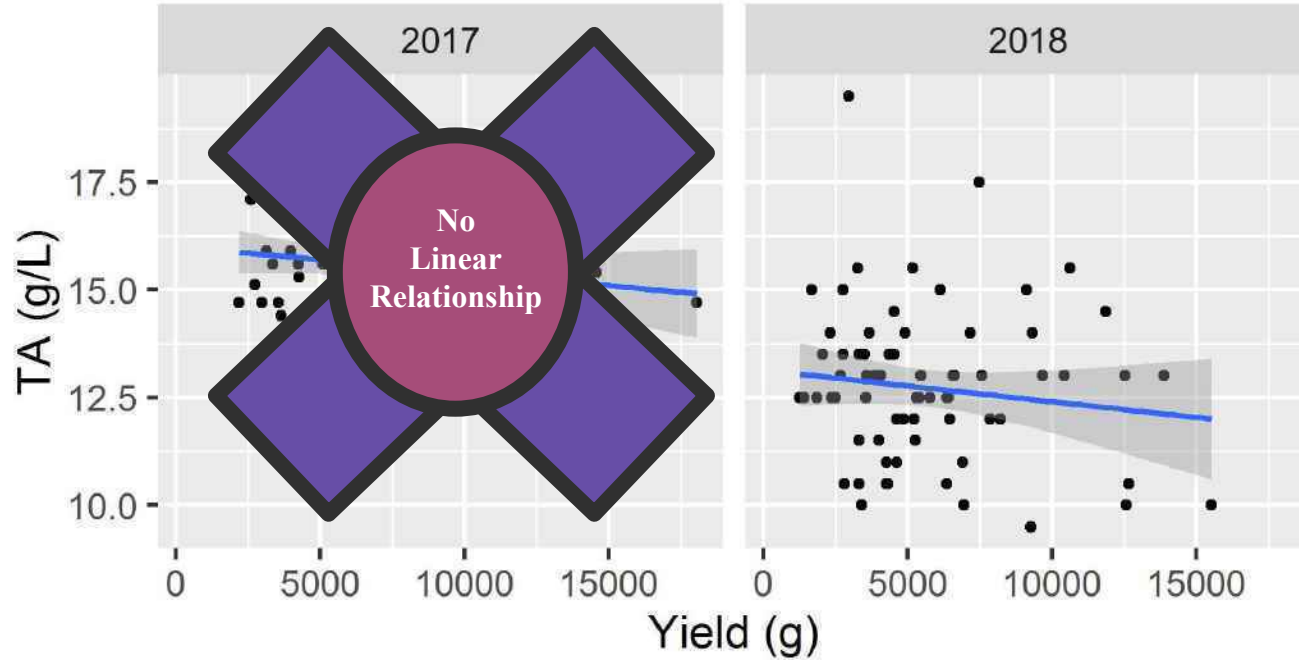




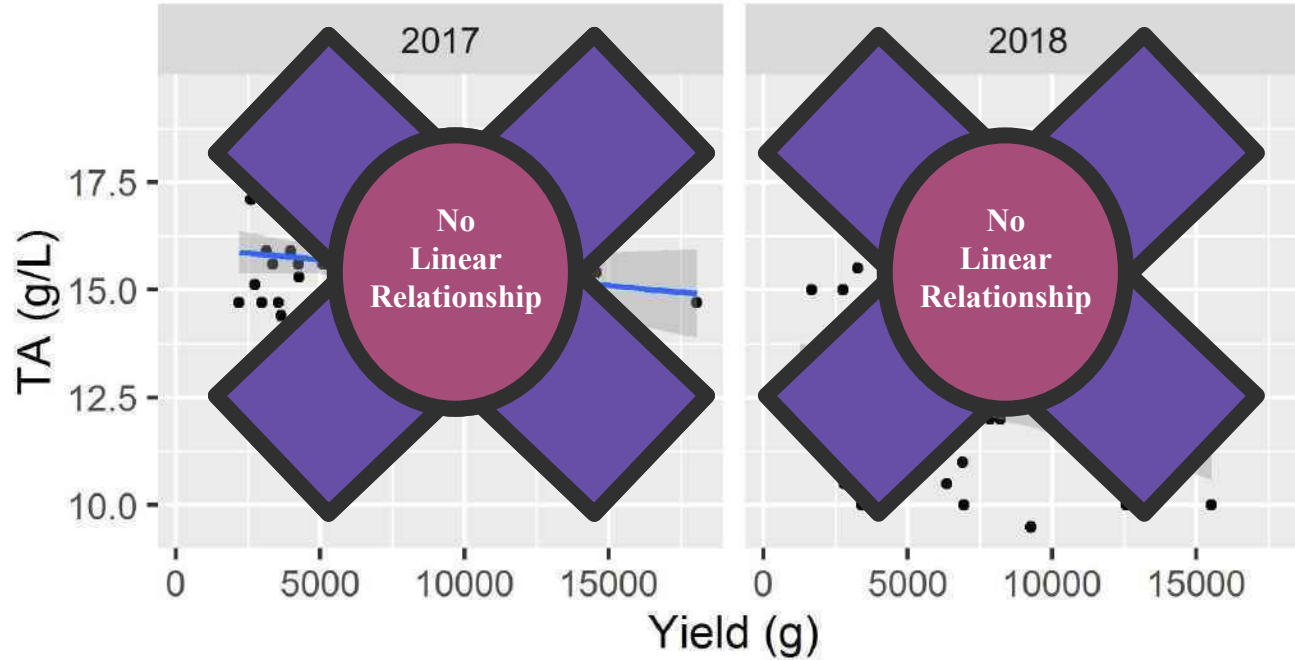
## Titrateable Acidity of Frontenac, Absaraka, ND



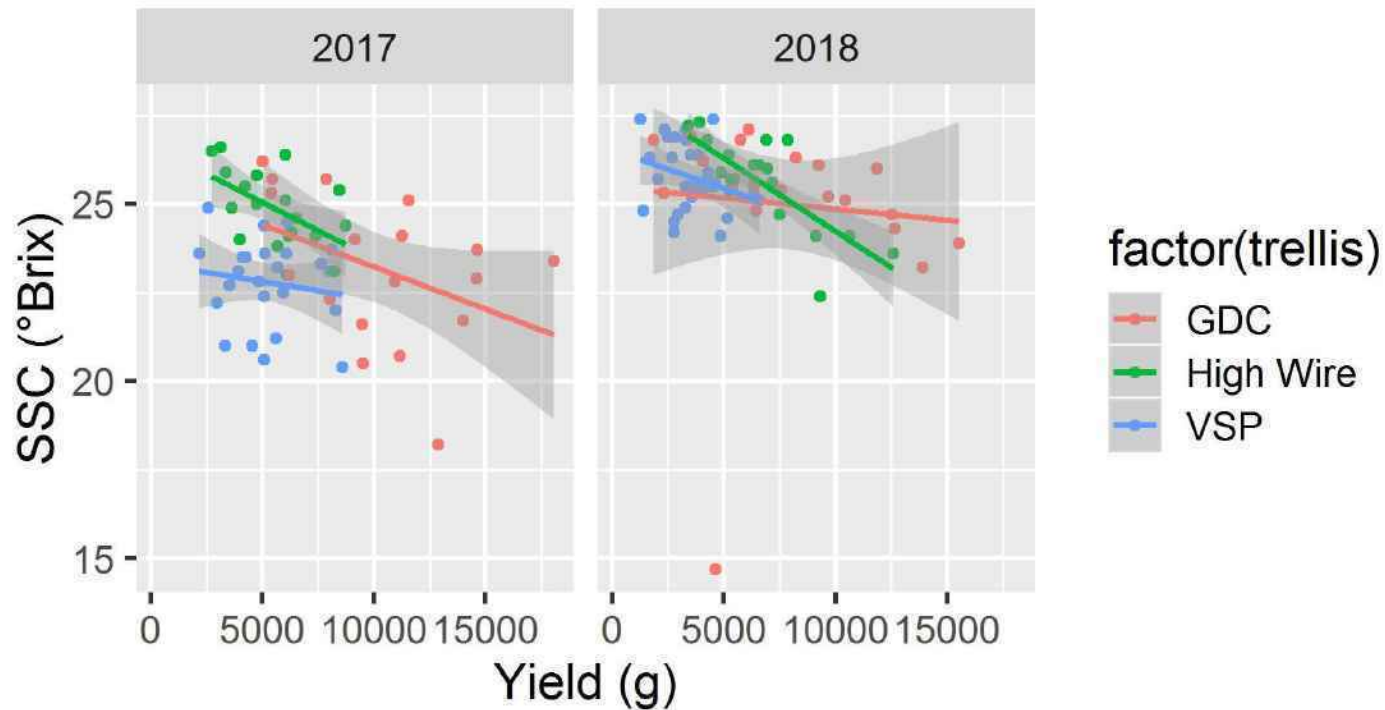
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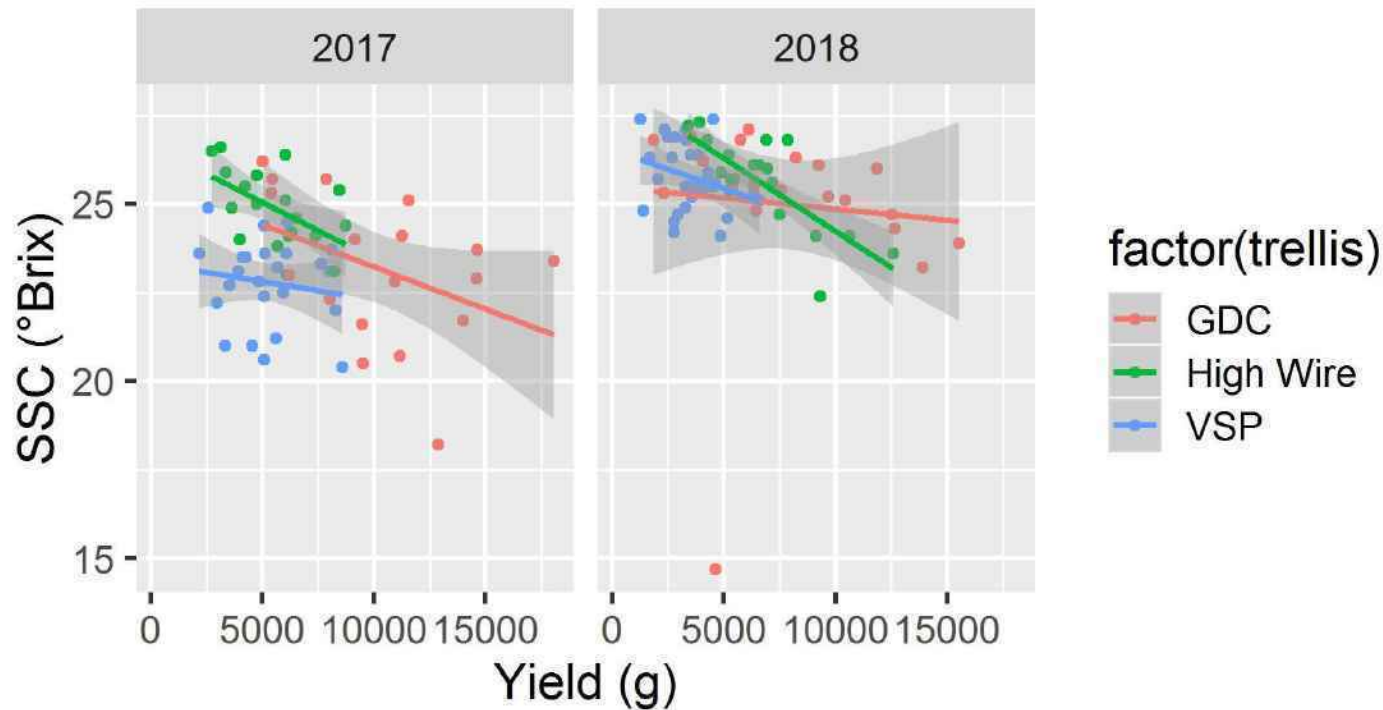


# Soluble Solids by Total Yield per Vine, 'Frontenac', Absaraka, ND



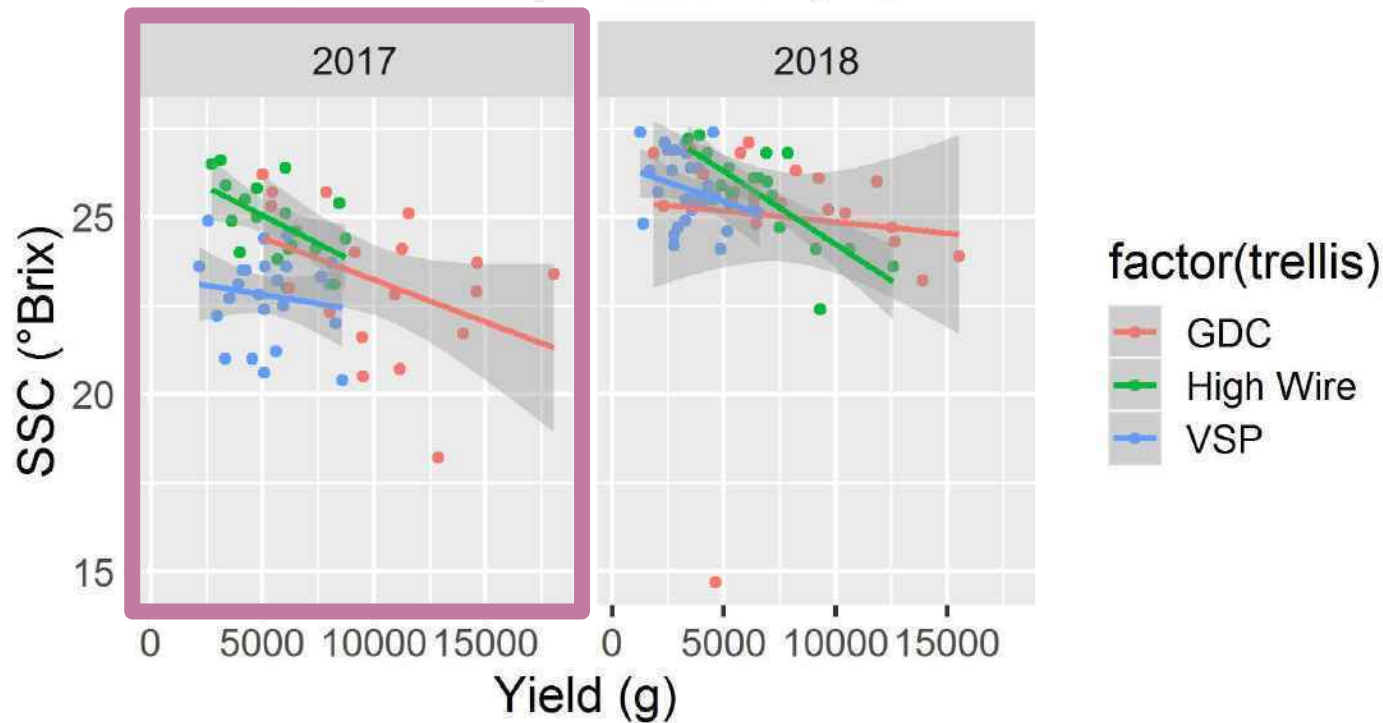


## Soluble Solids by Total Yield per Vine, 'Frontenac', Absaraka, ND



2017:  $SSC = 25.17 - 0.22(\text{yield kg/vine}) + 0.28 (\text{GDC}) + 0.94 (\text{HW}) - 1.23 (\text{VSP})$   
R-squared: 0.37

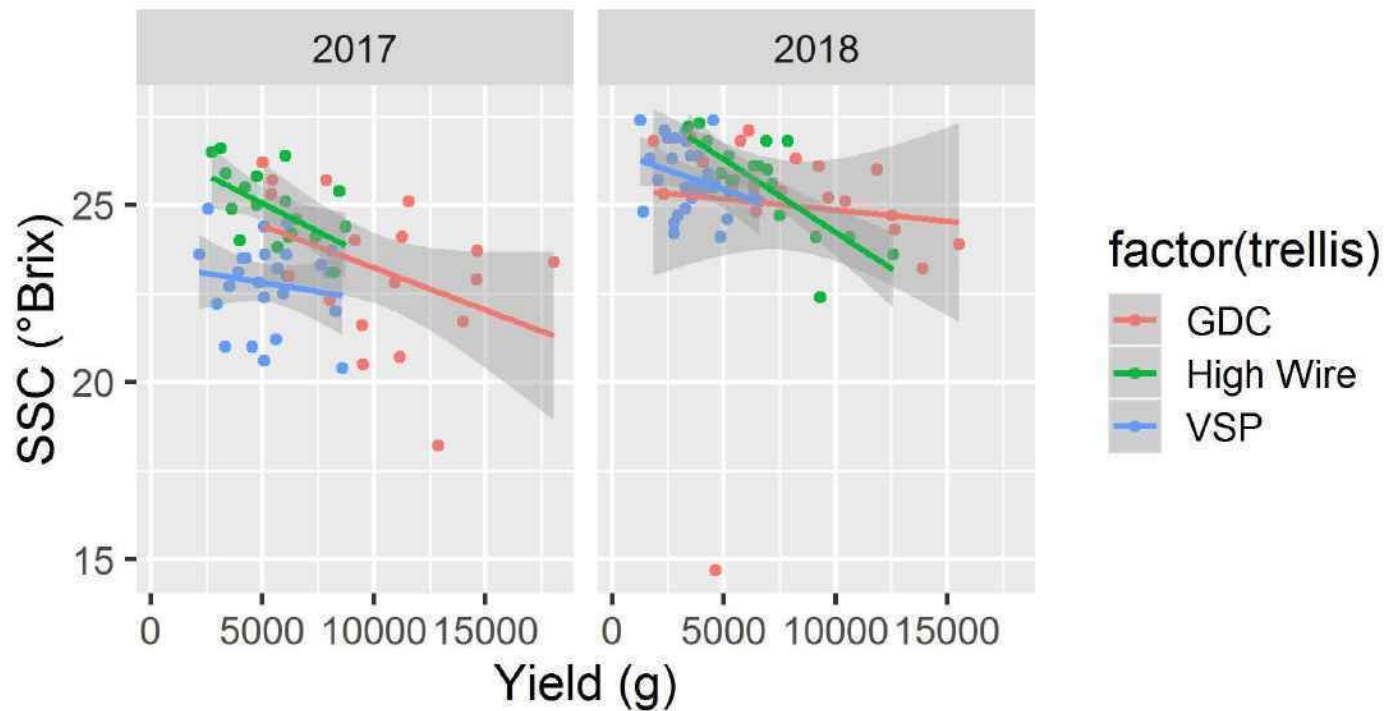
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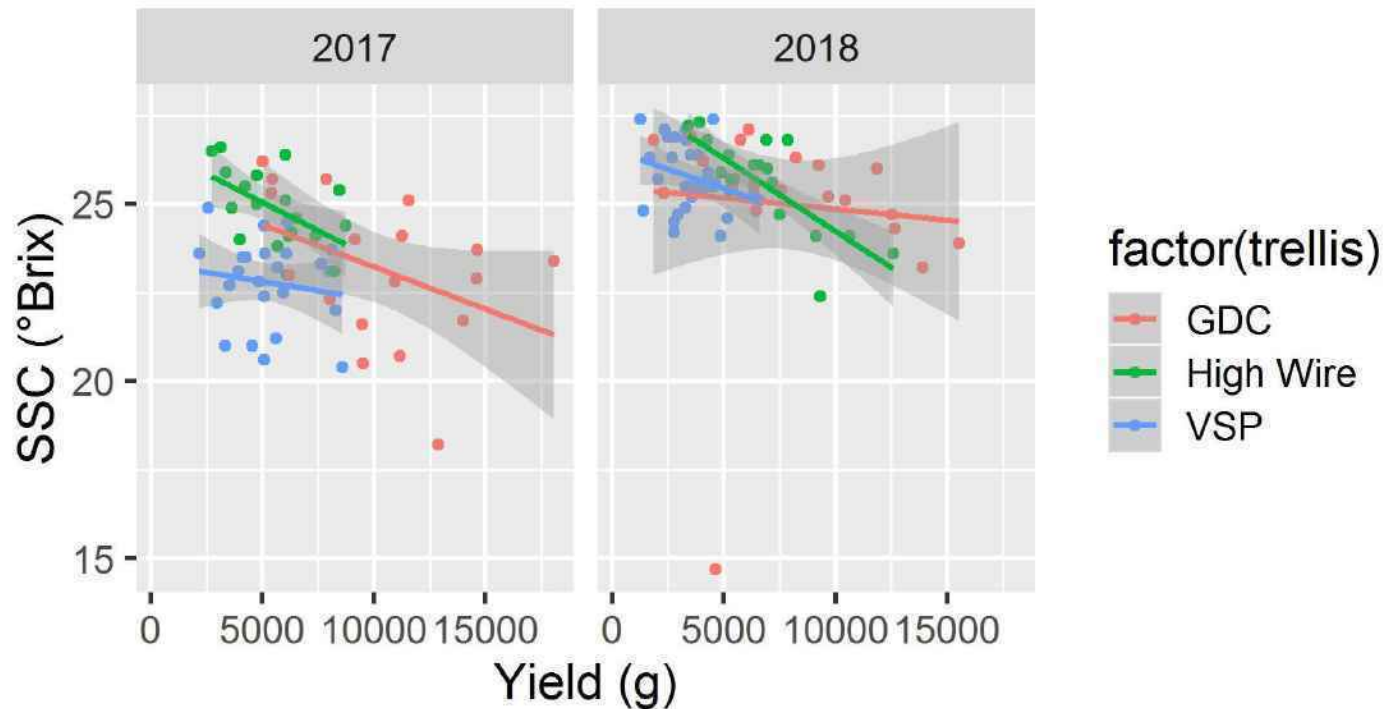
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# Soluble Solids by Total Yield per Vine, 'Frontenac', Absaraka, ND



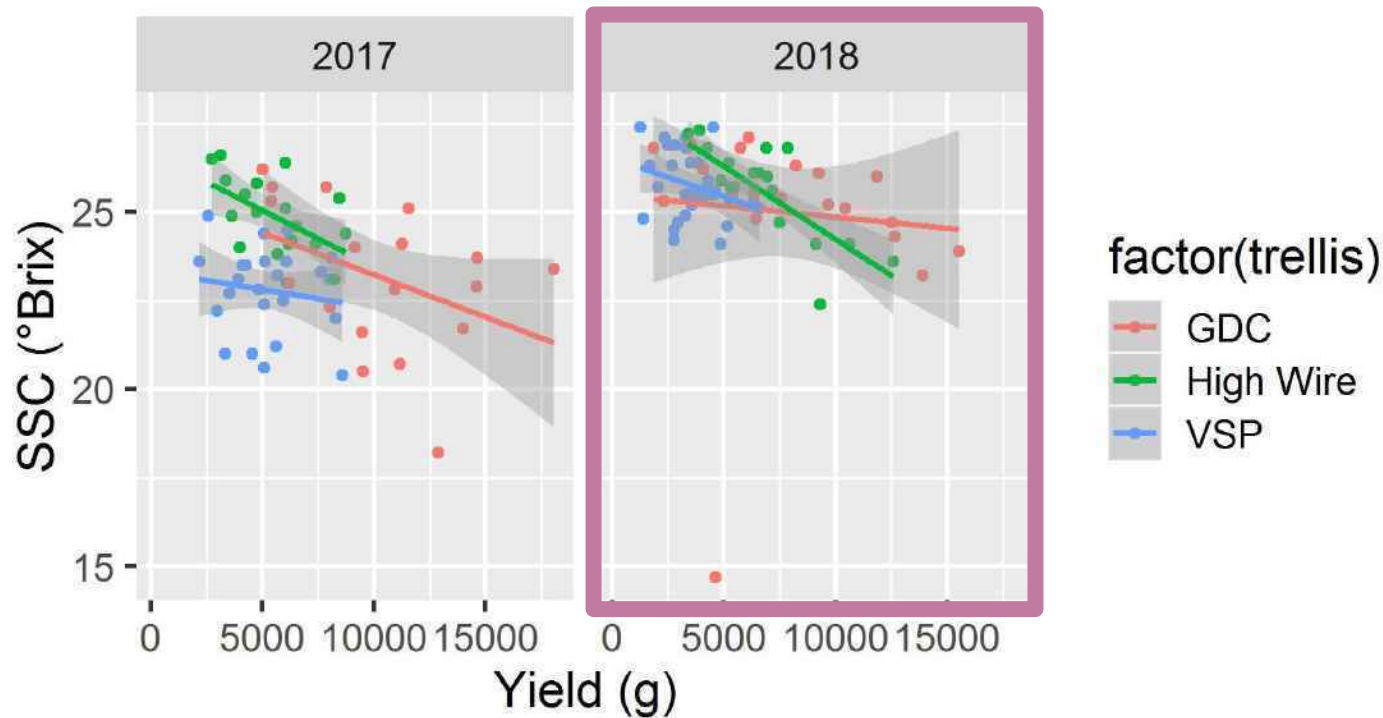


# Soluble Solids by Total Yield per Vine, 'Frontenac', Absaraka, ND



2018:  $SSC = 26.44 - 0.17(\text{yield kg/vine}) - 0.17 (\text{GDC}) + 0.27(\text{HW}) - 1.06 (\text{VSP})$   
R-squared: 0.09

## Soluble Solids by Total Yield per Vine, 'Frontenac', Absaraka, ND



2018:  $SSC = 26.44 - 0.17(\text{yield kg/vine}) - 0.17 (\text{GDC}) + 0.27(\text{HW}) - 1.06 (\text{VSP})$

R-squared: 0.09

# Preliminary Conclusions 'Frontenac'

Fruit Quality: SSC

There is a subtle  
relationship between SSC  
and Yield.

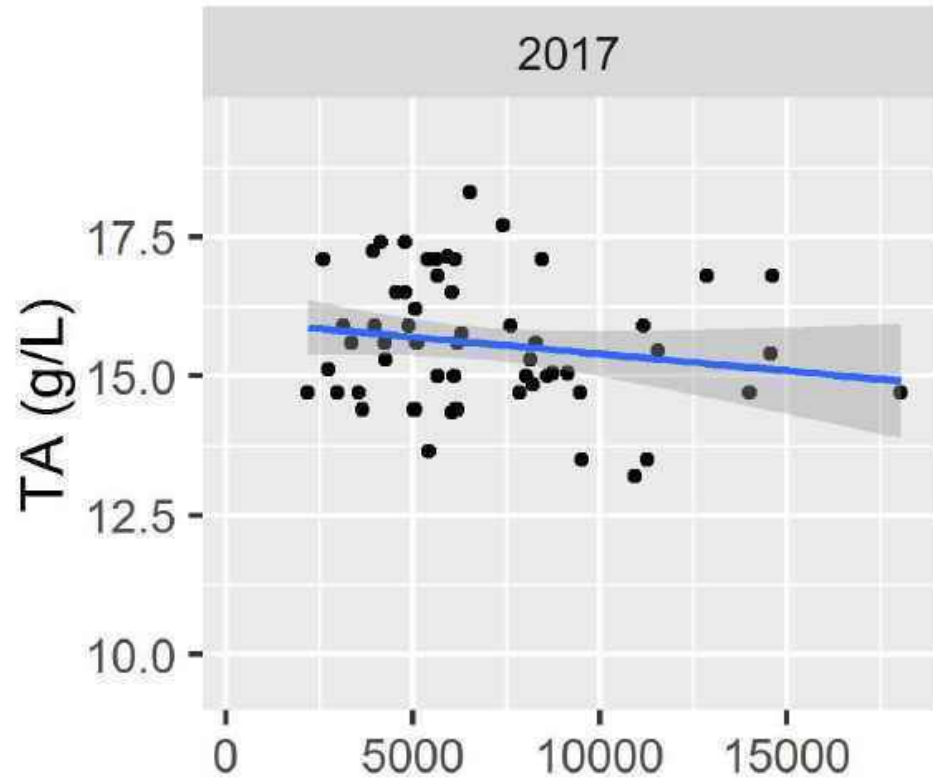
Yield does not explain the  
majority of variation, and  
the trade-off is a bargain.

[1 °Brix for ~11 lb (5 kg) fruit]



# Preliminary Conclusion

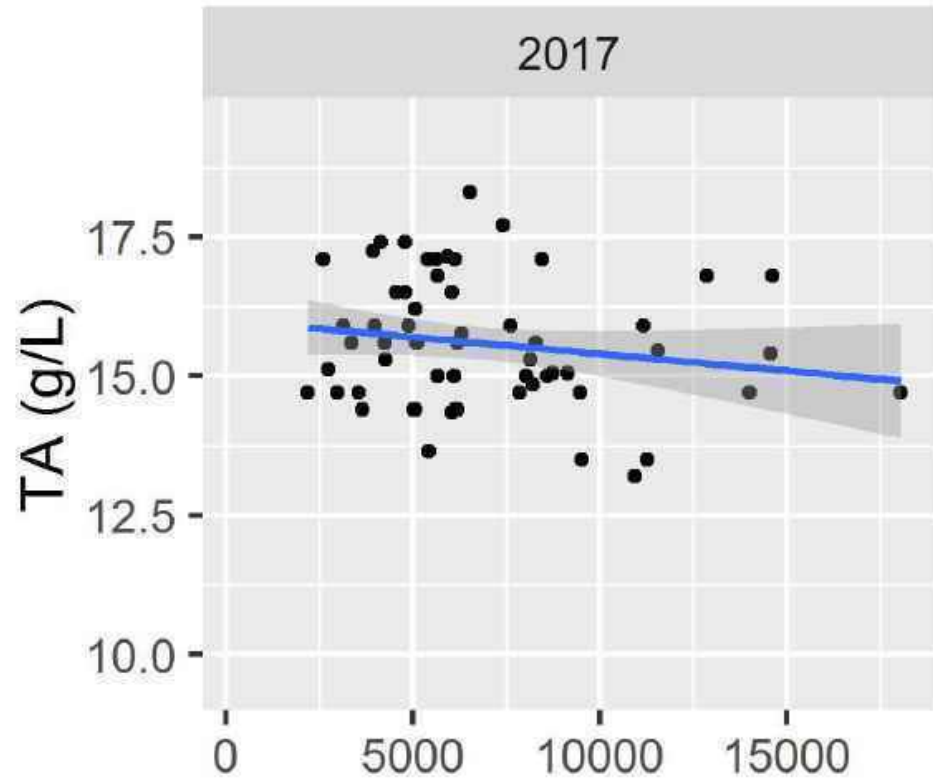
Fruit Quality: TA



I want to believe there may be a subtle relationship between TA and yield, but I have no evidence to support it.

# Preliminary Conclusion

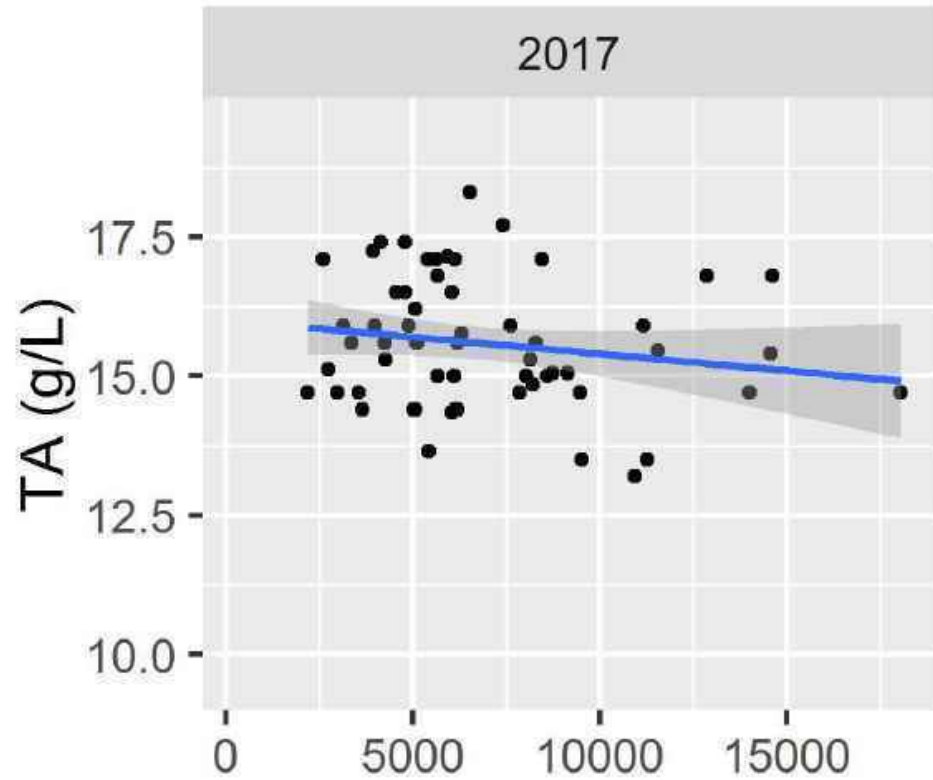
Fruit Quality: TA



Our growing season may be too short to detect subtleties.

# Preliminary Conclusion

Fruit Quality: TA



At least in ND, so far, we cannot say that-  
Acidity is Linearly Correlated with Yield for  
'Frontenac' Grapevines.



# Preliminary Conclusion

Fruit Quality: TA



However, isn't that a good thing?

# Preliminary Conclusion

DTA



Our DTA results give no clear indication that yield is detrimentally harming bud cold-hardiness.

# North Dakota Viticulture Told in Three Experiments



























Yield: 'Prairie Star'

Yield: 'Frontenac'

Quality: 'Marquette'













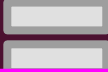
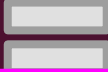




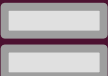








Leaf Removal	Berry Size	Cluster Size	Cluster Number	Yield	Sugars	Acids	Vine Size
Frontenac (1)							
Frontenac gris (2)							
Marquette (3)							
Sabrevois (4)							TBD

(1) Olson, 2016.

(2) Aipperspach, 2013.

(3) Svyantek, On-going.

(4) Svyantek, On-going.

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# Fruit Zone Leaf Removal in 'Marquette'



# Fruit Zone Leaf Removal in 'Marquette'

## Trace-bloom (TBLR)

BBCH: 60-63

EL: 19-22

**50% FZLR**

**100% FZLR**

## Fruit-set (FSLR)

BBCH: 71-73

EL: 28-30

**50% FZLR**

**100% FZLR**

## Veraison (VRLR)

BBCH: 81-83

EL: 34-36

**50% FZLR**

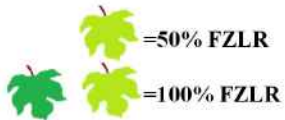
**100% FZLR**



Leaves above the fruit zone were retained for photosynthesis.

Only the fruit zone, the area immediately around the clusters, was altered to increase the fruit exposure.

FZLR Severities





Before Leaf Removal





After Leaf Removal

# ‘Marquette’ yield components as affected by fruit zone leaf removal practices in Buffalo, ND.

Treatment	Single berry mass (g)		Cluster mass (g)		Total yield (ton/a)	
Severity (S)	2017	2018	2017	2018	2017	2018
50%	1.06 ns	1.22 ns	53.3 ns	46.9 a	2.1 ns	1.5 ns
100%	1.07	1.20	49.2	41.1 b	1.9	1.3
Timing (T)	2017	2018	2017	2018	2017	2018
Trace bloom	1.09 a	1.18 b	47.0 b	37.5 b	1.9 b	1.2 b
Fruit-set	1.02 b	1.20 ab	46.1 b	49.6 a	1.7 b	1.7 a
Veraison	1.09 a	1.26 a	59.2 a	48.5 a	2.4 a	1.5 a



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# Leaf Removal Timing

Earlier leaf removal  
timing has yielded  
smaller clusters, and  
lower yields.



# ‘Marquette’ fruit quality as affected by fruit zone leaf removal practices in Buffalo, ND.

Treatment	SSC (°Brix)				pH				TA (g/L)			
Severity (S)	2017		2018		2017		2018		2017		2018	
50%	23.1	ns	26.1	ns	3.19	ns	3.29	ns	13.9	ns	10.6	b
100%	23.3		26.3		3.16		3.31		13.5		10.1	a
Timing (T)	2017		2018		2017		2018		2017		2018	
Trace bloom	24.3	a	26.6	a	3.15	ns	3.29	ns	14.0	ns	10.5	ab
Fruit-set	23.8	a	26.2	ab	3.19		3.31		13.7		10.1	b
Veraison	21.5	b	25.8	b	3.19		3.30		13.5		10.7	a



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# Leaf Removal Timing

Fruit from veraison  
leaf removal  
treatments had

- lower sugar  
(both years)
- higher acidity  
(one year)





# Leaf Removal Suggestions

Pick your poison.

Early leaf removal reduced acidity (in riper year), while leading to smaller clusters and smaller yields.

Veraison leaf removal had less impact on fruit quality, but also less reduction in yield.



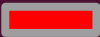


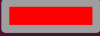








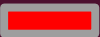


# Leaf Removal Suggestions [Overly Simplified]

Vineyard Goal	Remove Earlier	Remove Later	Do not Remove Leaves
Reduce disease	+	+	-
Reduce acidity	+	-	-
Increase sugar content	+	-	-
Reduce yield	+	-	+
Reduce idle hands	+	+	-



# Leaf Removal Suggestions [Overly Simplified]

Vineyard Goal	Remove Earlier	Remove Later	Do not Remove Leaves
Reduce disease			
Reduce acidity			
Increase sugar content			
Reduce yield			
Reduce idle hands			

Your site is not my site, nor is it your neighbor's site.

Make the most of your planting by observing, exploring, and reflecting.

Year has a major effect on harvest parameters, if something fails in 2019, it may still be useful in 2020.

Take Chances.  
Make Mistakes.  
Get Messy.

# Data: A Guide To a Happy Harvest

Pruning Weight	Flowering Date	Cluster Weight
Cane Number	Weather at Bloom	Yield
Average Cane Diameter + Length	10 % Berry Color	Brix
Bud Number Retained	50 % Berry Color	pH
Pruning Date	100 % Berry Color	TA
Bud Burst Date	Harvest Date	Leaf Fall
Last Frost Date		First/Killing Frost Dates



# NDSU Grape Germplasm Enhancement Project



# Grape Breeding Simplified

Step 1. Generate Seedlings

Step 2. Evaluate Growth and  
Agronomic Characteristics

Step 3. Replicate Selected  
Lines for Further Evaluation

Step 4. Small-scale Wine  
Evaluations

Step 5. Generate New  
Seedlings



# Vine Performance

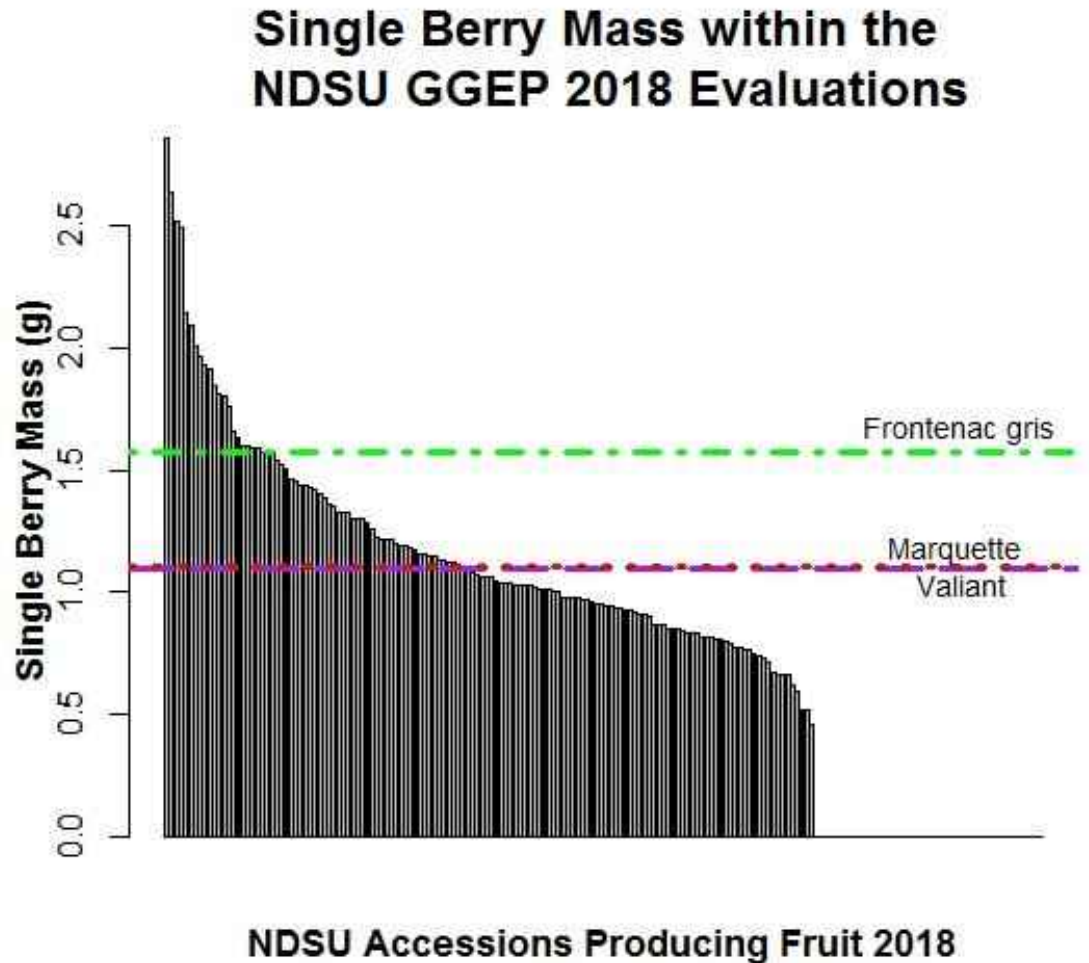
We monitor seedling performance relative to the performance of regional cultivars, gaining perspective for given years/ environments.





## Berry Size

~ 50% of accessions  
have berries larger  
than 'Marquette'  
and 'Valiant'



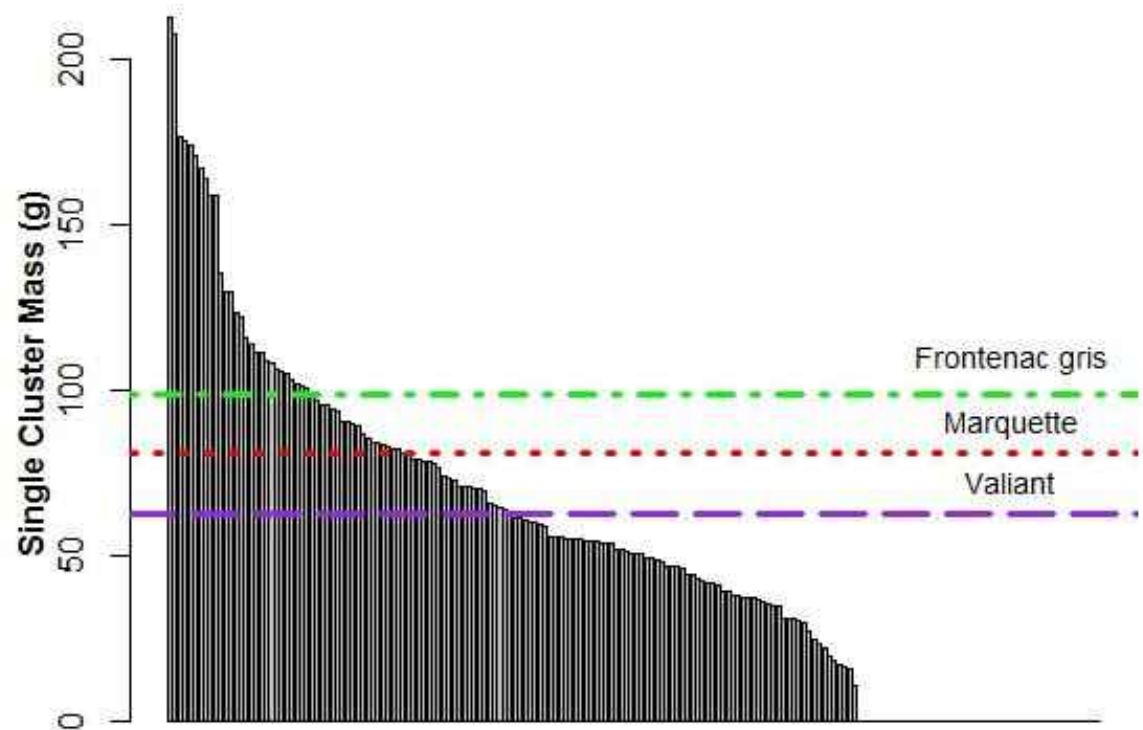


## Cluster Size

~ 50% of accessions bore clusters larger than 'Valiant'

~20% of accessions yielded clusters larger than 'Frontenac gris'

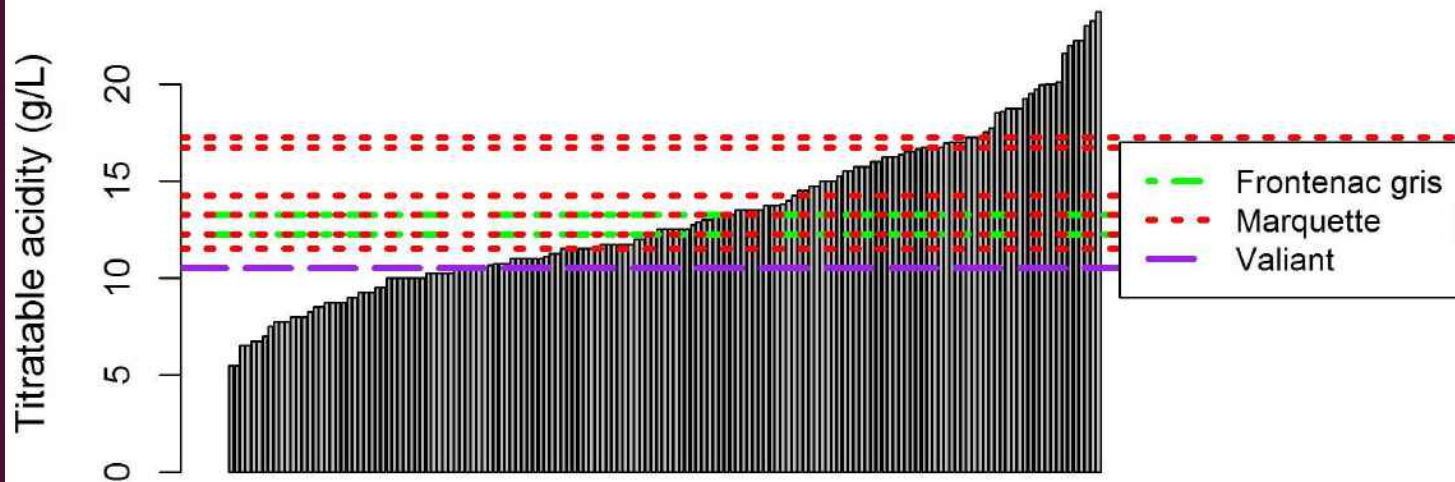
## Single Cluster Mass within the NDSU GGEP 2018 Evaluations



NDSU Accessions Producing Fruit 2018

# Quality: Titratable Acidity

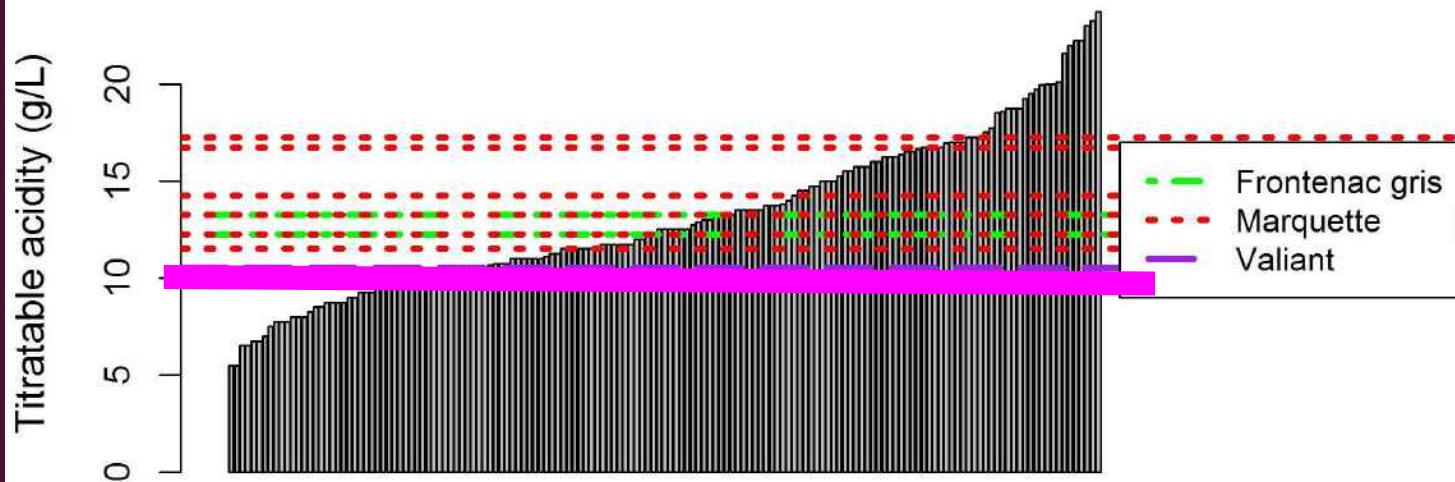
## Titratable Acidity within the NDSU GGEP 2018 Evaluations



NDSU Accessions Producing Fruit 2018

# Quality: Titratable Acidity

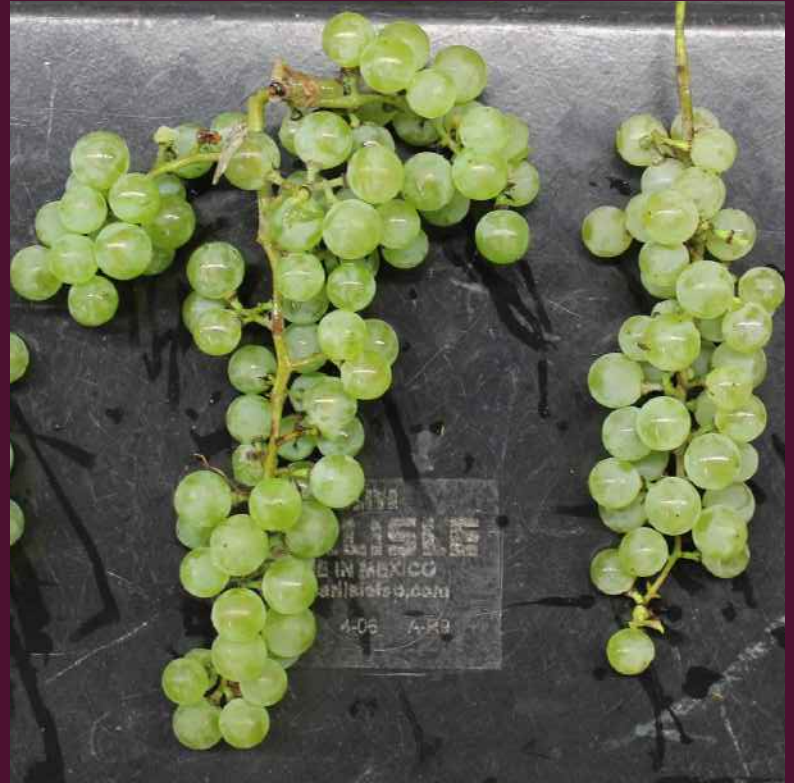
## Titratable Acidity within the NDSU GGEP 2018 Evaluations



# Seedling Evaluation

No “control” vine fell below a TA of 10 g/L in 2018.

~10% of NDSU GGEP seedlings came in below 10 g/L.





# Replicated Trial

Elite accessions identified by the NDSU GGEP were planted in 2016 and 2017, establishing replicated trials in which NDSU lines are evaluated directly against regional “control” cultivars (‘Frontenac gris’, ‘King of the North’, and ‘Marquette’).



# Replicated Trial



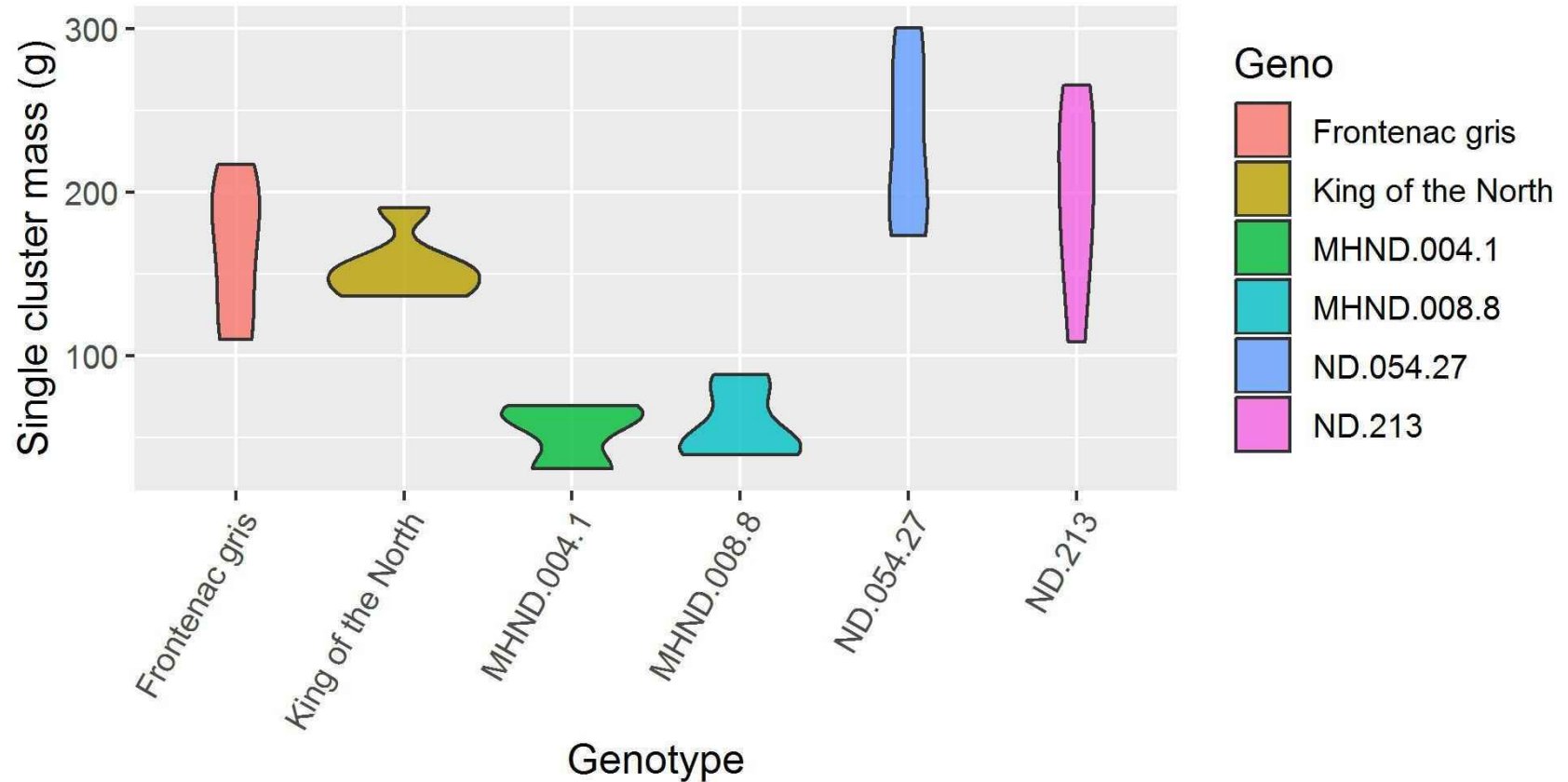
Accession/ CV	SSC (° Brix)		pH		TA (g/L)	
Frontenac gris	24.6	a	3.27	a	15.8	b
King of the North	18.4	c	3.14	b	19.3	a
MHND 004#1	22.1	b	3.22	ab	15.4	b
MHND 008#8	20.5	b	3.22	ab	12.1	b
ND 054#27	20.0	bc	3.17	a	11.0	c
ND 213	19.8	bc	3.29	b	10.9	c

## Replicated Trial



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ND 213	19.8	bc	3.29	b	10.9	c

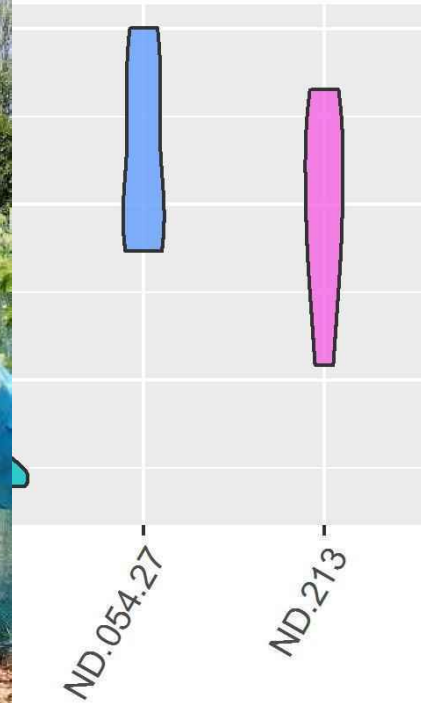
# Single Cluster Mass of Genotypes within the NDSU 2016 Replicated Trial Planting, Grown 2018, Absaraka, ND







otypes within the  
Trial Planting,  
aka, ND

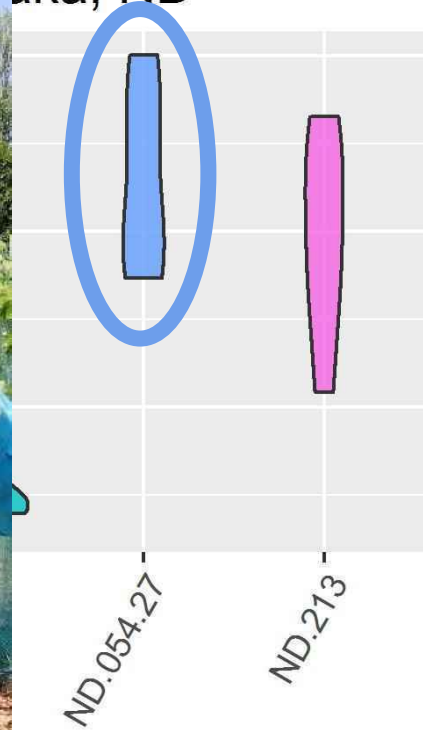


Geno

- Frontenac gris
- King of the North
- MHND.004.1
- MHND.008.8
- ND.054.27
- ND.213



otypes within the  
Trial Planting,  
aka, ND



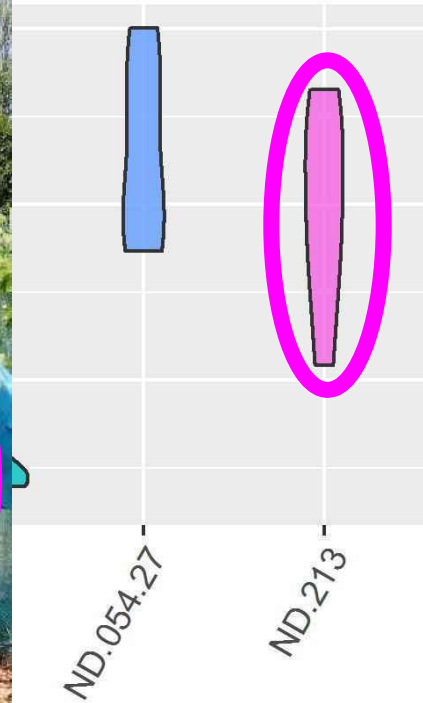
Geno

- Frontenac gris
- King of the North
- MHND.004.1
- MHND.008.8
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otypes within the  
Trial Planting,  
aka, ND



Geno

- Frontenac gris
- King of the North
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- MHND.008.8
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- ND.213

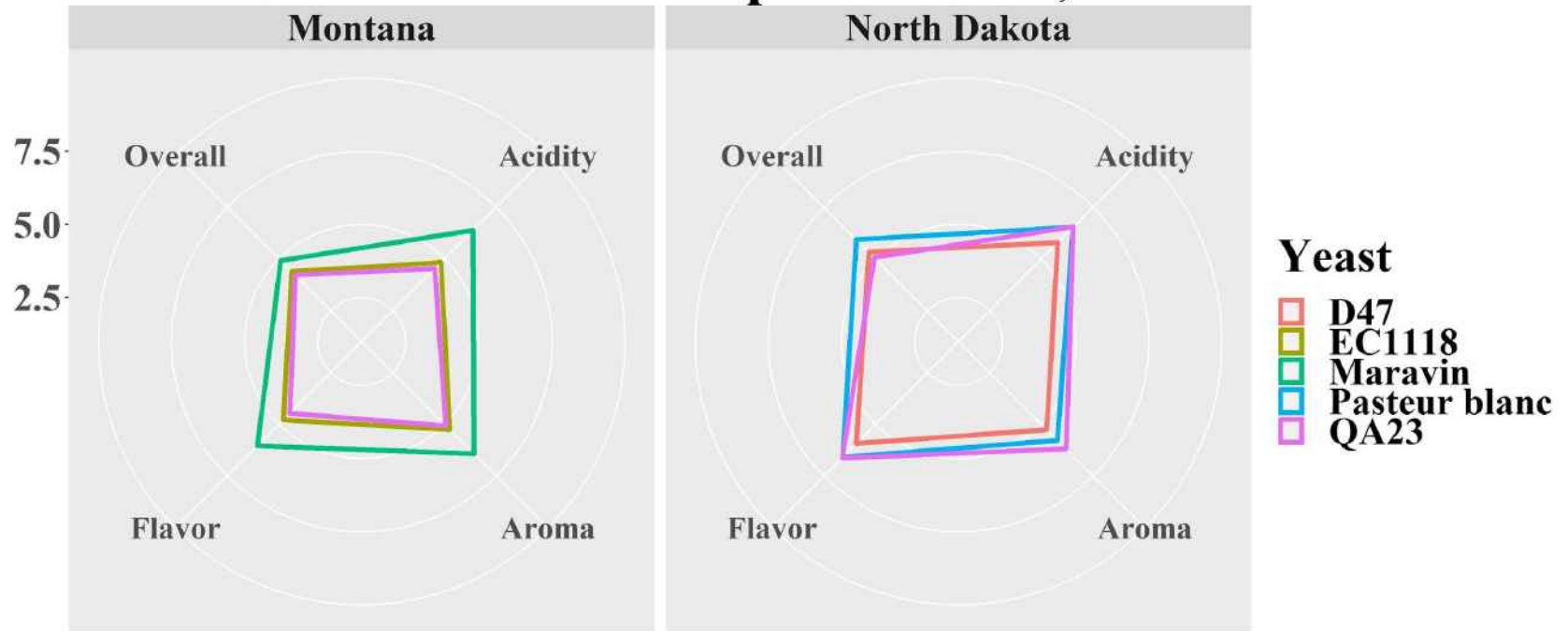
## A large yellow plastic crate is filled with several bunches of ripe, dark purple grapes. The grapes are clustered together, showing a deep purple color with some lighter, greenish-yellow areas, possibly indicating ripeness or variety. The crate has a perforated design on its sides and a sturdy, ribbed structure. The background is a plain, light-colored surface.





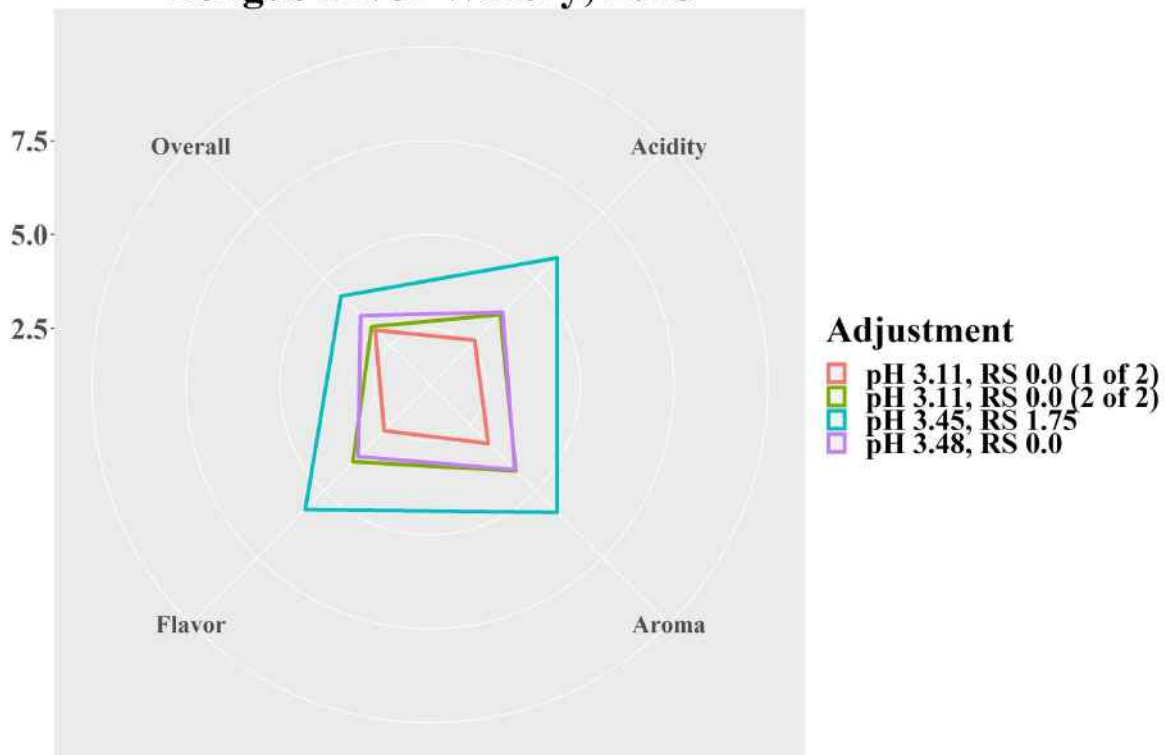
# Preliminary Hedonic Evaluation of ND213

## Evaluation of ND213 Grape Accession, 2018



# Preliminary Hedonic Evaluation of ND054#27

## Evaluation of ND054#27 Grape Accession, Tongue River Winery, 2018



# Going Forward

Continuing towards the future of the NDSU GGEP:

Nearly 20,000 seeds were produced for ~120 crosses in 2018.

Many of the crosses produced in 2018 were NDSU Elite x NDSU Elite crosses, indicative of the maturation of the program.



We are excited for what comes next. More grapes.





# 2017 Seedling Planting; 2019 Evaluations

~200 Crosses

~4,640 Unique  
Grapevines

Only ~928  
Evaluations/Person



That's a lot of work for HVC.



# Thankfully, We Have New Tools for Selection







Growth Chamber Dormancy Experiments





Growth Chamber Dormancy Experiments



Growth Chamber Dormancy Experiments











Growth Chamber Dormancy Experiments



Growth Chamber Dormancy Experiments



## Grape Breeding Collaborator

Marker Assisted Selection:  
Sex, Color, Flavor, Powdery  
Mildew Resistance, and More







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Cornell University



Cornell University  
Cooperative Extension



United States Department Of Agriculture  
Agricultural Research Service



UNIVERSITY OF MINNESOTA



**UC DAVIS**  
UNIVERSITY OF CALIFORNIA

WASHINGTON STATE  
UNIVERSITY

**NDSU** NORTH DAKOTA  
STATE UNIVERSITY



Olmo, 1955

“Many are the vines that do not come up to specification. In one breeding block of some 1,000 seedlings ... only six were saved from the bonfire—a lone vine left here and there where before stood a veritable forest.”



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Andrej Svyantek

PhD Student

High Value Crops

NDSU

