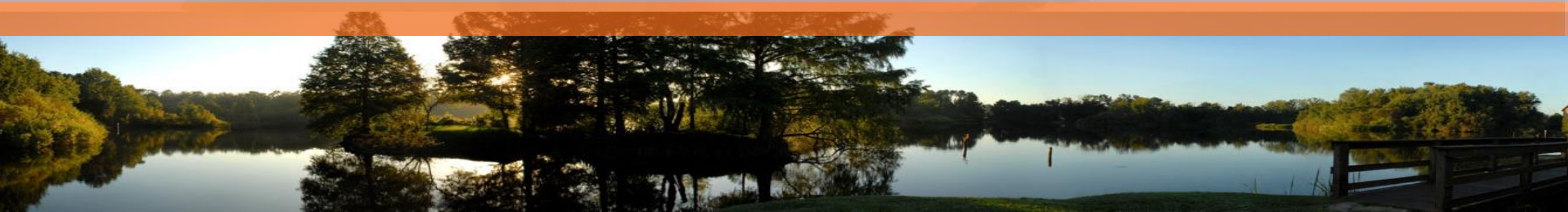




NITROGEN FERTILIZATION IN SUBTROPICAL PEACHES

Zilfina Rubio Ames - Horticultural Sciences Department



BACKGROUND INFORMATION

Nitrogen in Peaches

- Increased N fertilization stimulates growth of axillary buds, increases shoot to root ratio, increases vegetative growth (causing shaded canopies): poor fruit production.
- Lower N results in smaller leaves, less branching, low emergence of axillary buds (*Jordan et al., 2009; Jordan et al., 2013*)
- Higher N rates extend the fruit developmental period, increasing fruit size (yield) (*Saenz et al., 1997, Wert et al., 2009*).

BACKGROUND INFORMATION

Nitrogen in Peaches

- Nitrogen and peach fruit quality:
 - Affects peel color (lower a^* value with higher N rates) (*Jia et al., 1999, Olienyk et al., 1997*).
 - No effect on firmness (*Dolinski et al., 2016, Rufat et al., 2011*).
 - Different responses for fruit composition (*Dolinski et al., 2016, Jia et al., 2000, Olienyk et al., 1997, Rufat et al., 2011*).
 - Low N increases/decreases PAL activity: ↑
phenolic compounds (*Hernandez-Fuentes et al., 2004, Liam et al., 2016,*). High N Levels decrease ascorbic acid.
 - Higher N: sour fruit, lower level of γ -decalactone.
(*Jia et al., 2000, Olienyk et al., 1997*)



RECOMMENDED FERTILIZATION RATES

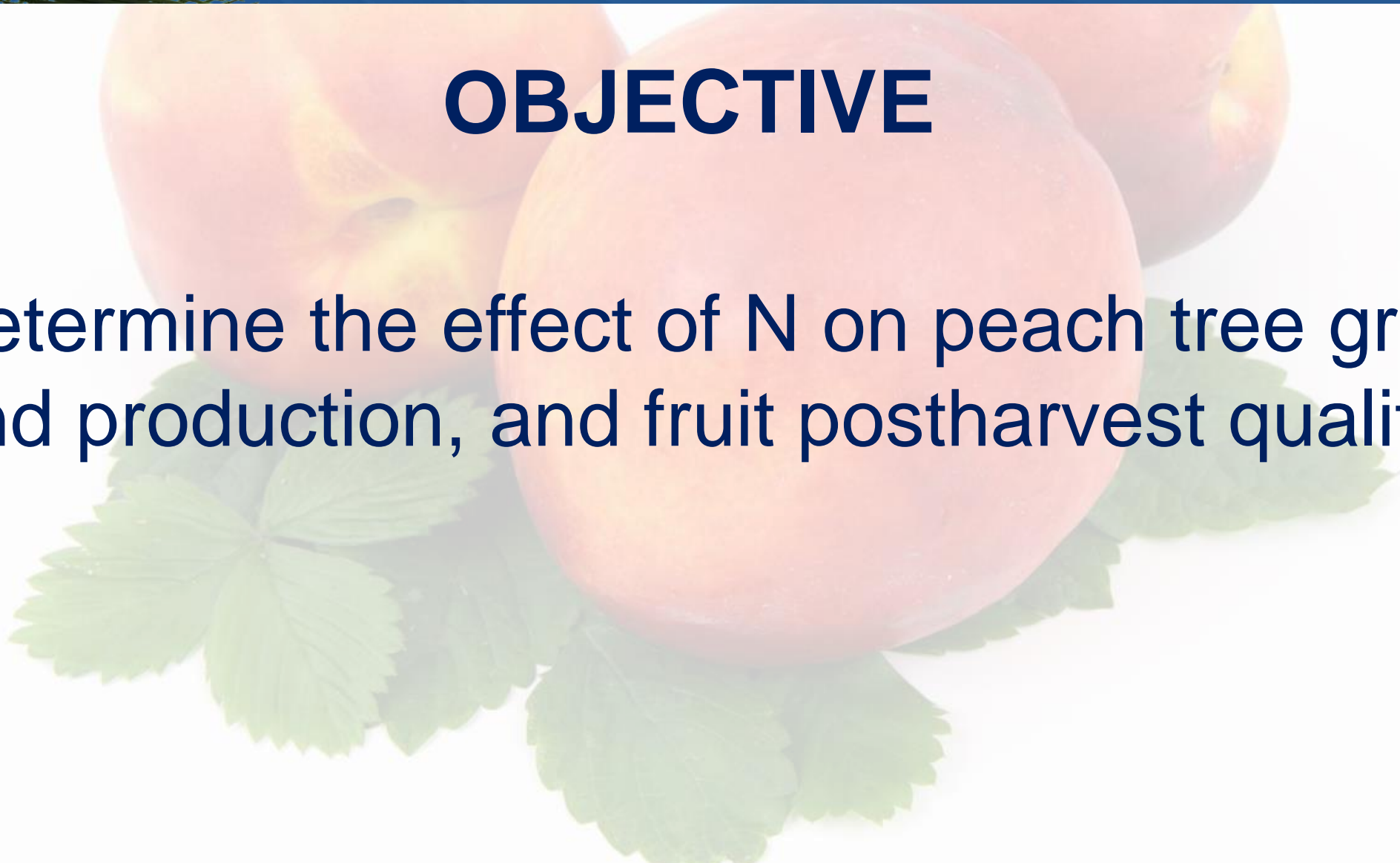
Peaches

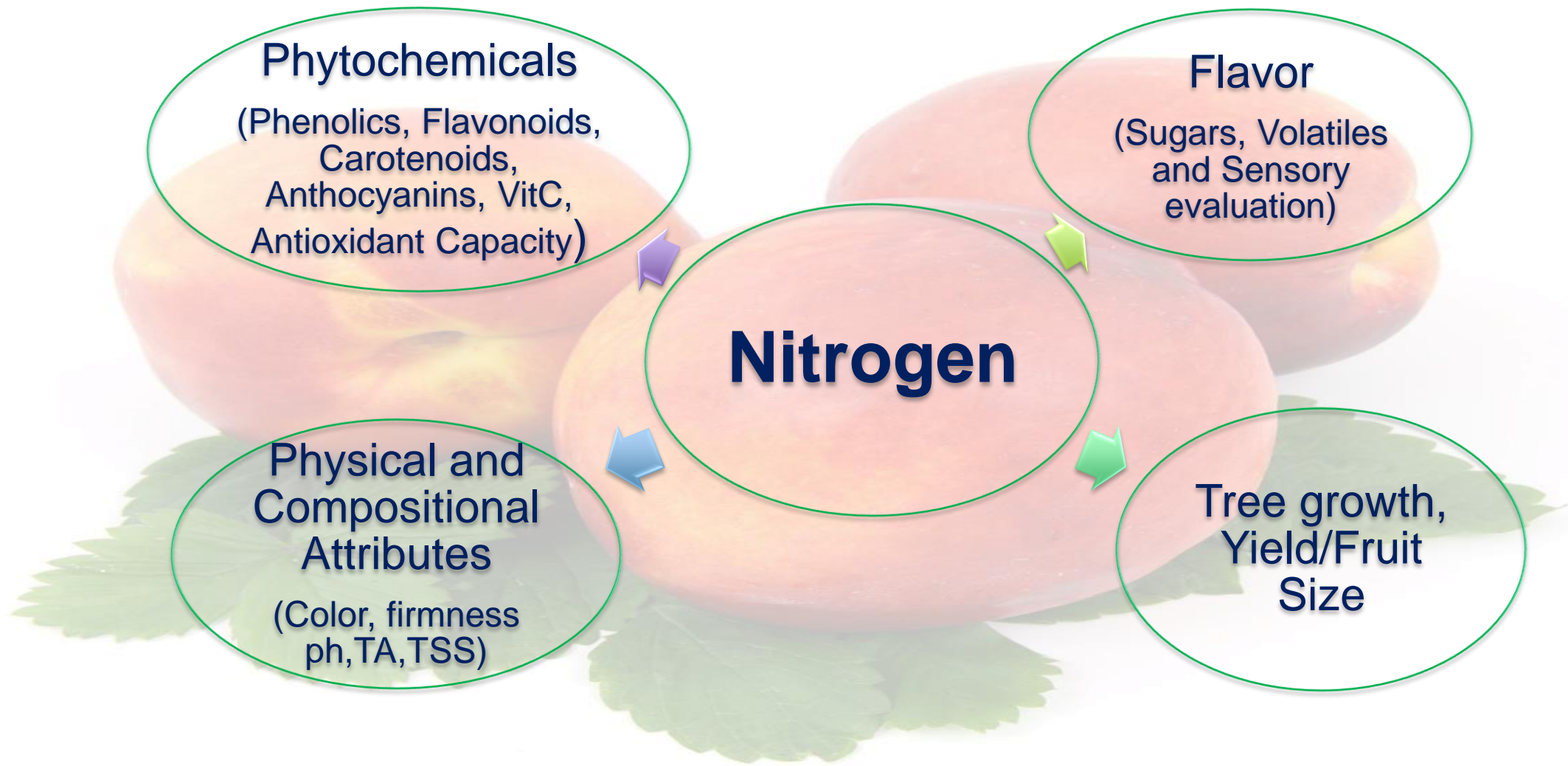
Year 2		
Application date	Sandy soils (central Florida) (12-4-8)	Loamy soils (North and West Florida) (8-8-8)
January	1-1.5	1-1.5
May	1-1.5	1-1.5
TOTAL ANNUAL APPLICATION	216-324 lb./acre/year or 25.9-38.9 lb. N	216-324 lb./acre/year or 17.3-25.9 lb. N
Year 3+		
January	30-40 lb. nitrogen per acre in mixed fertilizer as above	
May (after harvest)	30-40 lb. nitrogen per acre in mixed fertilizer as above	
August	20-30 lb. nitrogen per acre during August if wet conditions	
TOTAL ANNUAL APPLICATION	80-110 lb. N/acre	



OBJECTIVE

Determine the effect of N on peach tree growth and production, and fruit postharvest quality.





Nitrogen Field Plot – Citra Florida TREATMENTS- EXPERIMENTAL DESIGN



LB OF NITROGEN PER ACRE

VARIETIES

'UFSharp'
Non-Melting Flesh (NMF)



MEDIUM CHILL
(325 CHILLING UNITS)

'TropicBeauty'
Melting Flesh (MF)



LOW CHILL
(150 CHILLING UNITS)

FIELD MEASUREMENTS



Chl content (SPAD),
N content

Fruit number, size, mass (yield)

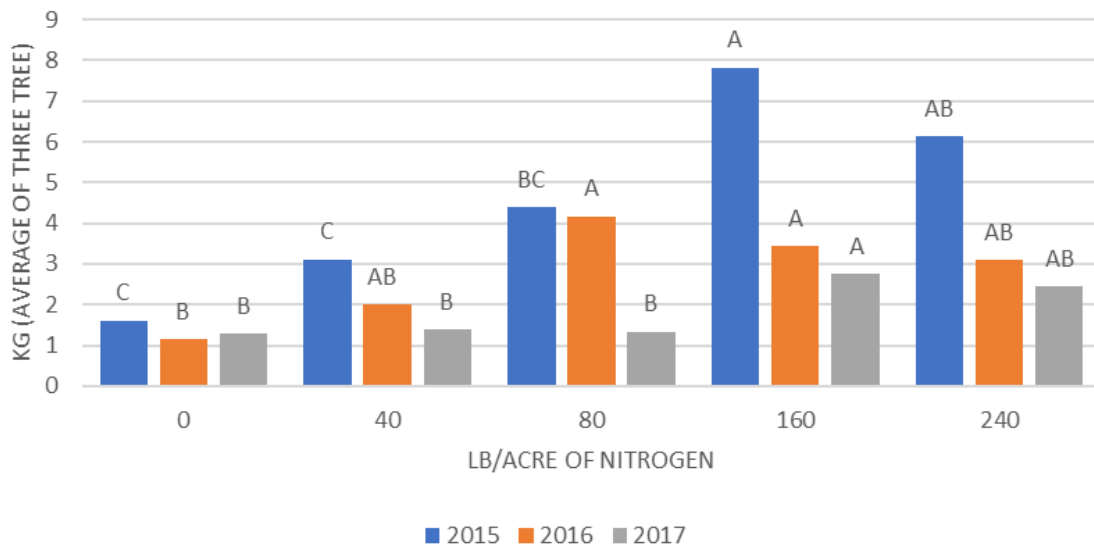


Pruning weight

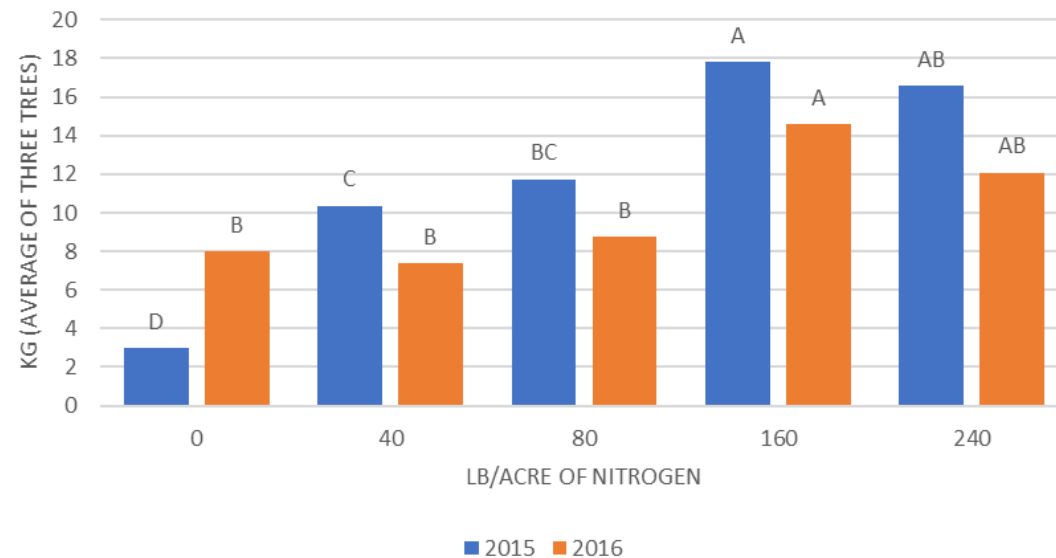


Tree Growth - UFSharp

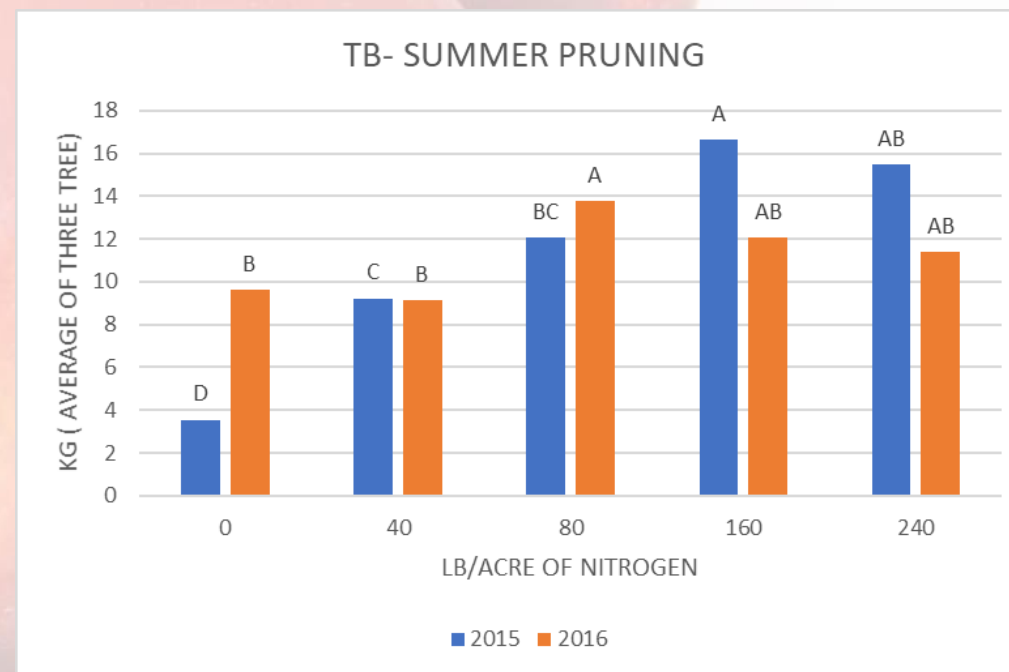
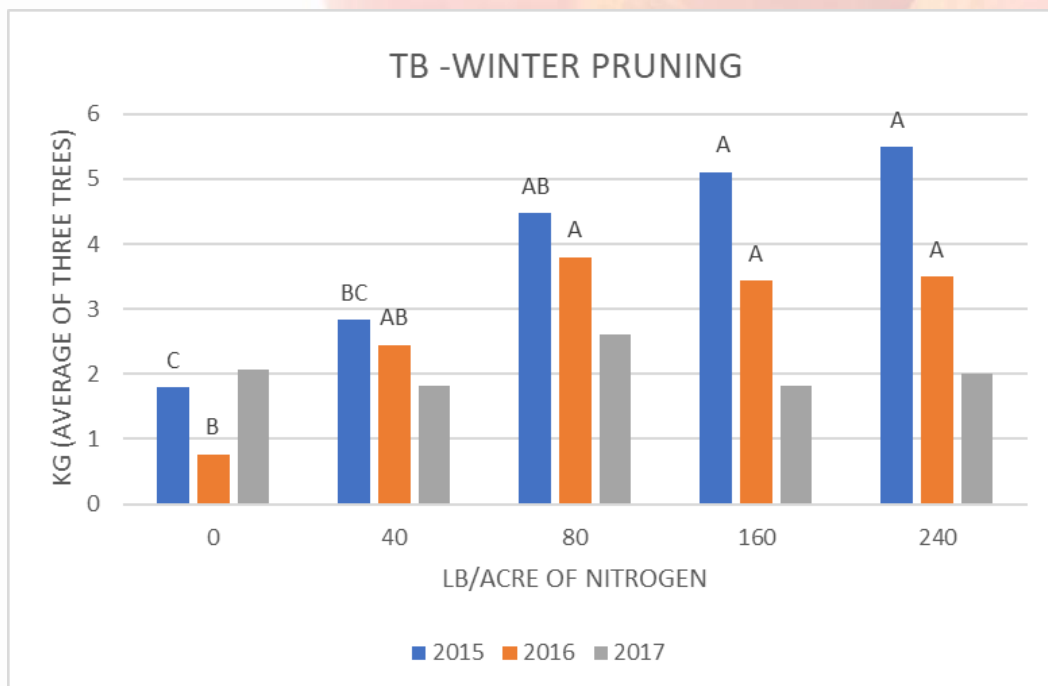
UFSHARP- WINTER PRUNING



UFSHARP-SUMMER PRUNING



Tree Growth – TROPICBEAUTY



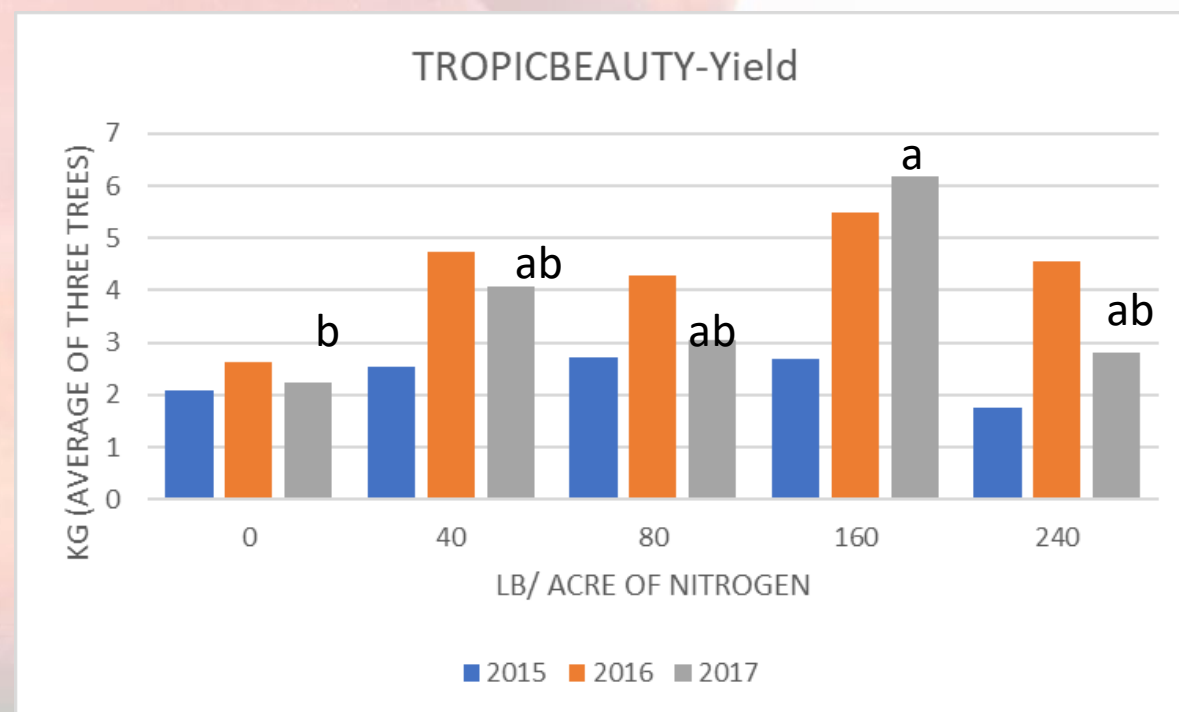
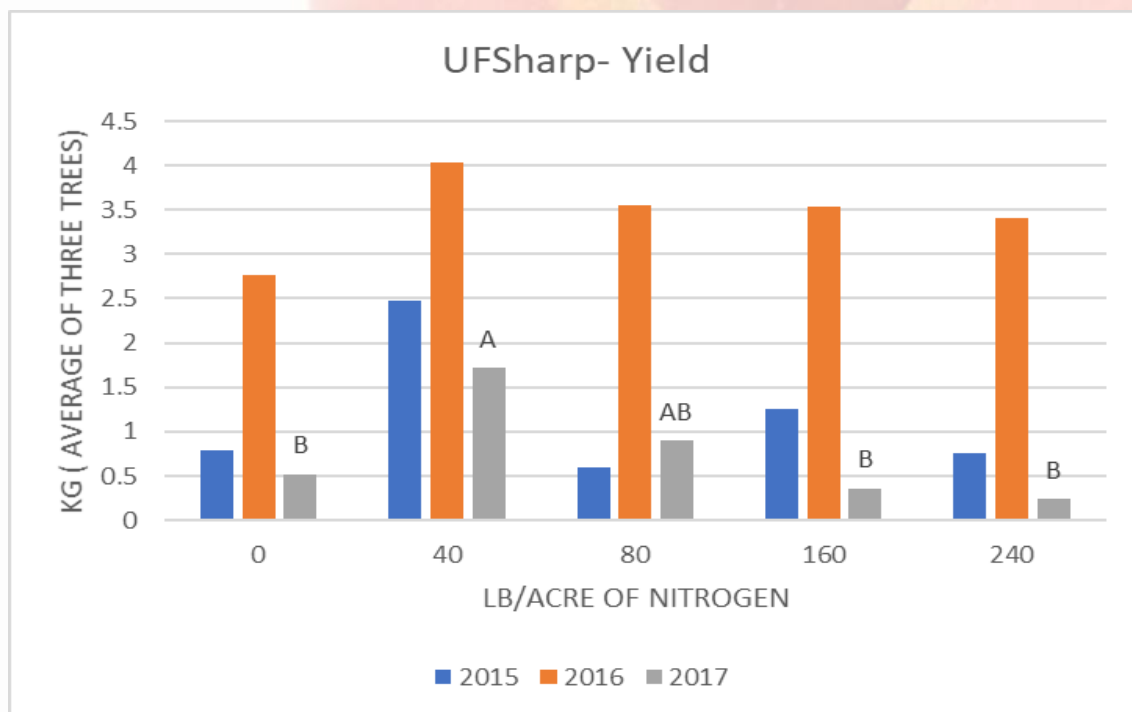
N status - UFSharp

Variety	N Treatment (kg/ha)	SPAD	Leaf N Content (%)
2015	N0-0	38.25b	2.70b
	N1-40	39.716ab	2.78ab
	N2-80	40.72ab	3.05ab
	N3-160	40.8ab	3.11a
	N4-240	41.8a	3.16a
<i>p-value</i>		0.0125	0.0046
2016	N0-0	38.12b	3.03
	N1-40	39.98a	3.03
	N2-80	40.92ab	3.16
	N3-160	39.90ab	3.14
	N4-240	40.72ab	2.96
<i>p-value</i>		0.0413	0.8487
2017	N0-0	37.48	3.09
	N1-40	38.18	3.29
	N2-80	38.44	3.15
	N3-160	37.58	3.18
	N4-240	39.28	3.34
<i>p-value</i>		0.7064	0.291

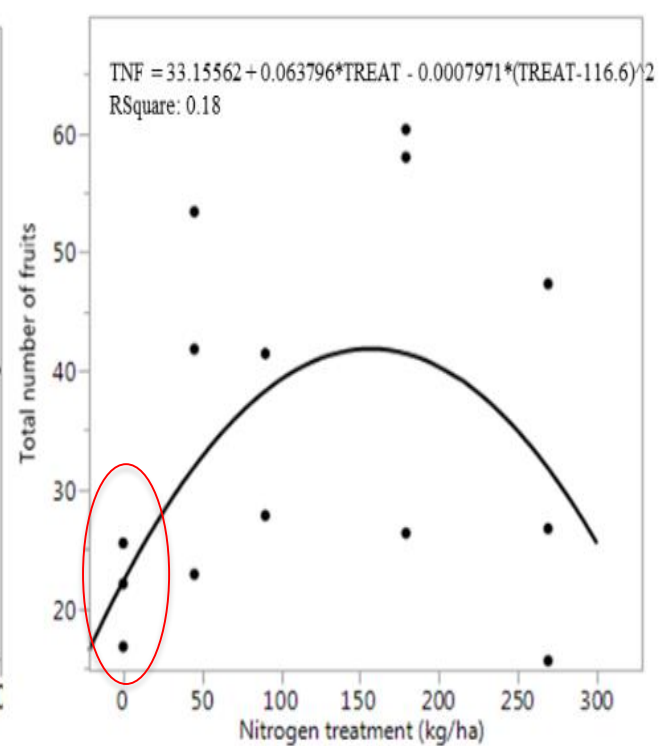
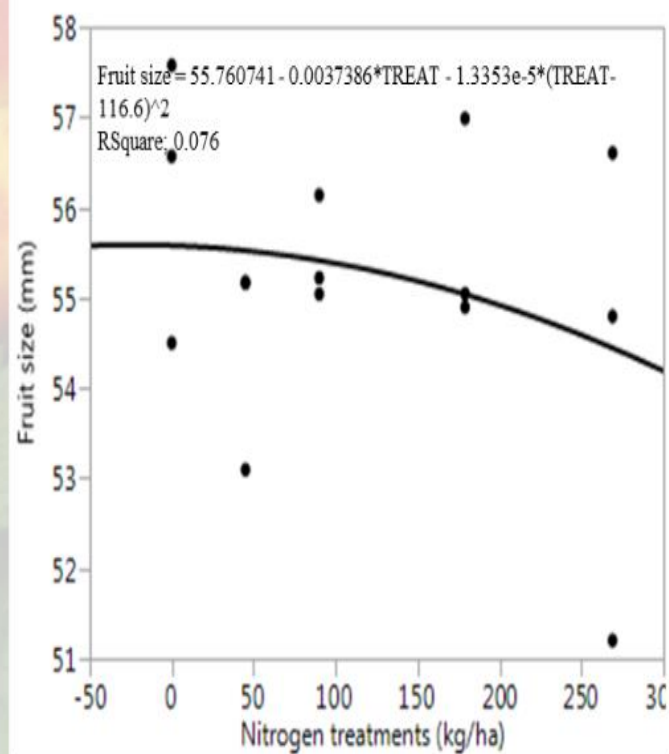
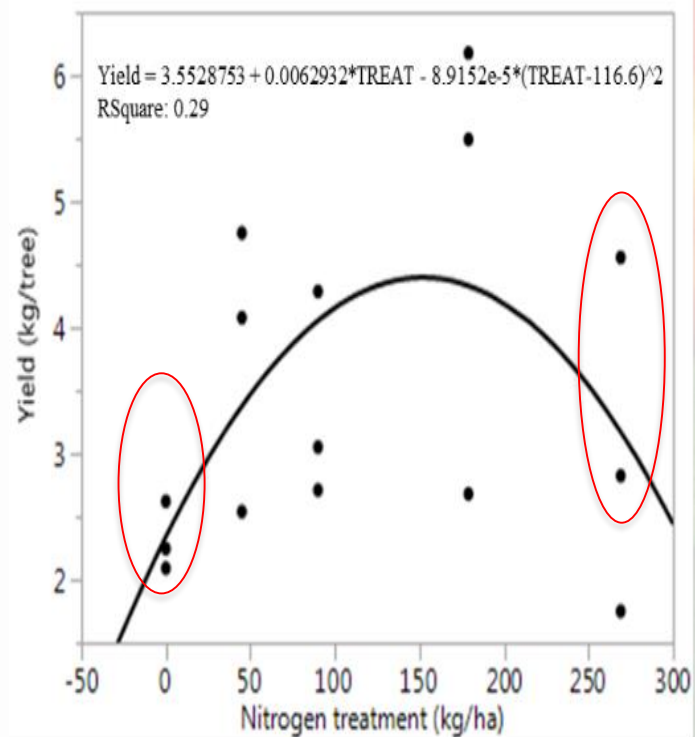
N status - TropicBeauty

Variety	N Treatment (lb/acre)	SPAD	Leaf N Content (%)
2015	N0-0	37.05c	2.67b
	N1-40	39.70b	2.78ab
	N2-80	42.67a	3.04ab
	N3-160	42.30a	3.02ab
	N4-240	42.56a	3.15a
<i>p-value</i>		<0.001	0.01
2016	N0-0	38.05	3.01
	N1-40	39.22	2.76
	N2-80	40.96	3.02
	N3-160	39.98	3.00
	N4-240	39.53	2.86
<i>p-value</i>		0.11	0.26
2017	N0-0	35.87	3.18
	N1-40	36.97	3.22
	N2-80	36.53	3.00
	N3-160	37.63	3.24
	N4-240	37.93	3.23
<i>p-value</i>		0.51	0.12

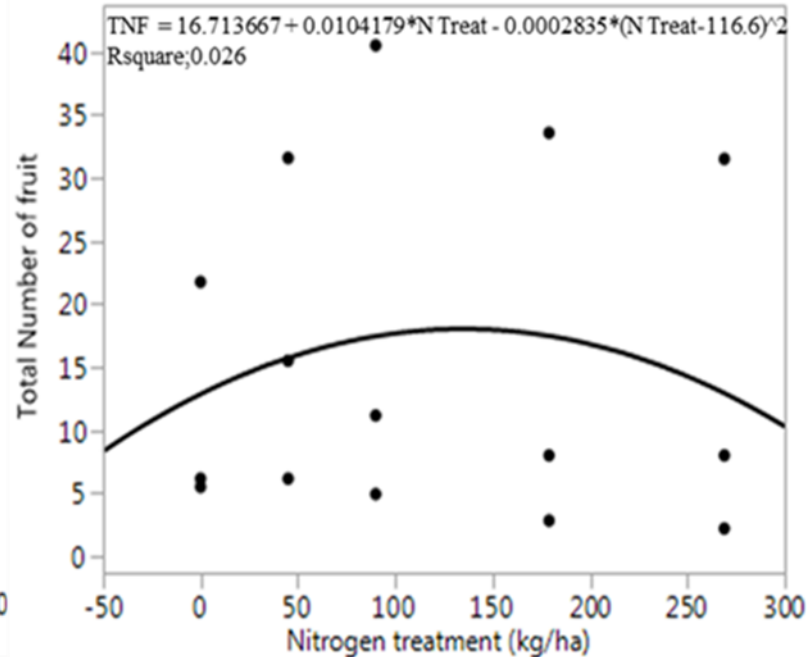
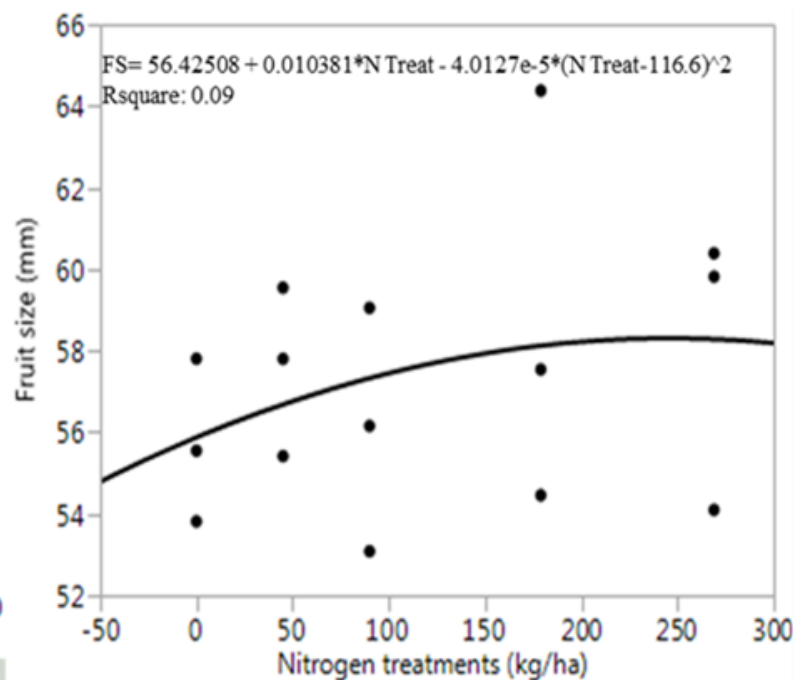
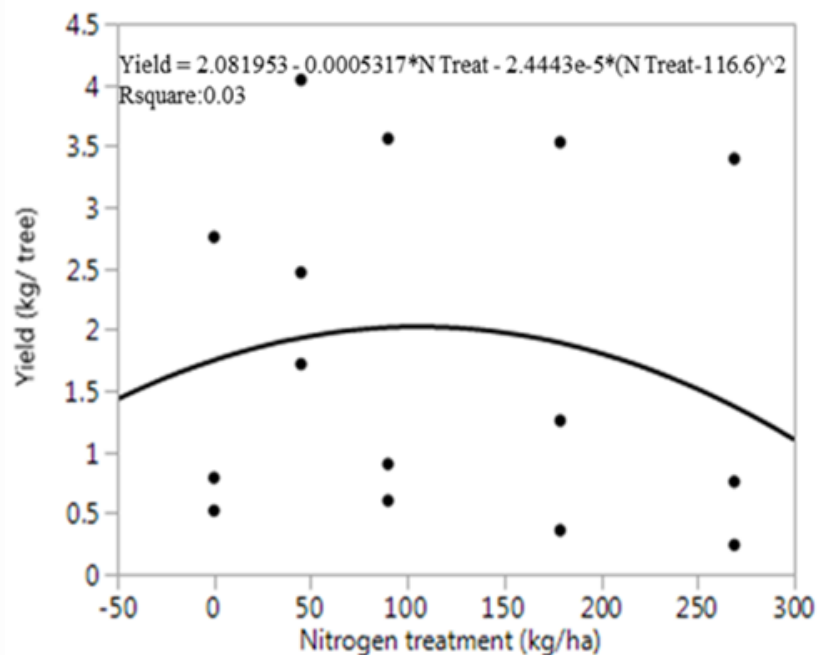
YIELD



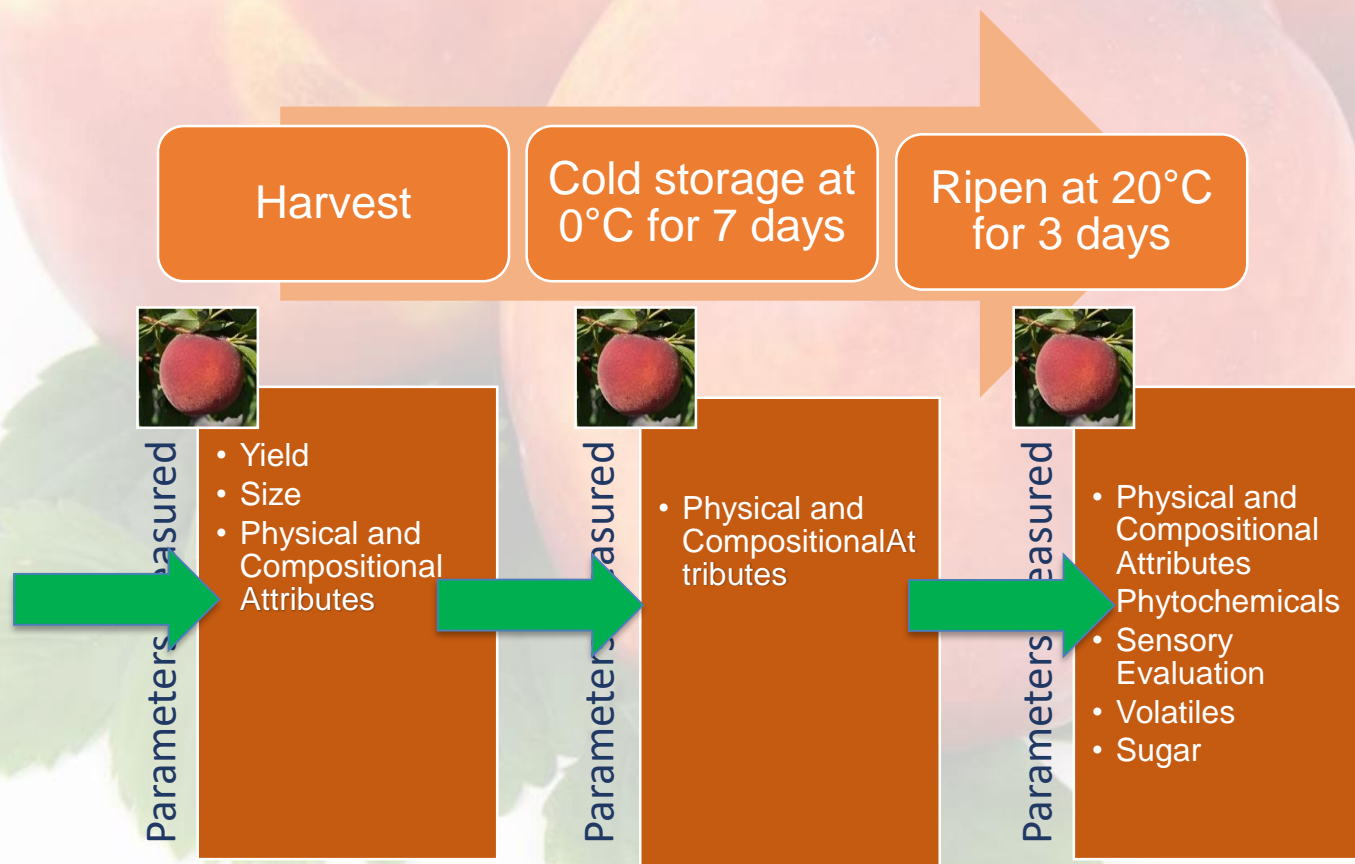
Trends- TropicBeauty



Trends-UFSharp

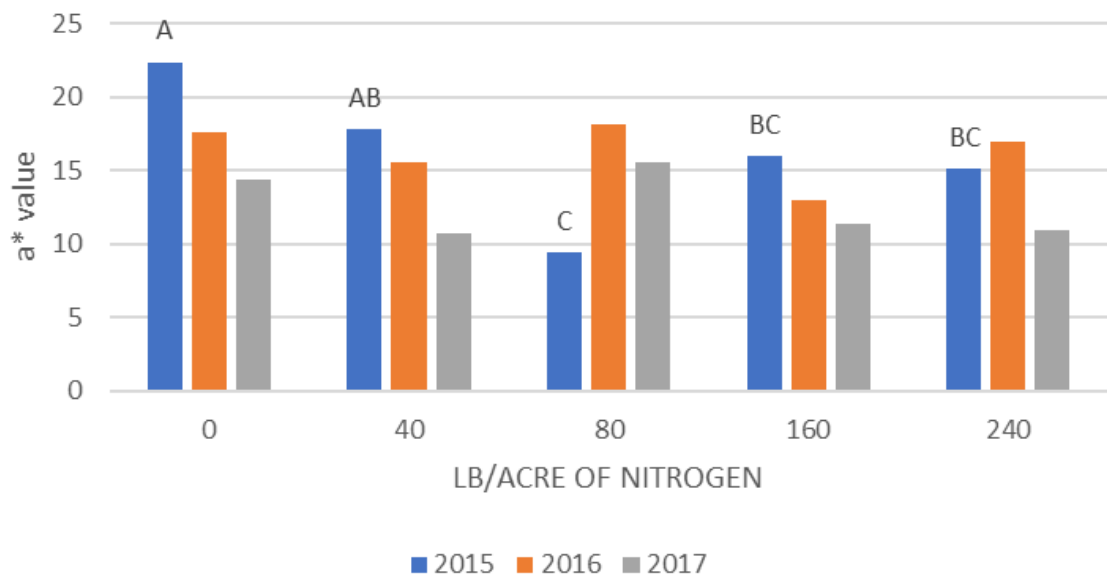


FRUIT ANALYSIS

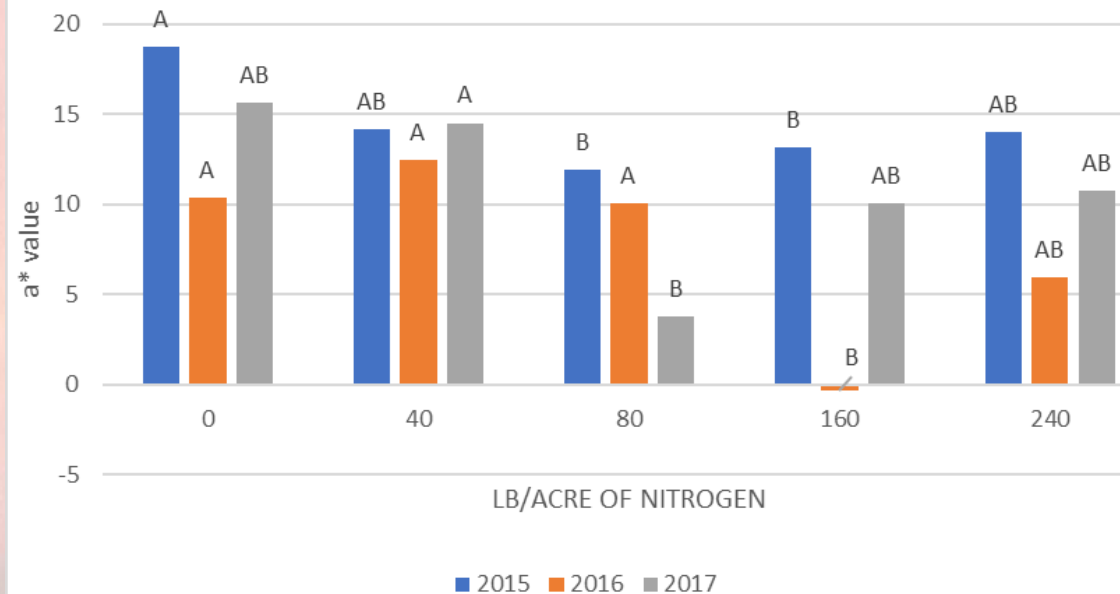


Color- UFSharp

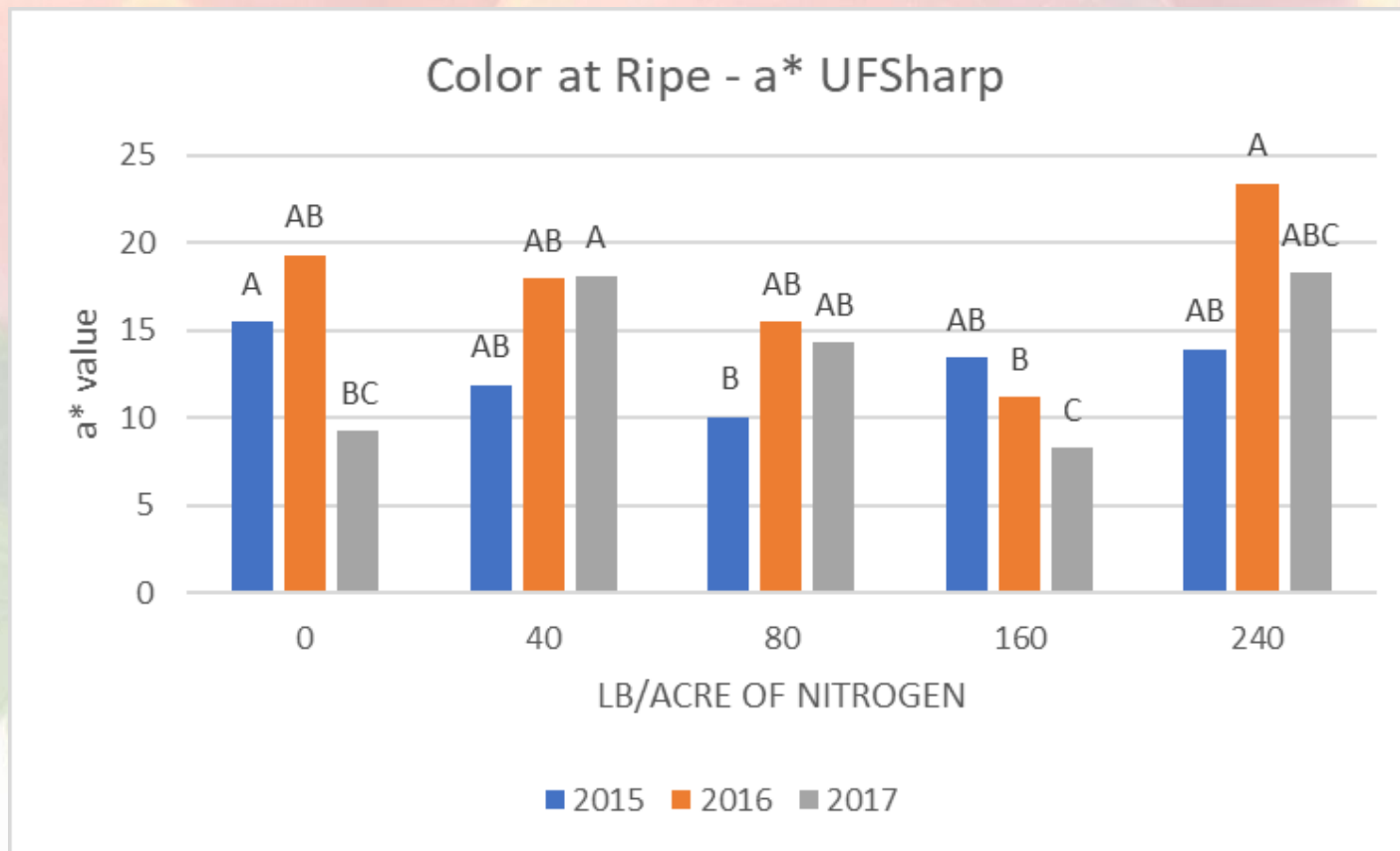
Color at Harvest - a* UFSharp



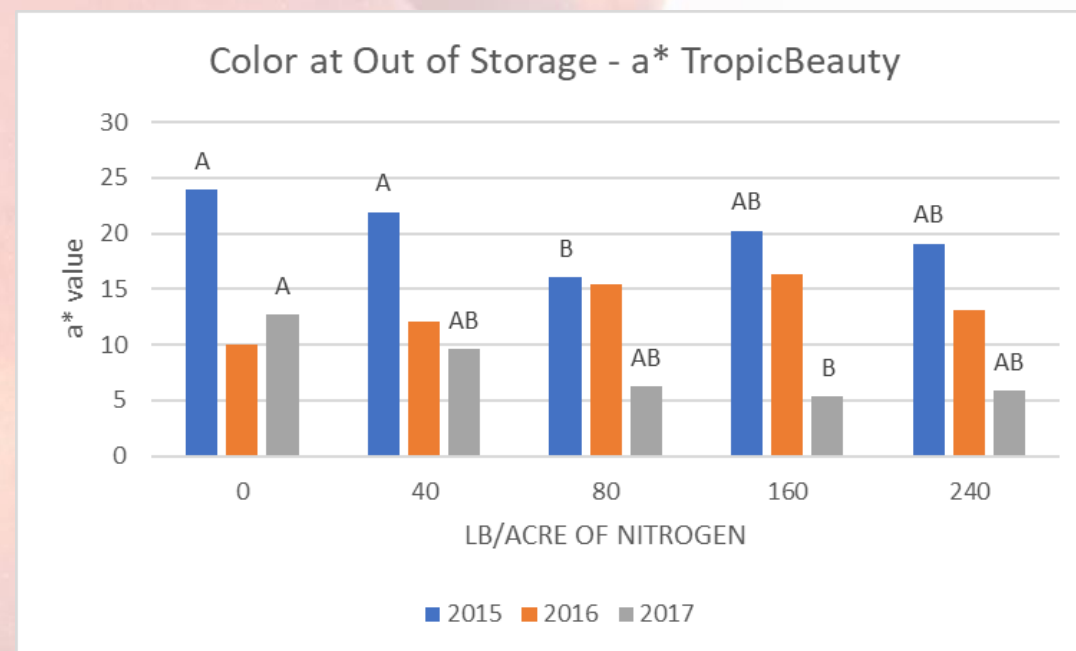
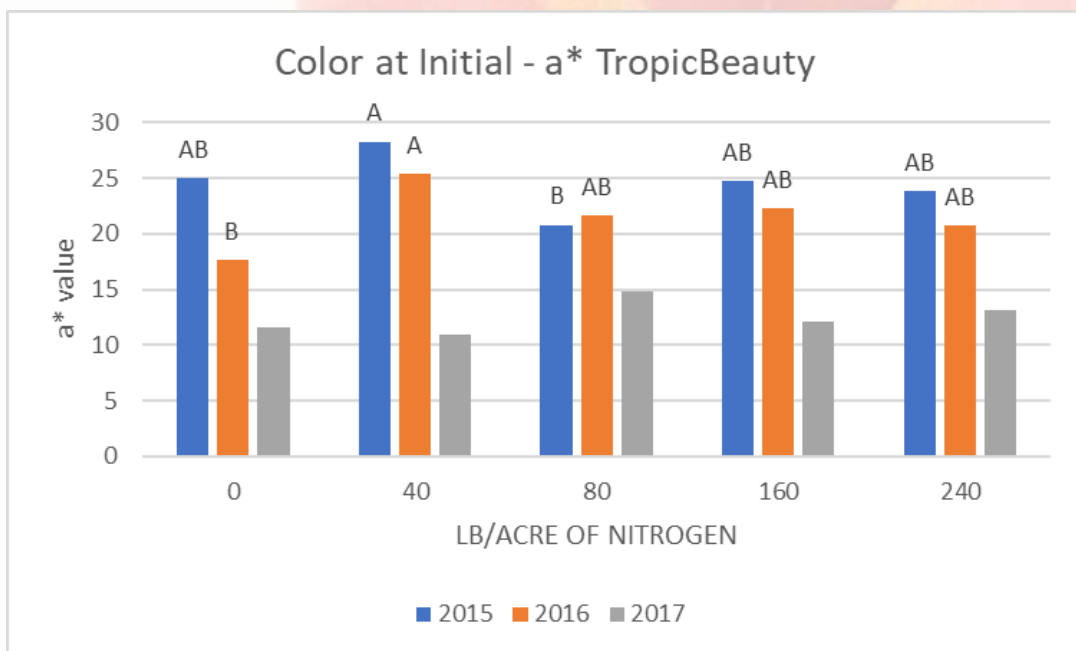
Color at Out Storage - a* UFSharp



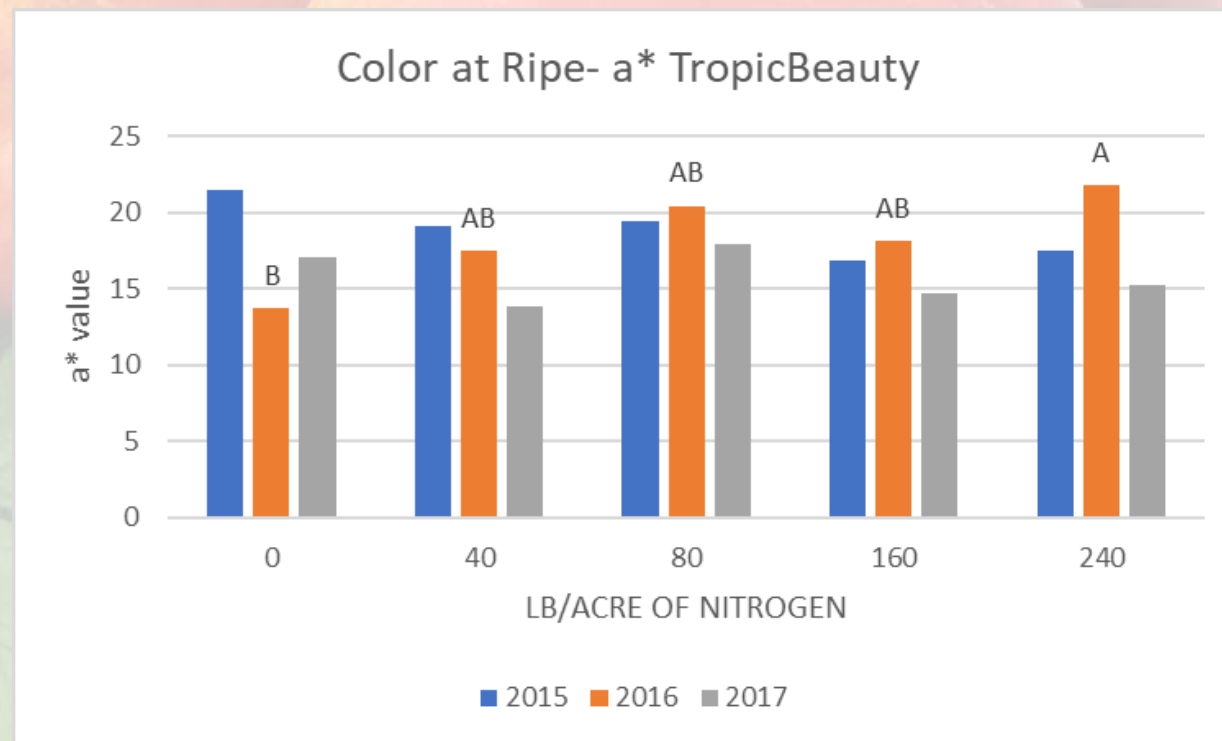
Color- UFSharp



Color- TropicBeauty



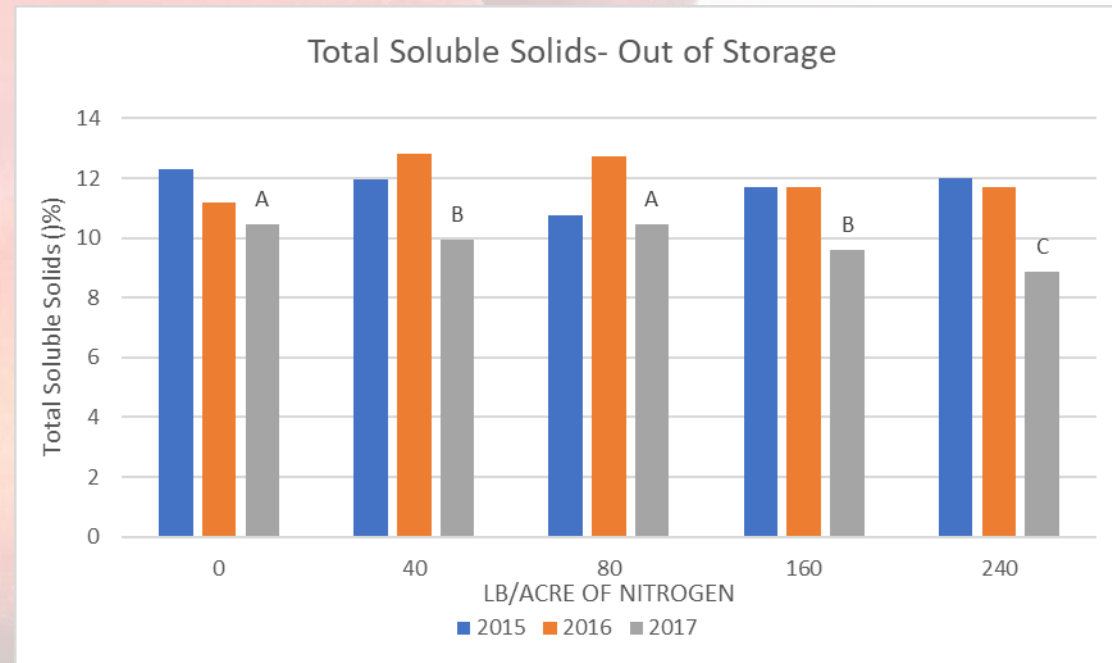
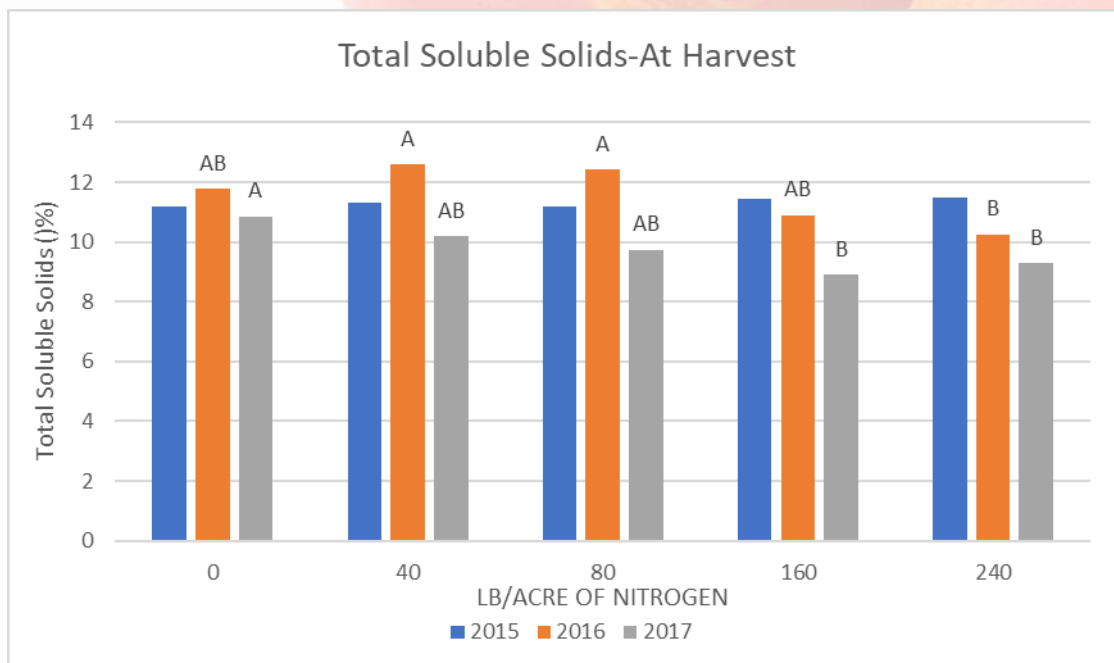
Color- TropicBeauty



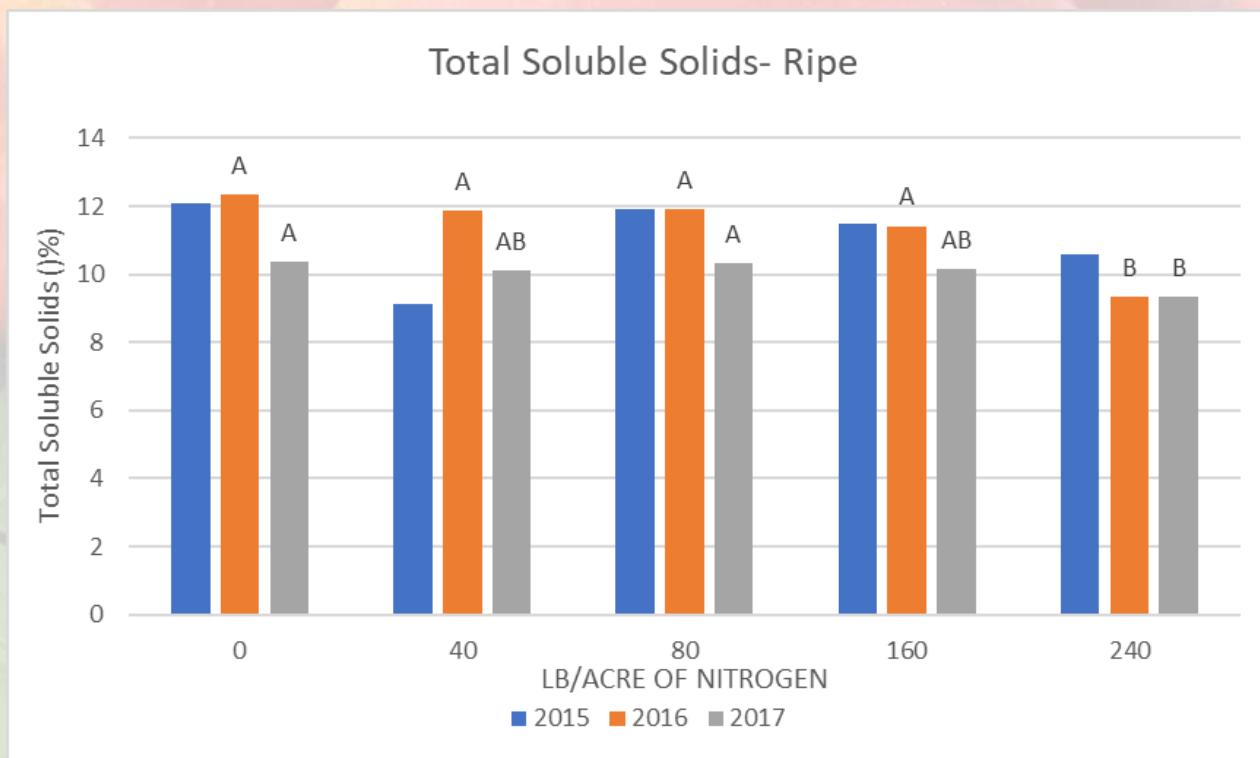
Firmness(N)

Year	N treatments (Code-kg/ha)	TropicBeauty			UFSharp		
		Initial	Out of storage	Ripe	Initial	Out of storage	Ripe
2015	N0-0	2.81	2.48b	2.43bc	11.71b	14.39b	10.66
	N1-45	4.33	2.64b	2.28bc	22.66a	17.13b	9.844
	N2-90	3.44	7.48a	2.16c	24.56a	19.14ab	11.54
	N3-179	3.98	3.37b	2.70ab	20.68a	18.70ab	9.63
	N4-269	3.32	4.21ab	2.94a	18.74ab	25.56a	9.33
	<i>p-value</i>	0.66	0.0009	<0.001	<0.001	0.005	0.79
2016	N0-0	16.09	14.80	3.15	20.73	27.78	9.64
	N1-45	8.90	6.07	2.68	23.09	22.18	8.13
	N2-90	15.75	10.88	2.53	21.34	27.29	11.43
	N3-179	12.12	8.73	2.80	28.69	35.54	9.99
	N4-269	15.21	12.87	3.08	29.28	25.43	12.96
	<i>p-value</i>	0.73	0.35	0.11	0.037	0.10	0.33
2017	N0-0	32.10	23.96b	1.92ab	35.00a	35.71	9.42
	N1-45	32.32	25.77b	2.10a	33.46a	32.28	4.51
	N2-90	27.70	40.44a	2.12ab	26.03ab	36.78	4.48
	N3-179	28.60	34.83ab	1.75b	24.59ab	33.54	6.48
	N4-269	34.36	37.21ab	2.13a	17.44b	44.57	8.33
	<i>p-value</i>	0.56	0.004	0.002	0.007	0.33	0.07

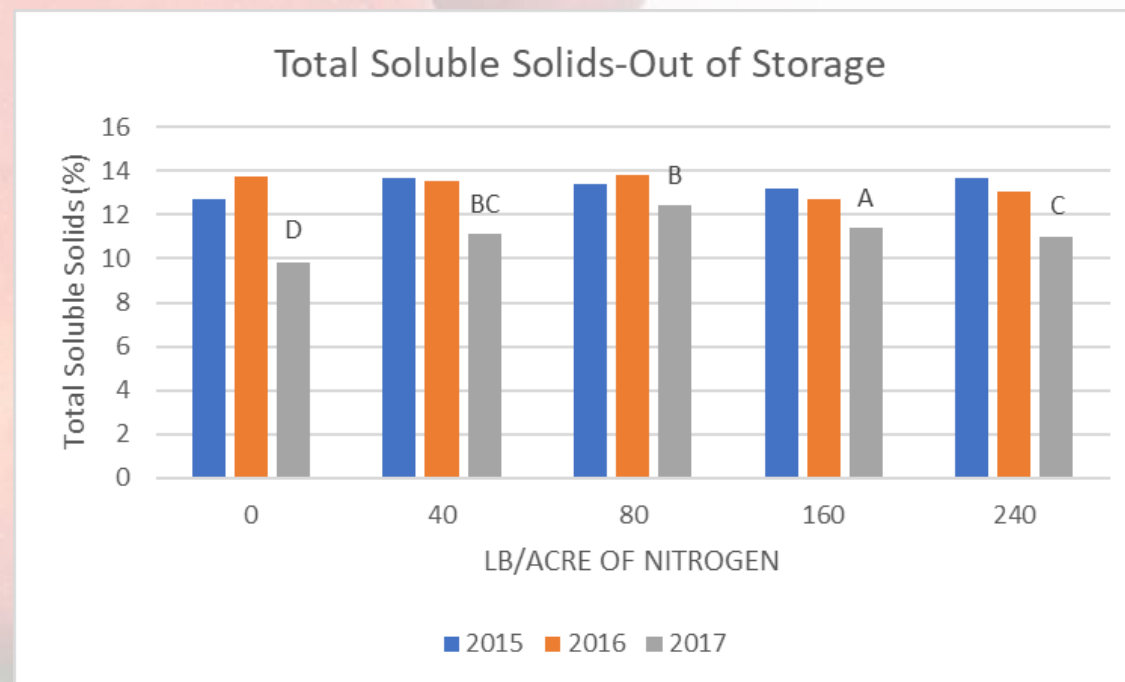
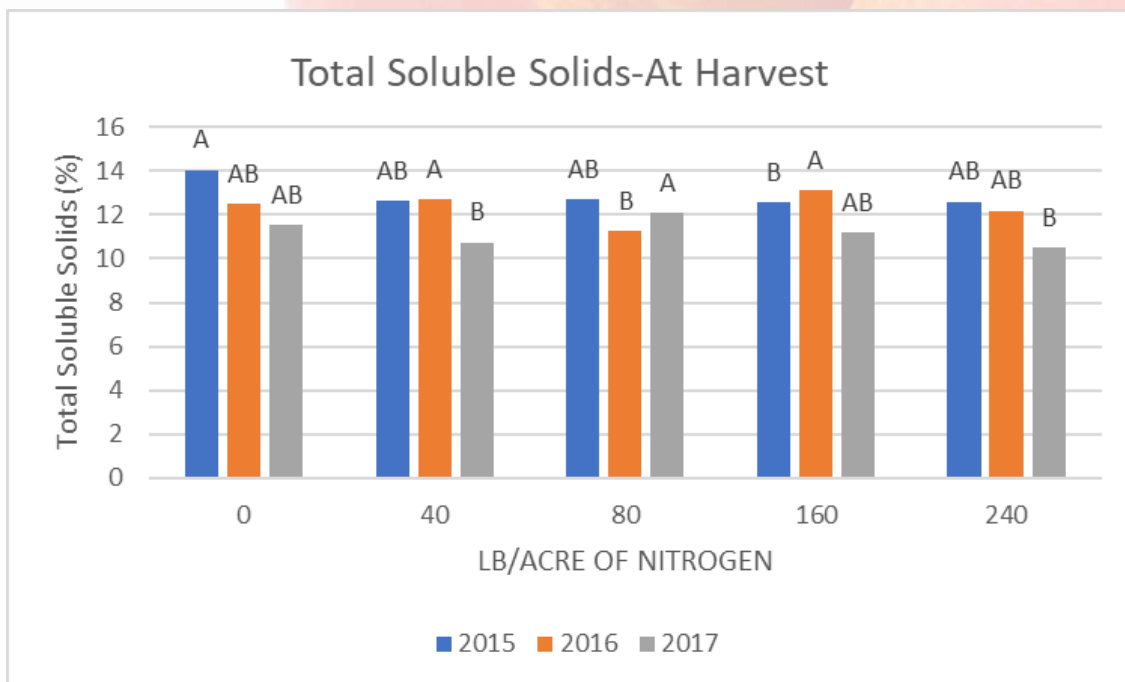
Total Soluble Solids- UFSharp



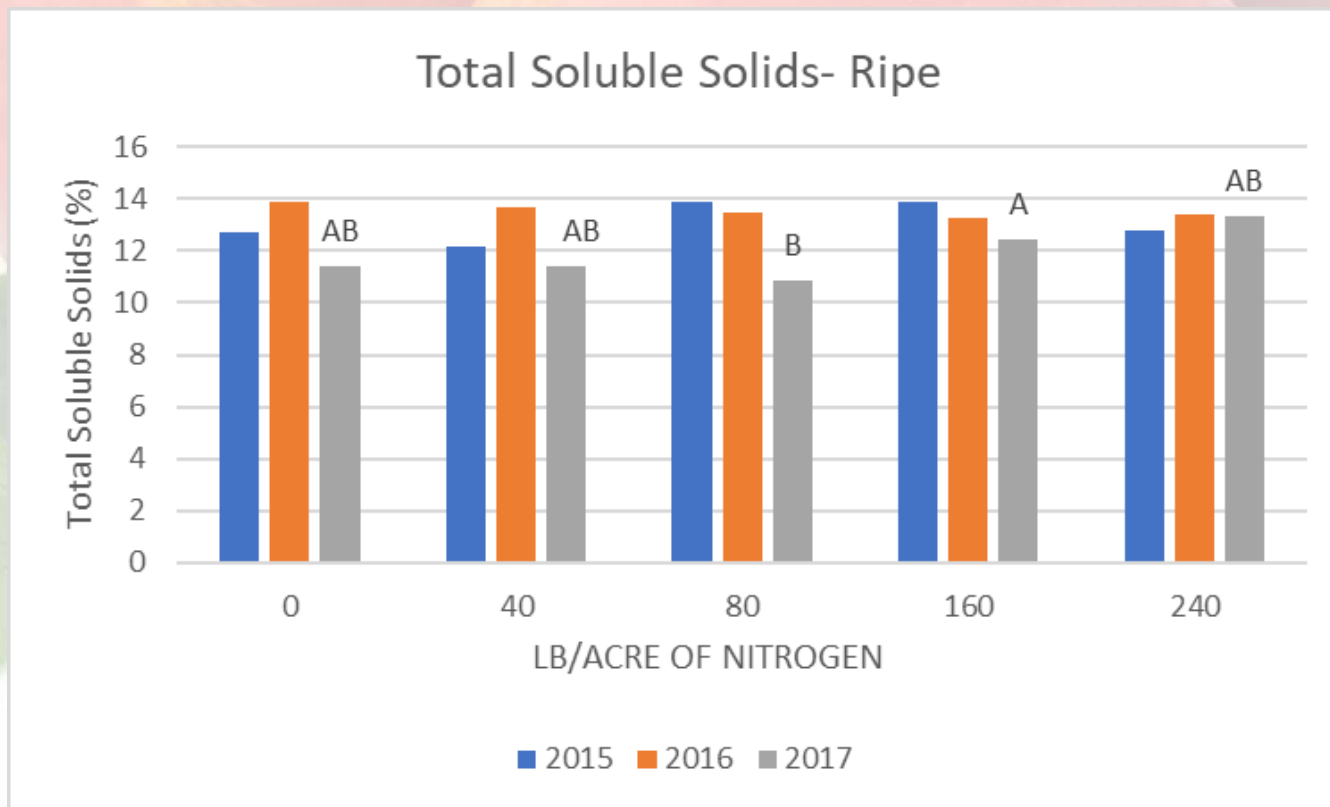
Total Soluble Solids- UFSharp



Total Soluble Solids- TropicBeauty



Total Soluble Solids- TropicBeauty



Composition - TropicBeauty

Treatment (Code- kg/ha)	Initial			Out of storage				Ripe				
	Total soluble solids (%)	Titratable acidity (%)	pH	TSS/ TA	Total soluble solids (%)	Titratable acidity (%)	pH	TSS/ TA	Total soluble solids (%)	Titratable acidity (%)	pH	TSS/ TA
N0-0	11.56ab	0.88ab	3.71a	13.10a	9.80d	0.70d	3.87a	14.11a	11.44ab	0.63b	3.93a	18.30a
N1-44	10.74b	0.81b	3.70a	13.30a	11.12bc	0.79c	3.74b	14.00a	11.42ab	0.79a	3.81b	14.40b
2017 N2-89	12.10a	0.92a	3.64b	13.21a	12.42b	0.97a	3.61c	12.80b	10.84b	0.81a	3.81b	13.42b
N3-179	11.22ab	0.87ab	3.66ab	12.90a	11.42a	0.95a	3.61c	12.09b	12.41a	0.80a	3.78b	15.20b
N4-269	10.52b	0.91a	3.62b	11.60b	11.02c	0.89b	3.72b	12.39b	11.34ab	0.81a	3.80b	14.10b
p-value	0.003	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	<0.001	<0.001	<0.001

Composition - UFSharp

Year	Treatment (Code-kg/ha)	Initial				Out of storage				Ripe			
		Total soluble solids (%)	Titratable acidity (%)	pH	TSS/TA	Total soluble solids (%)	Titratable acidity (%)	pH	TSS/TA	Total soluble solids (%)	Titratable acidity (%)	pH	TSS/TA
2017	N0-0	10.86a	0.78c	3.65c	13.85b	10.44a	0.66d	3.85a	15.81a	10.38a	0.78ab	3.77b	13.27ab
	N1-44	10.18ab	0.93b	3.578d	10.91c	9.92b	0.71c	3.82a	14.03b	10.12ab	0.70c	3.85a	14.60a
	N2-89	9.74ab	0.978a	3.574d	9.96c	10.44a	0.81b	3.76b	12.83c	10.32a	0.70bc	3.89a	14.68a
	N3-179	8.92b	0.80c	3.726b	11.15c	9.60b	0.88a	3.70c	10.87d	10.16ab	0.80a	3.79b	12.80b
	N4-269	9.28b	0.60d	3.944a	15.57a	8.87c	0.90a	3.74bc	9.89e	9.35b	0.82a	3.82ab	11.43b
	p-value	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.001	<0.001	0.0006

UFSharp (ripe)

Year	N Treatment (kg/ha)	Total phenolics (mg of gallic acid/ 100g of FW)	Total flavonoids (mg of catechin/ 100g of FW)	Total carotenoids (mg/ 100g of FW)	Total anthocyanins (mg/ 100 g of FW)	Ascorbic acid (mg/100g of FW)	Antioxidant capacity (µM of Trolox equivalents/ g of FW)
2015	N0-0	78.139	18.454	11.876	1.052	7.546	78.214
	N1-45	92.772	16.648	10.409	0.970	7.926	106.371
	N2-90	92.154	14.627	10.895	1.052	8.860	96.442
	N3-179	63.806	18.141	11.961	1.604	12.528	149.262
	N4-269	100.407	21.309	11.284	1.122	11.431	138.665
	<i>p-value</i>	0.5131	0.5431	0.8691	0.0757	0.34	0.3378
2016	N0-0	64.901	11.929b	18.133	0.054b	20.461	289.708b
	N1-45	69.156	16.869ab	16.025	0.045b	19.657	268.025b
	N2-90	59.778	34.146a	17.709	0.075ab	21.248	328.130ab
	N3-179	59.072	14.766b	15.537	0.078ab	17.784	334.733ab
	N4-269	73.705	25.189ab	14.600	0.117a	19.856	393.944a
	<i>p-value</i>	0.1047	0.0129	0.1065	0.0006	0.1028	0.0003
2017	N0-0	71.739	10.337	7.624a	0.0728	8.442	287.570a
	N1-45	66.972	10.120	6.106b	0.0888	8.373	172.575c
	N2-90	63.888	11.435	7.891a	0.0977	8.332	261.380ab
	N3-179	63.062	9.649	7.000ab	0.1019	7.364	209.198bc
	N4-269	-	-	-	-	-	-
	<i>p-value</i>	0.7636	0.5676	0.0005	0.2315	0.099	0.0004

TropicBeauty (ripe)

Year	N Treatment (kg/ha)	Total phenolics (mg of gallic acid/ 100g of FW)	Total flavonoid (mg of catechin/ 100g of FW)	Total carotenoids (mg/ 100g of FW)	Total anthocyanins (mg/ 100 g of FW)	Ascorbic acid (mg/100g of FW)	Antioxidant capacity (µM of Trolox equivalents/ g of FW)
2015	N0-0	47.738	13.532	9.570	1.477b	11.687	143.481
	N1-45	68.314	21.052	12.957	1.325b	13.167	149.843
	N2-90	57.140	20.595	9.557	1.667ab	11.231	112.561
	N3-179	60.822	19.631	12.482	1.667ab	12.848	136.194
	N4-269	68.669	19.355	14.157	2.638a	12.658	216.194
	<i>p-value</i>	0.6214	0.4152	0.225	0.0262	0.8655	0.0517
2016	N0-0	57.589b	13.747b	15.675a	0.050b	14.388	200.723b
	N1-45	60.499b	16.533b	13.290ab	0.052b	14.807	295.131a
	N2-90	55.623b	16.819b	14.855a	0.107b	14.679	303.876a
	N3-179	64.661b	17.791b	10.475ab	0.133b	14.415	288.228a
	N4-269	78.676a	32.390a	8.900b	0.265a	15.601	349.589a
	<i>p-value</i>	0.0001	0.0001	0.0075	0.0001	0.6357	0.0001
2017	N0-0	40.185ab	12.363	8.666b	0.109ab	8.926	201.295b
	N1-45	30.906b	11.781	8.906b	0.133a	9.264	280.549ab
	N2-90	35.836ab	11.952	9.921ab	0.096ab	9.543	374.018a
	N3-179	45.877a	10.634	9.074b	0.079b	8.626	236.742b
	N4-269	33.120b	12.203	10.466a	0.113a	9.395	226.880b
	<i>p-value</i>	0.0028	0.6367	0.0028	0.0025	0.3847	0.008

VOLATILES ANALYZED

ALDEHYDES {
Cis-3-hexanal
hexanal
trans-2-hexenal
benzyl aldehyde
phenylacetaldehyde
nonyl aldehyde

LACTONES {
 γ -hexalactone
 γ -heptalactone
 γ -octalactone
6-amyraldehyde
 γ -decalactone
 δ -decalactone

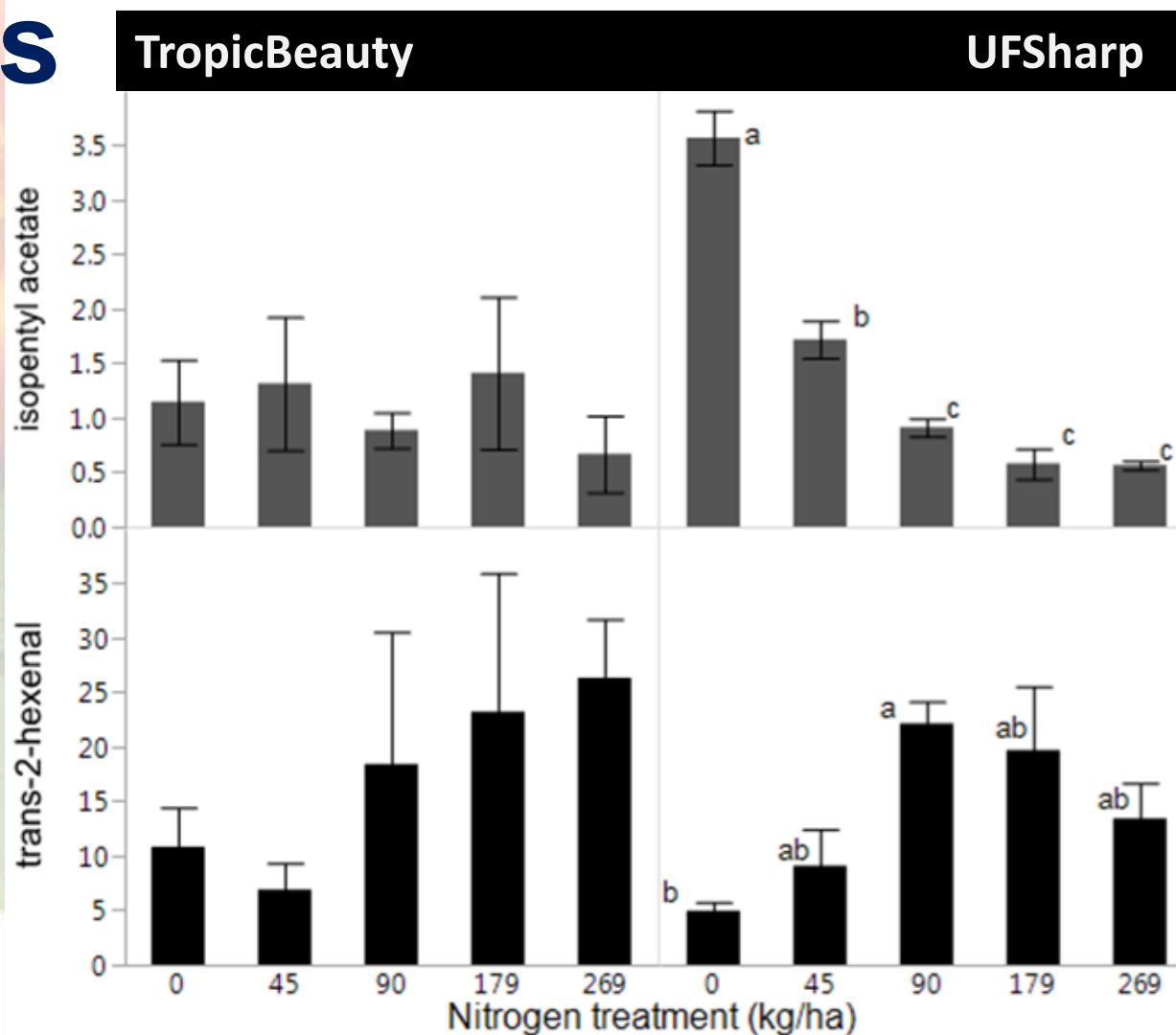
ESTERS {
propyl acetate
isobutyl acetate
butyl acetate
isopentyl acetate
amyl acetate
4-pentenyl acetate
cis-3-hexenyl acetate
hexyl acetate
trans-2-hexenyl acetate
ethyl heptanoate

ALCOHOLS {
cis-3-hexen-1-ol
trans-2-hexen-1-ol
1-hexanol

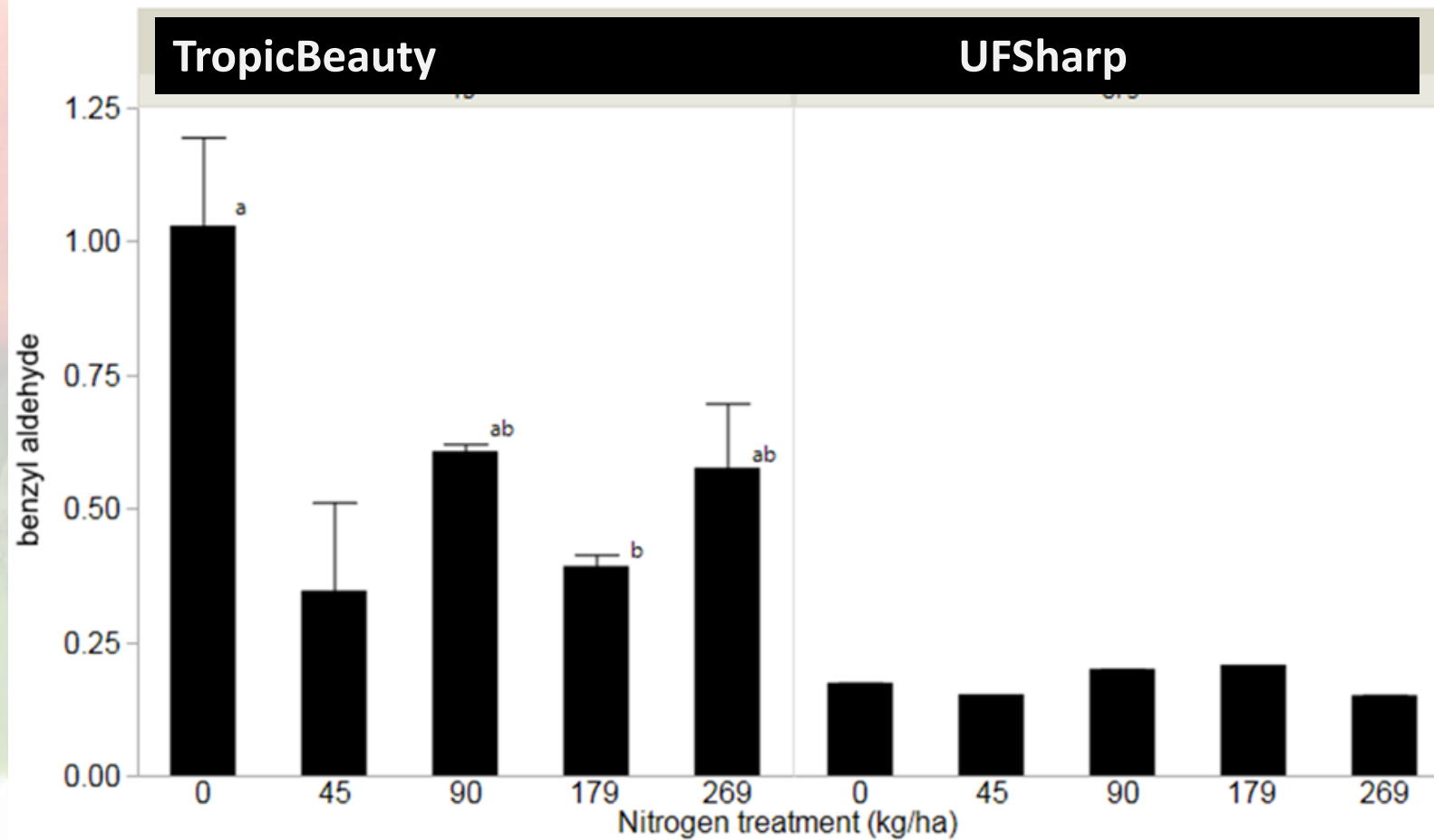
TERPENES {
prenyl acetate
linalool

OTHERS {
2-pentanone
styrene
hexanoic acid
2-butoxyethyl acetate
undecane
dodecane
benzyl thiozole

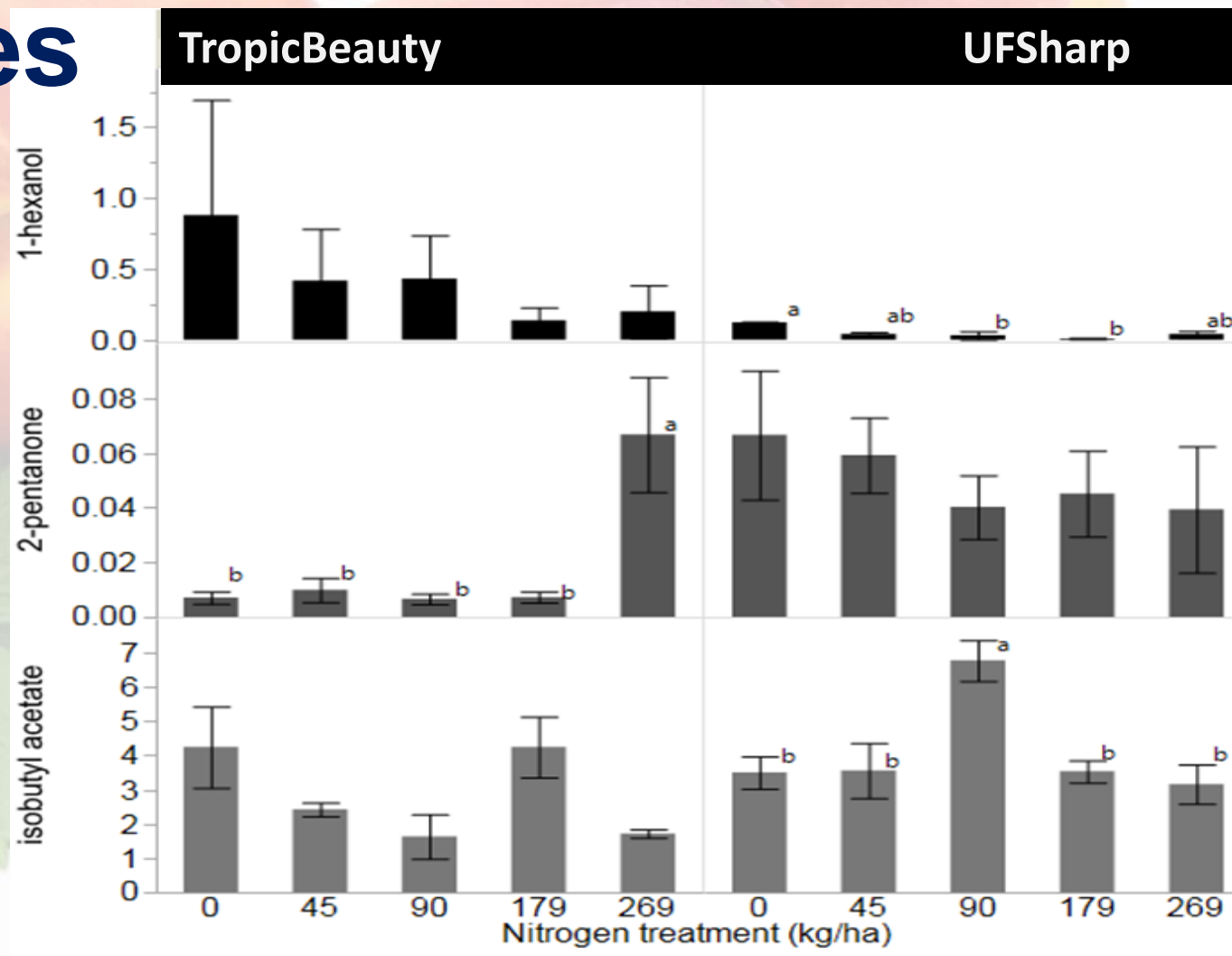
Volatiles 2015



Volatiles 2017



Volatiles 2016

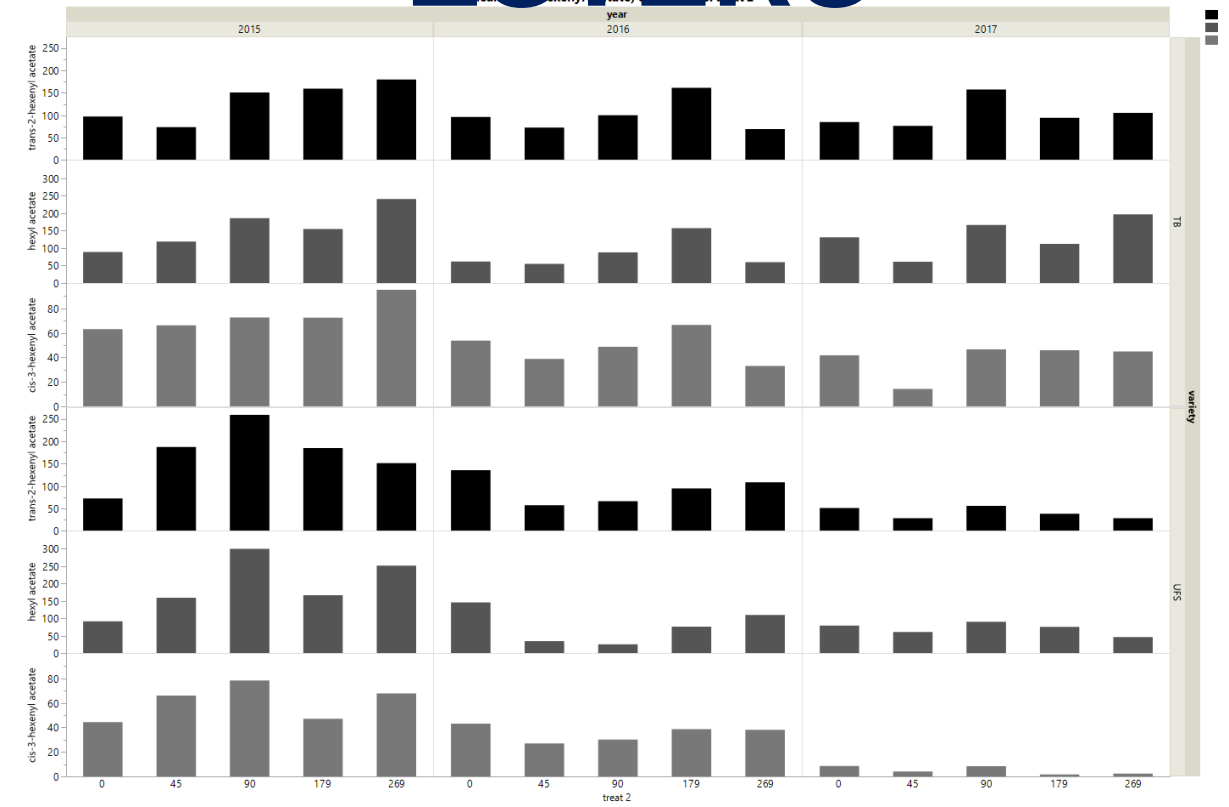
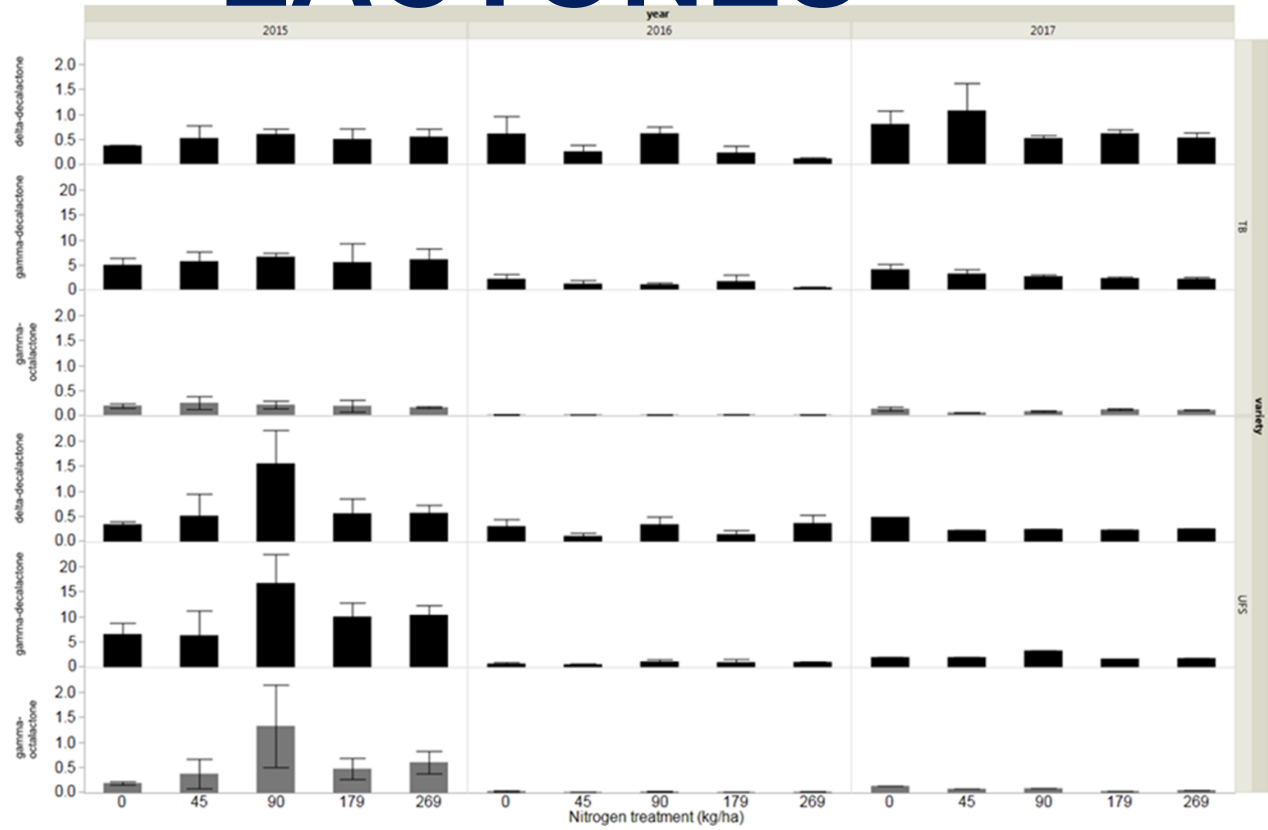




VOLATILES

LACTONES

ESTERS



Sensory Evaluation-2015

Scale Nitrogen Treatments Variety (kg/ha)	Overall liking	gLMS		JRS			GLMS		Overall Peach flavor Intensity
		Texture	Flavor	Firmness	Juiciness	Sweetness	Sourness	Bitterness	
N0- 0-TB	29.20abc	14.89	29.7ab	2.13d	3.10a	31.48a	11.67ab	4.03	31.7a
N2-45-TB	29.74ab	22.52	31.41a	2.30cd	3.10a	30.08ab	12.13ab	5.82	30.25ab
N4-269-TB	30.25a	23.41	30.23a	2.51c	2.98a	30.30ab	14.48a	5.48	31.54a
N0-0-UFS	28.54abc	20.87	26.33ab	3.51b	2.56b	26.92ab	11.95ab	5.95	27.51abc
N2-45-UFS	21.89bc	20.51	22.1bc	3.46b	2.49bc	25.74bc	8.49b	5.54	25.16bc
N4-269-UFS	21.59c	20.26	17.26c	3.05a	2.23c	20.87c	9.8ab	5.82	23.07c
<i>p-value</i>	<i>0.0053</i>	<i>0.2469</i>	<i><0.001</i>	<i><0.001</i>	<i><0.001</i>	<i><0.001</i>	<i>0.0073</i>	<i>0.5655</i>	<i><0.0001</i>

gLMS -100 to +100
 GLMS 0 to +100
 JRS 1 to 5

Sensory Evaluation- 2016

Scale Nitrogen treatment Variety (kg/ha)	Overall liking	gLMS		JRS			GLMS		Overall Peach flavor Intensity
		Texture	Flavor	Firmness	Juiciness	Sweetness	Sourness	Bitterness	
N0-0-TB	34.68a	25.95ab	33.83a	2.26b	3.03a	37.26a	17.51ab	7.03a	38.88a
N2-90-TB	32.7ab	29.75a	31.23ab	2.33b	2.86a	34.21abc	19.2ab	7.91a	36.14ab
N4-269-TB	32.6ab	27.3ab	32.23ab	2.3b	2.9a	34.88ab	16.64a	8.94a	37.31a
N0-0-UFS	27.9ab	21.63ab	29.64ab	3.74a	2.29b	31.21bcd	16.76ab	6.59a	32.39bc
N2-90-UFS	26.46b	19.75b	24.75b	3.79a	2.23b	28.7d	15.7b	8.08a	29.89c
N4-269-UFS	27.06b	20.44b	25.23b	3.8a	2.39b	28.7cd	15.45b	7.65a	31.74bc
p-value	0.0073	<0.0068	0.005	<0.001	<0.001	<0.000	0.017	0.2205	<0.0001

gLMS -100 to +100
 GLMS 0 to +100
 JRS 1 to 5

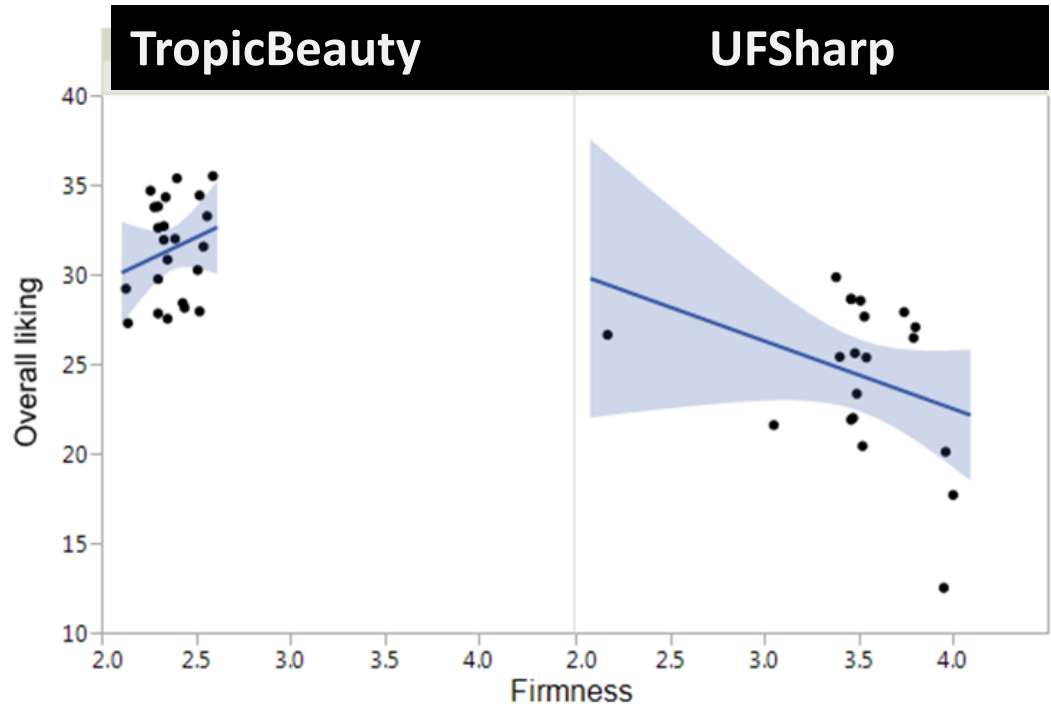
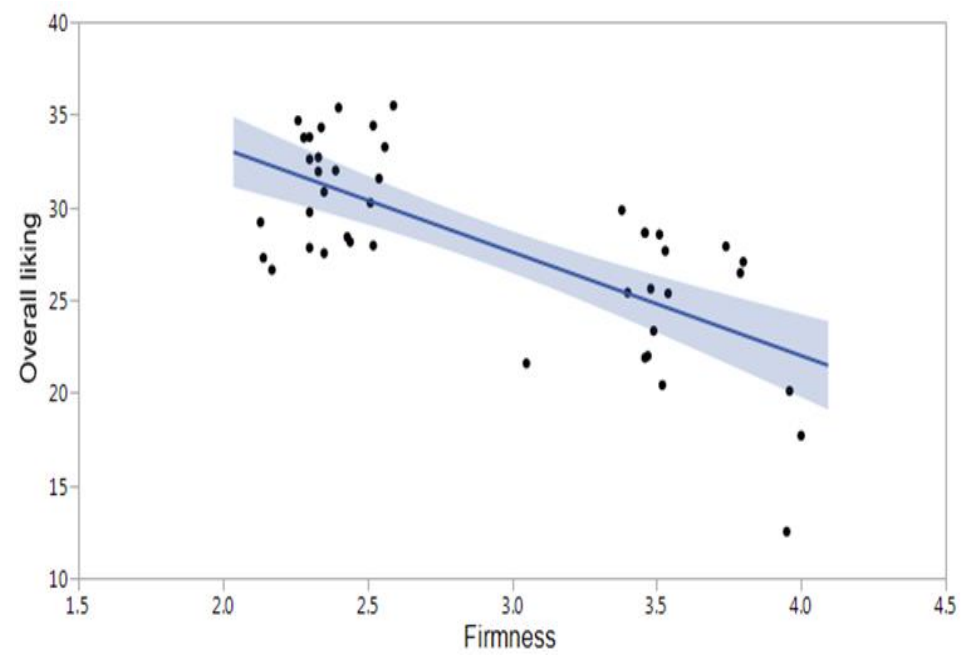
Sensory Evaluation- 2017

Scale Nitrogen treatment Variety	Overall liking	gLMS		JRS			GLMS		Overall Peach flavor Intensity
		Texture	Flavor	Firmness	Juiciness	Sweetness	Sourness	Bitterness	
N0-0-UFS	20.10bc	19.04b	18.29bc	3.96a	2.12c	19.29bc	17.49a	11.43a	23.55bc
N1-45-UFS	25.61ab	25.17ab	23.36abc	3.48b	2.49b	23.57ab	16.36a	7.23a	29.56ab
N2-90-UFS	12.51c	16.75b	12.34c	3.95a	2.18c	15.95c	22.12a	11.34a	22.38c
N3-179-UFS	17.69bc	17.29b	18.66bc	4.00a	2.18c	16.26c	21.74a	12.51a	23.82bc
N0-0-TB	27.82ab	27.99ab	26.82ab	2.30c	2.92a	24.25ab	19.55a	11.97a	30.96a
N3-179-TB	33.79a	31.35a	32.36a	2.30c	3.08a	29.18a	17.81a	8.90a	34.29a
p-value	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.0334	0.0458	<0.001

gLMS -100 to +100
 GLMS 0 to +100
 JRS 1 to 5

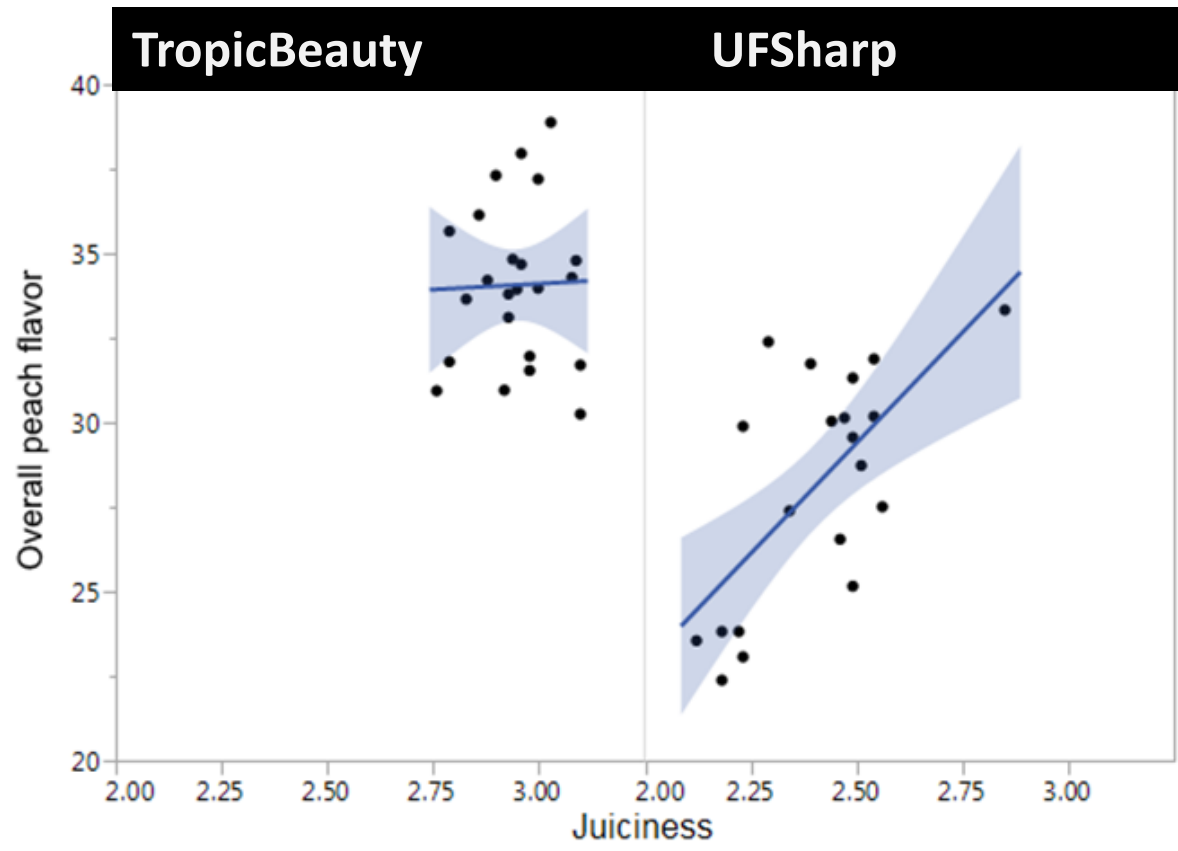
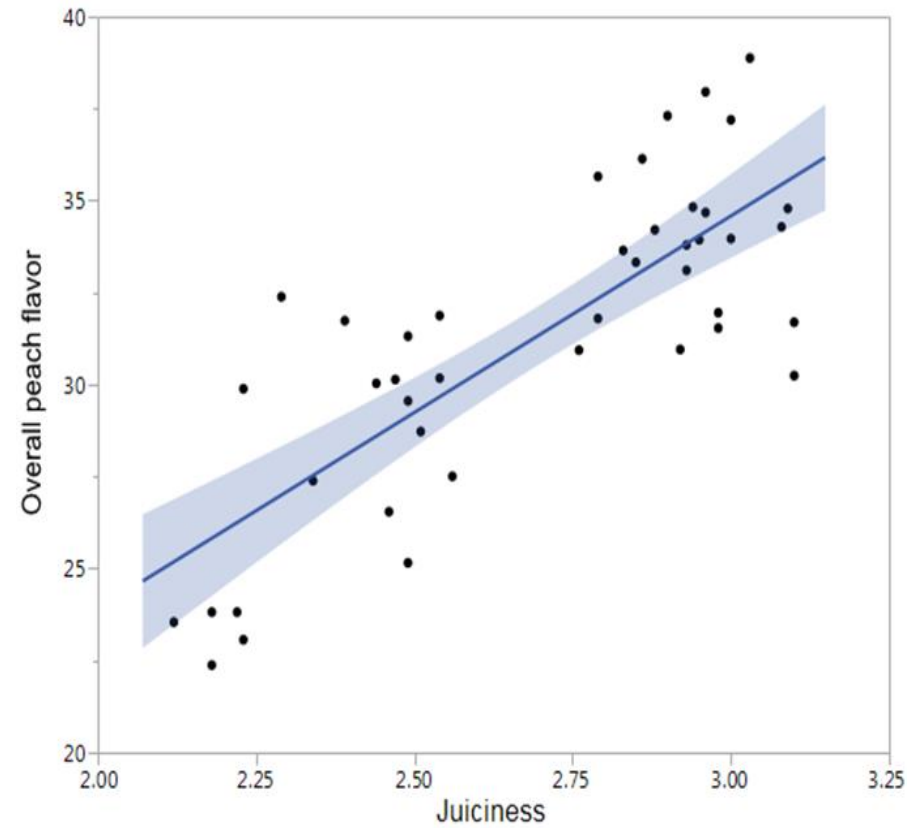


Overall liking - Firmness



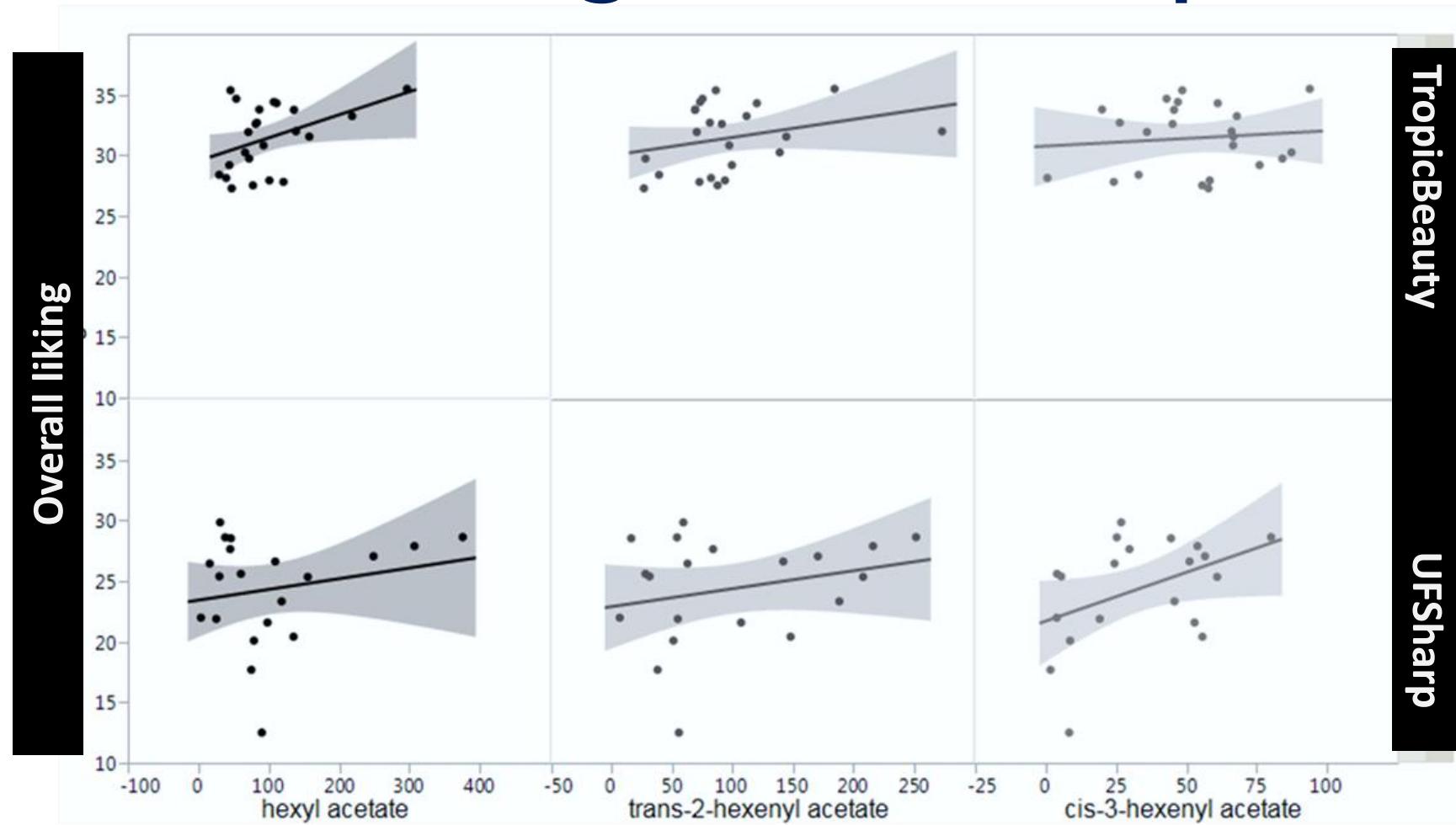


Overall liking - Juiciness





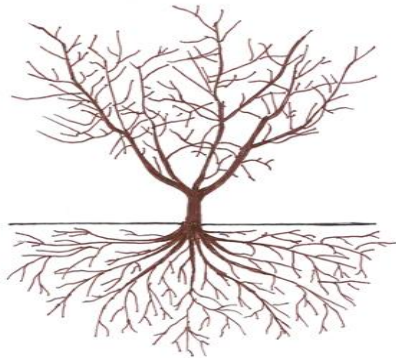
Overall liking - Ester compounds



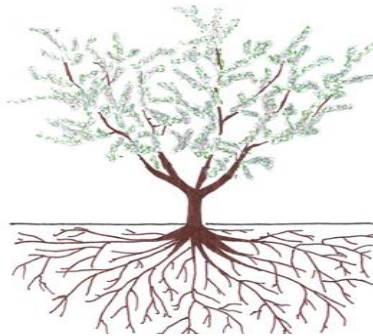
Young
Trees



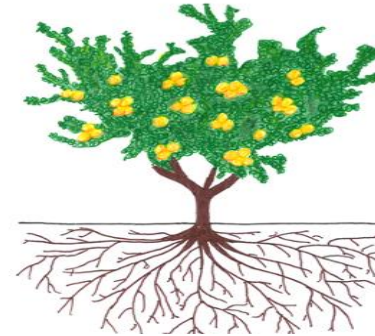
Dormancy
Winter



Bloom
Spring



Fruit Development
Summer



Post-Harvest
Fall



NITROGEN CYCLE

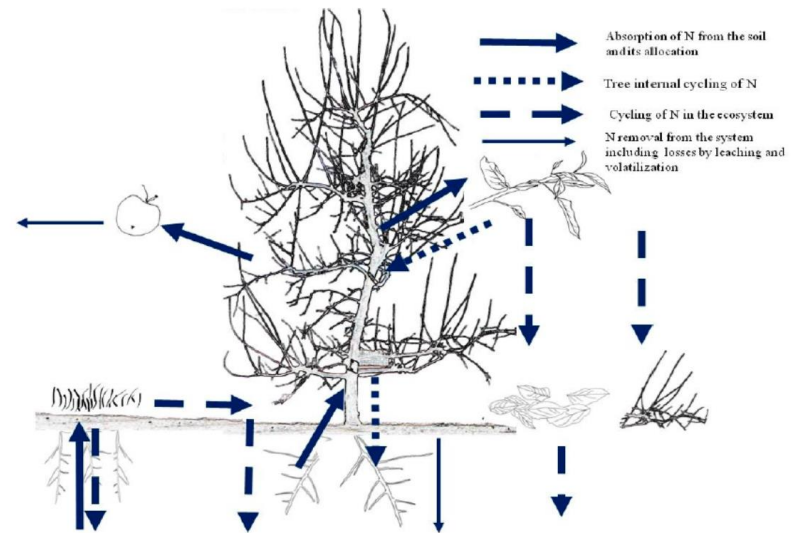


Figure 1. Nitrogen dynamics in a fruit tree ecosystem (Source: [32]).

SOIL SAMPLES

2015			
Depth	N Treatment (kg/ha)	After Harvest Nitrate (lb/acre)	Amonium After Harvest
12"	N0-0	1.668	1.668
	N1-45	1.691	1.521
	N2-90	1.848	1.341
	N3-179	2.351	2.596
	N4-269	3.192	1.69
	<i>p-value</i>	0.1275	0.1281
36"	N0-0	1.865	0.373
	N1-45	1.84	0.675
	N2-90	2.055	0.93
	N3-179	2.053	0.95
	N4-269	2.148	0.762
	<i>p-value</i>	0.9588	0.4371
60"	N0-0	1.842ab	0.3416
	N1-45	1.451b	0.215
	N2-90	1.984ab	1.007
	N3-179	1.726ab	0.765
	N4-269	2.644a	0.678
	<i>p-value</i>	0.0145	0.0698

2016			
Depth	N Treatment (kg/ha)	After Harvest Nitrate (lb/acre)	Amonium After Harvest
12"	N0-0	3.296	2.301
	N1-45	2.946	1.443
	N2-90	3.988	1.25
	N3-179	3.851	0.973
	N4-269	4.093	1.488
	<i>p-value</i>	0.239	0.0897
36"	N0-0	3.305	1.156
	N1-45	2.625	1.303
	N2-90	3.171	1.26
	N3-179	3.861	1.081
	N4-269	3.741	1.671
	<i>p-value</i>	0.1808	0.8402
60"	N0-0	3.146	0.87
	N1-45	3.45	0.9416
	N2-90	2.888	0.805
	N3-179	3.266	0.7533
	N4-269	3.408	1.476
	<i>p-value</i>	0.8139	0.3349

CONCLUSIONS

- High N fertilization increased vegetative growth and shade within the canopy.
- Nitrogen fertilization rate had no consistent effect on fruit composition.
- N affected the two varieties differently, and environmental conditions and cultural practices such as the training system may have played an important role in the response of the peach trees to N fertilization.



The Bottom Line

- N promotes axillary bud formation and branch extension; excess N is stored in the trunk and branches and is lost with pruning.
- Stored N is mobilized each season to resume vegetative growth. Thus, the potential effect of high N on fruit is minimized in a commercial setting due to tree size management.



The “Ideal Peach”

K-cluster segmentation

2 main consumer segments were identified

“Flavorful and sizeable”

“Locally grown and healthy”





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