Interaction of Gibberellic Acid and Abscisic Acid on Sovereign Coronation and Skookum Seedless Table Grapes 2013-15

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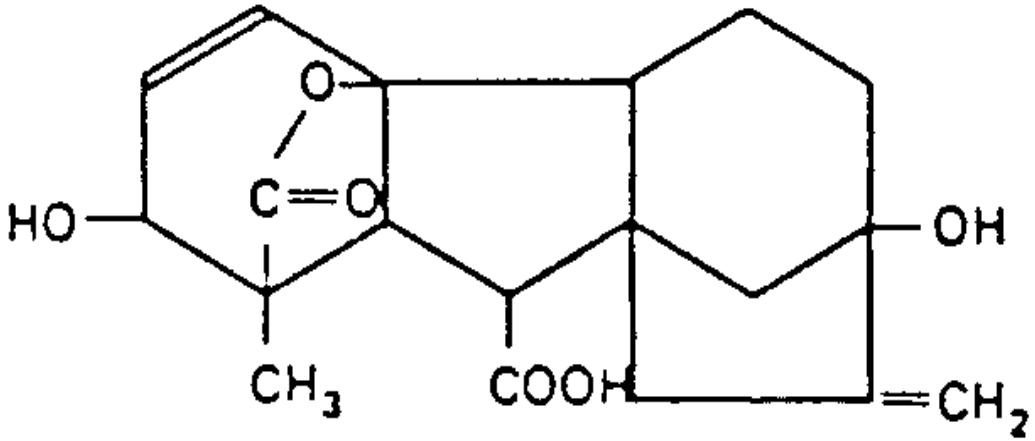
Background-Gibberellic Acid

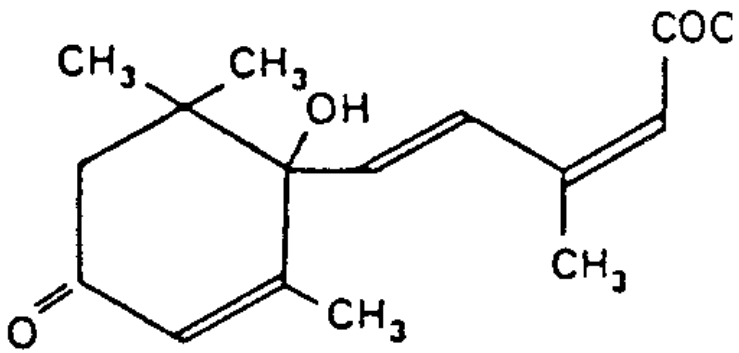
- Gibberellic acid (GA) is well known for increasing berry and cluster size in seedless table grapes
- Also eliminates vestigial seeds in Sovereign Coronation (Reynolds & de Savigny 2004; Reynolds et al. 2006)
- Used worldwide (e.g. California, Chile, Australia) but not registered in Canada for grapes



GA_3

Background-Abscisic Acid

- Abscisic acid (ABA) has been studied in the past decade for accelerating fruit maturity in table and wine grapes
- Registered now in US and elsewhere but not Canada
- Local research on Cabernet Sauvignon confirmed its efficacy for increasing anthocyanins, phenols, color, etc. (Balint & Reynolds 2013)
- **Some color enhancement of Coronation in 2013 in this project**



ABA

Objectives

- Accelerate berry maturity with ABA with the goal of attaining earlier harvests of more physiologically mature fruit
- Increase berry and cluster size with GA
- Examine GA x ABA interactions with the hope of finding combinations that simultaneously increase cluster/ berry size and accelerate maturity
- Verify that beneficial berry size and composition results of GA and ABA applications correspond to increased sensory quality

Materials and Methods

- Two Sovereign Coronation blocks: Lambert Farms (Niagara-on-the-Lake) and Hipple Farms (Vineland)
- One Skookum Seedless block (Lambert Farms)
- Randomized complete block with four blocks (partial rows) and two-panel treatment replicates (Coronation) or single panel replicates (Skookum)
- GA levels: 0, 15, 30 mg/L applied full bloom and ≈14 and 21 days post-set
- ABA levels: 0, 150, 300 mg/L applied ca. 10 days pre-veraison (2013) and twice pre-veraison (6 and 13 August 2014)

Sovereign Coronation, Summerland, BC

Skookum Seedless, Summerland, BC 1989– 0, 1 10 mg/L CPPU +/- 100 mg/L GA

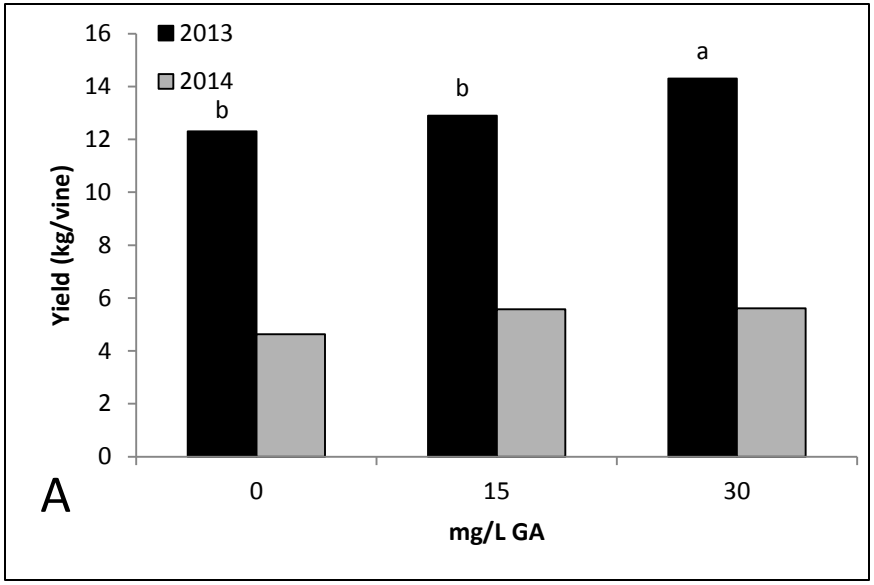
Plot Layout, Hipple Farms

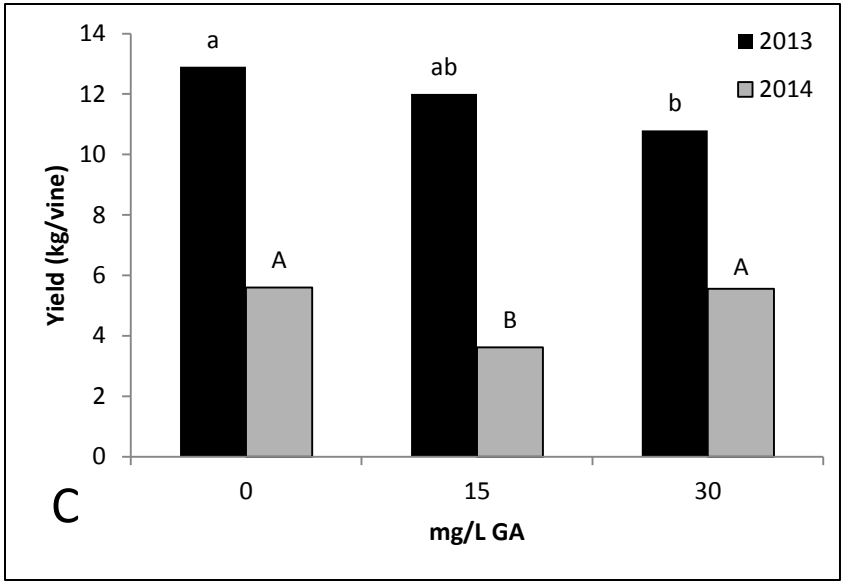
1	2 GA/ABA	3 GA/ABA	4 GA/ABA	5 GA/ABA	6
B	B	B	B	B	B
B	30/150	0/0	15/150	30/150	B
B	30/150	0/0	15/150	30/150	B
B	30/300	0/300	30/150	0/150	B
B	30/300	0/300	30/150	0/150	B
B	15/300	30/150	0/0	30/300	B
B	15/300	30/150	0/0	30/300	B
B	30/0	15/300	30/0	15/0	B
B	30/0	15/300	30/0	15/0	B
B	15/0	15/0	0/150	0/300	B
B	15/0	15/0	0/150	0/300	B
B	15/150	30/300	15/300	30/0	B
B	15/150	30/300	15/300	30/0	B
B	0/0	0/150	15/0	0/0	B
B	0/0	0/150	15/0	0/0	B
B	0/150	15/150	0/300	15/150	B
B	0/150	15/150	0/300	15/150	B
B	0/300	30/0	30/300	15/300	B
B	0/300	30/0	30/300	15/300	B
B	B	B	B	B	B

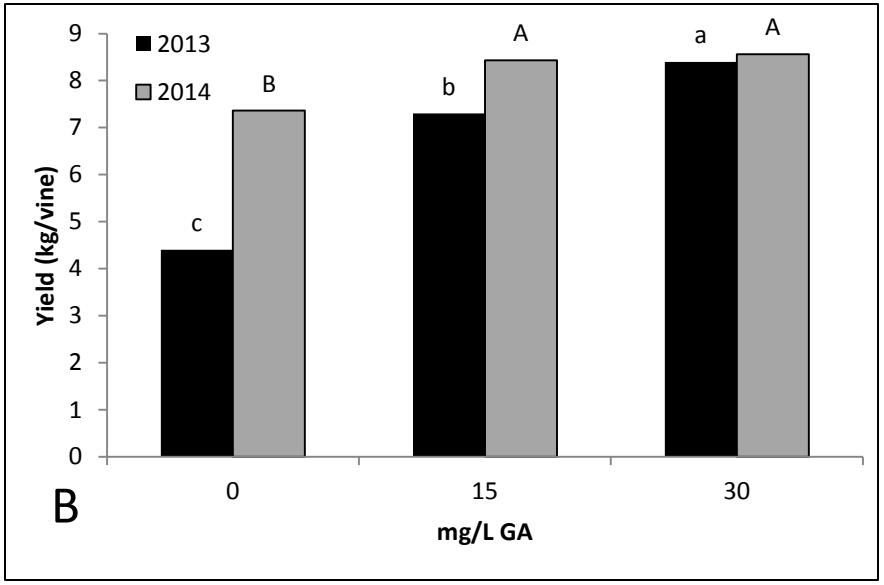
Materials and Methods contd.

- All sprays applied with 20-L backpack sprayer with Agral 90 surfactant adjunct
- Harvest occurred at the same time as growers harvested
- Measured yield, clusters per vine; calculated cluster weight.
- Clusters were sampled for subsequent sensory descriptive analysis
- 100-berry samples were obtained after sensory analysis and used for: berry weight, Brix, titratable acidity, pH; A520, total anthocyanins (Coronation)

GA vs. Yield

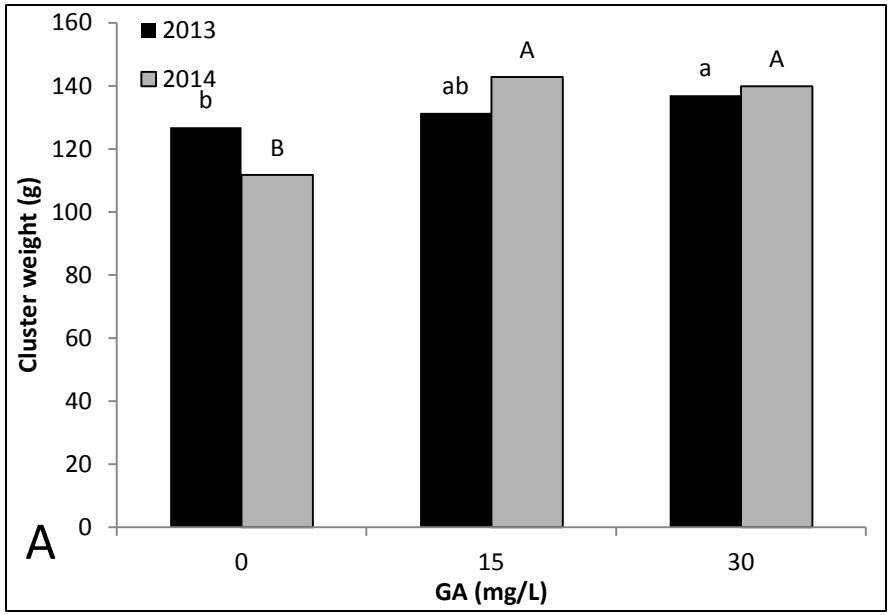


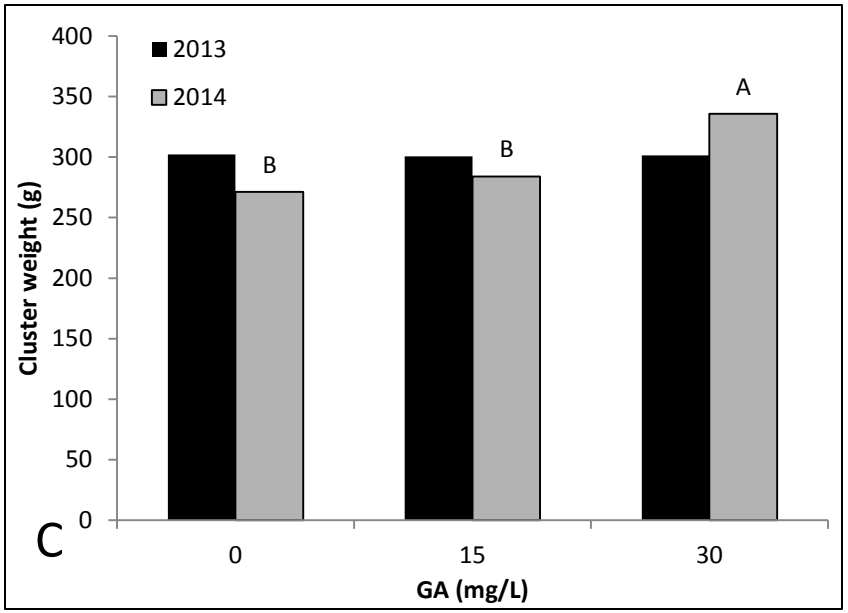


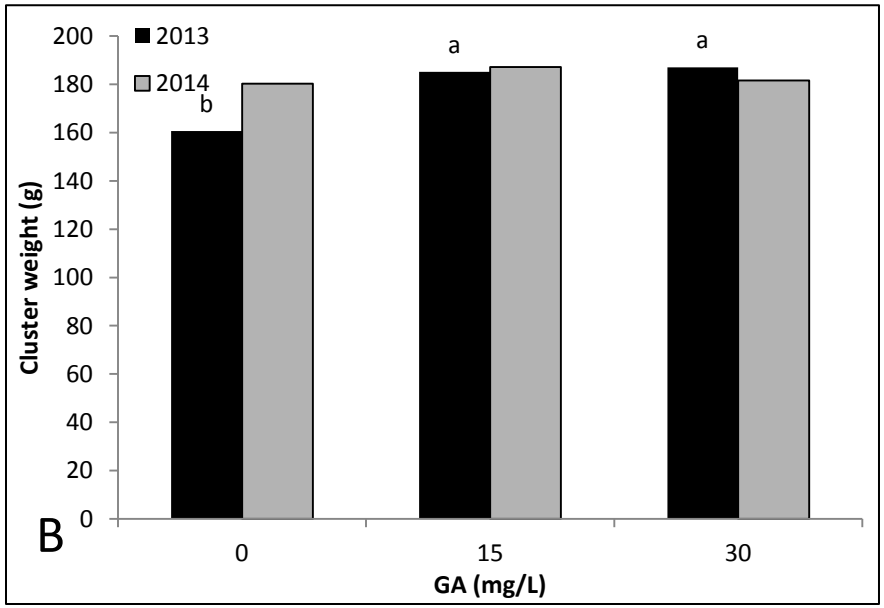


Yield per vine 2013-14: A: Hipple; B: Lambert; C: Lambert Skookum. Note increased yield with GA one of two seasons (Hipple) and both years (Lambert) in Coronation.

GA vs. Cluster Weight

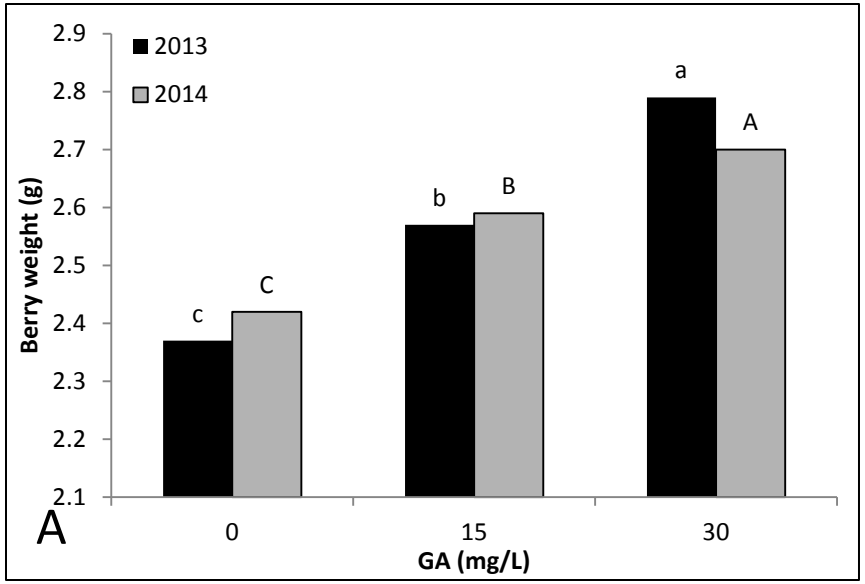


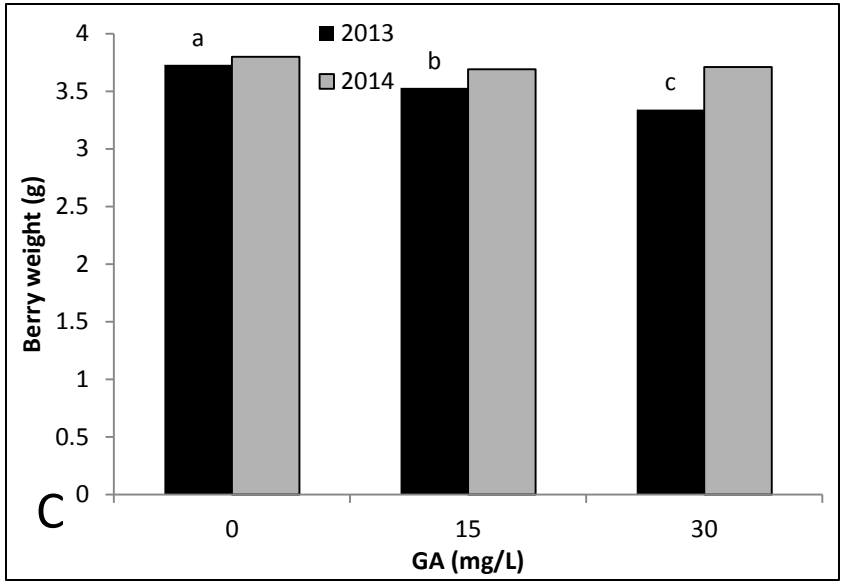


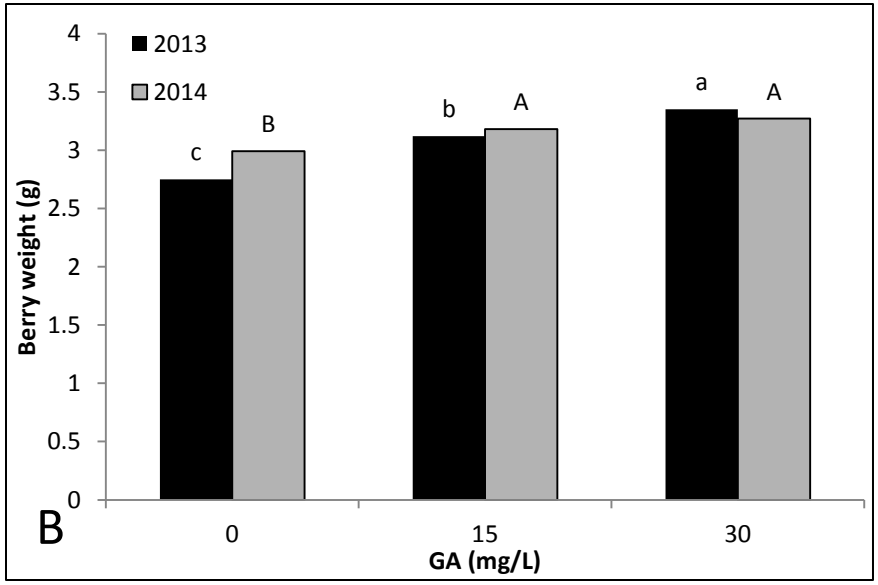


Cluster weight 2013-14: A: Hipple; B: Lambert; C: Lambert Skookum. Note increased cluster weight with GA both seasons (Hipple) and one of two years (Lambert) in Coronation. Skookum also responded in 2014.

GA vs. Berry Weight

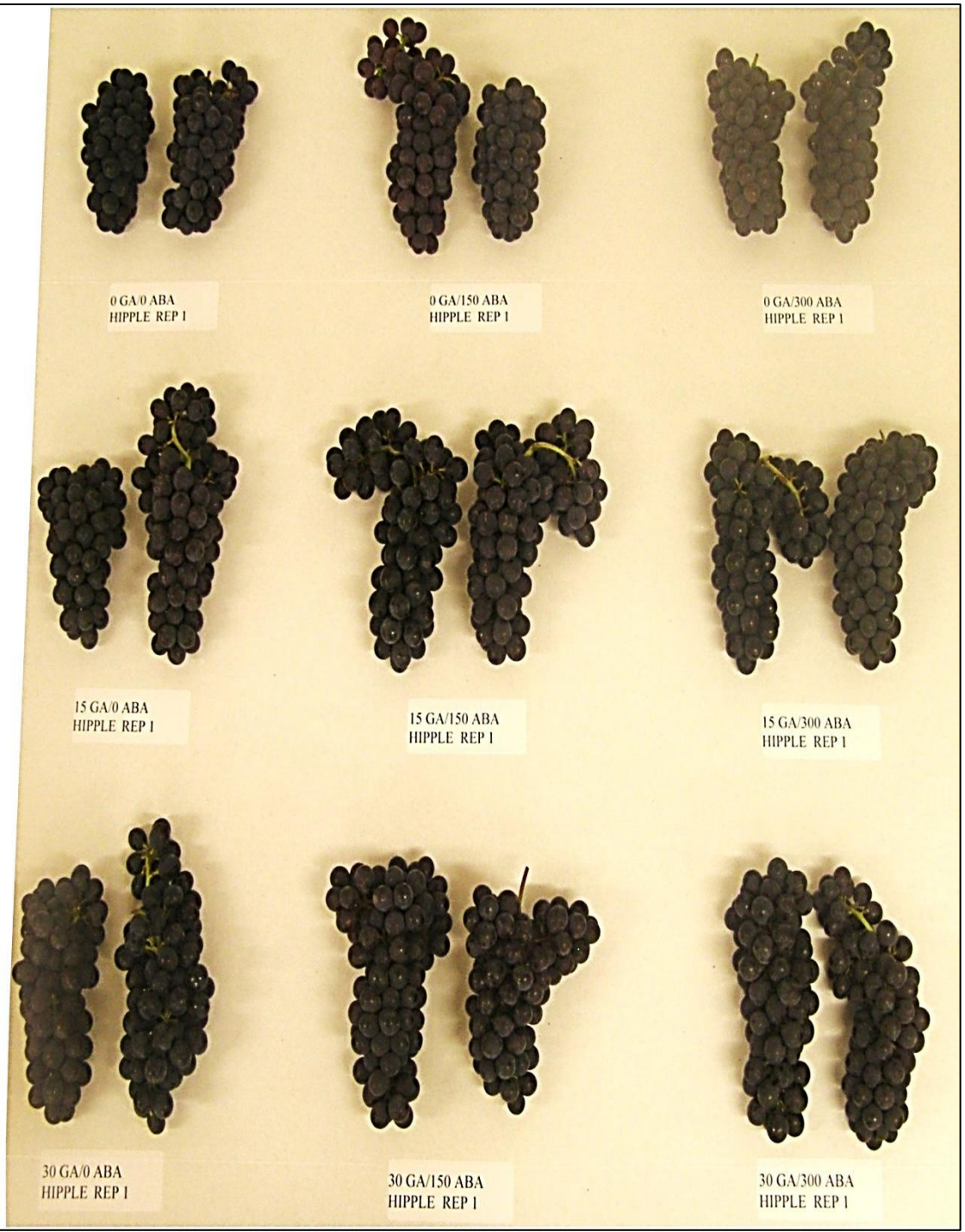




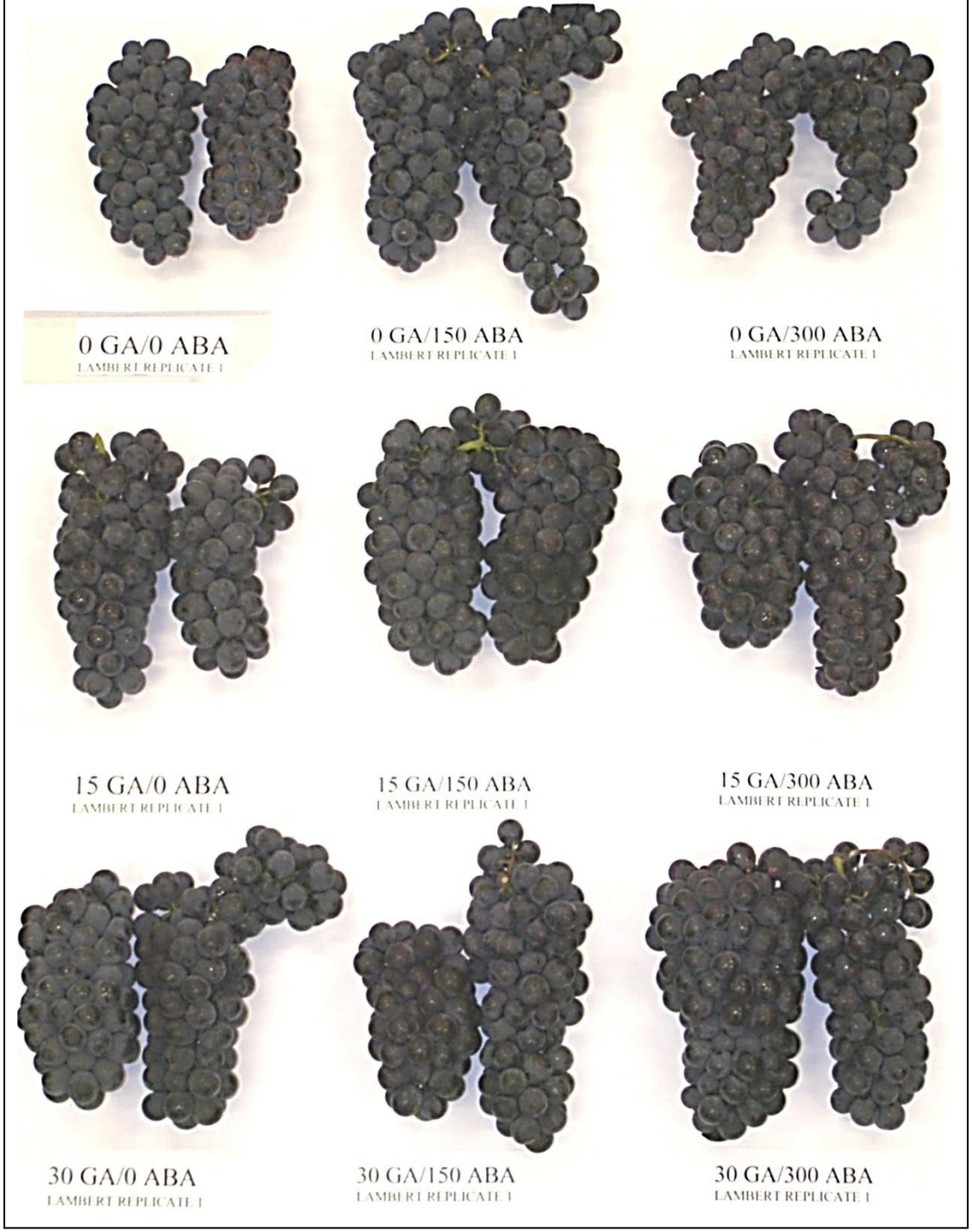


Berry weight 2013-14: A: Hipple; B: Lambert; C: Lambert Skookum. Note increased cluster weight with GA both seasons in both Coronation sites.

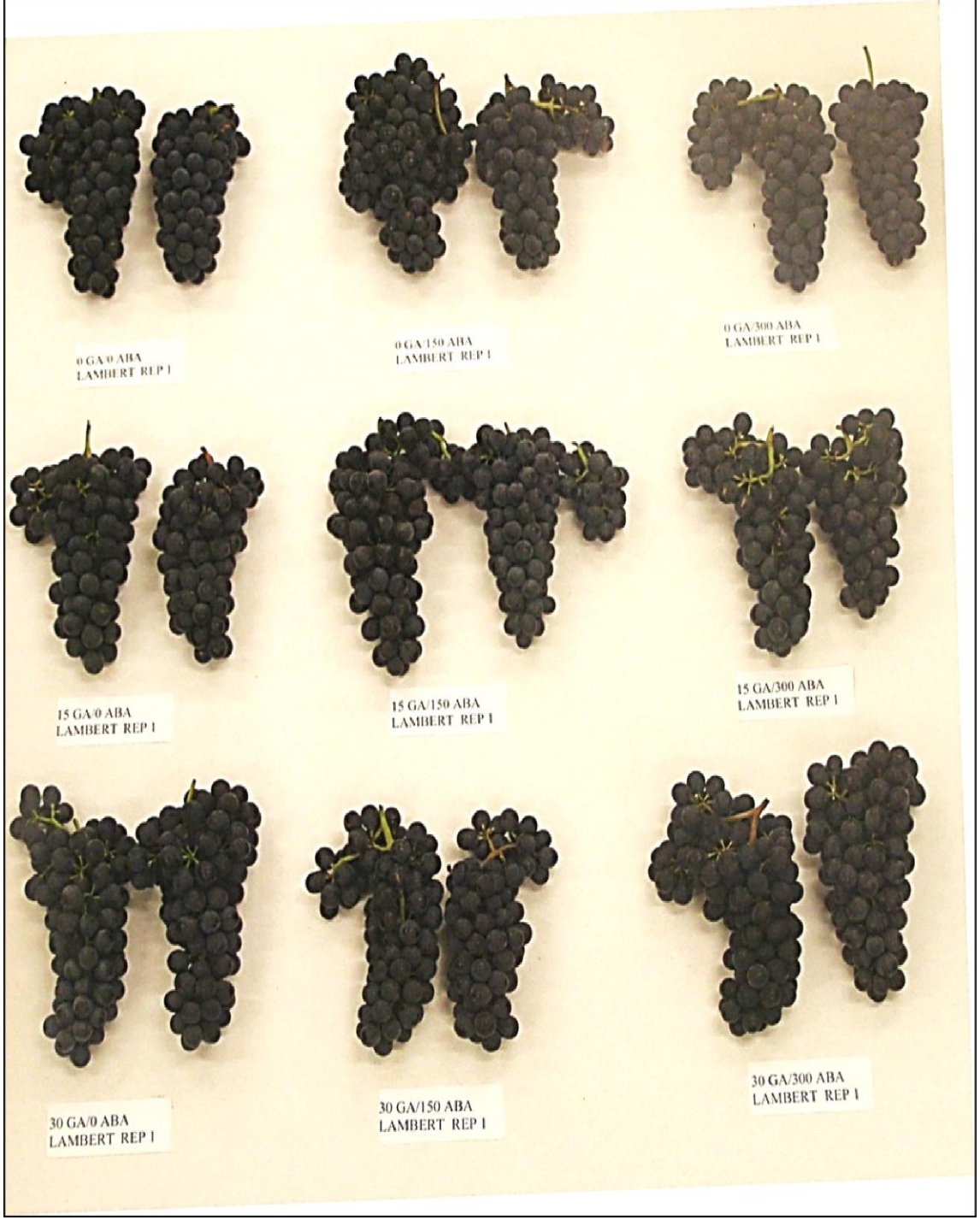
Hipple clusters 2013—note substantial increased cluster and berry size with GA top to bottom



Hipple clusters 2014—note once again substantial increased cluster and berry size with GA top to bottom

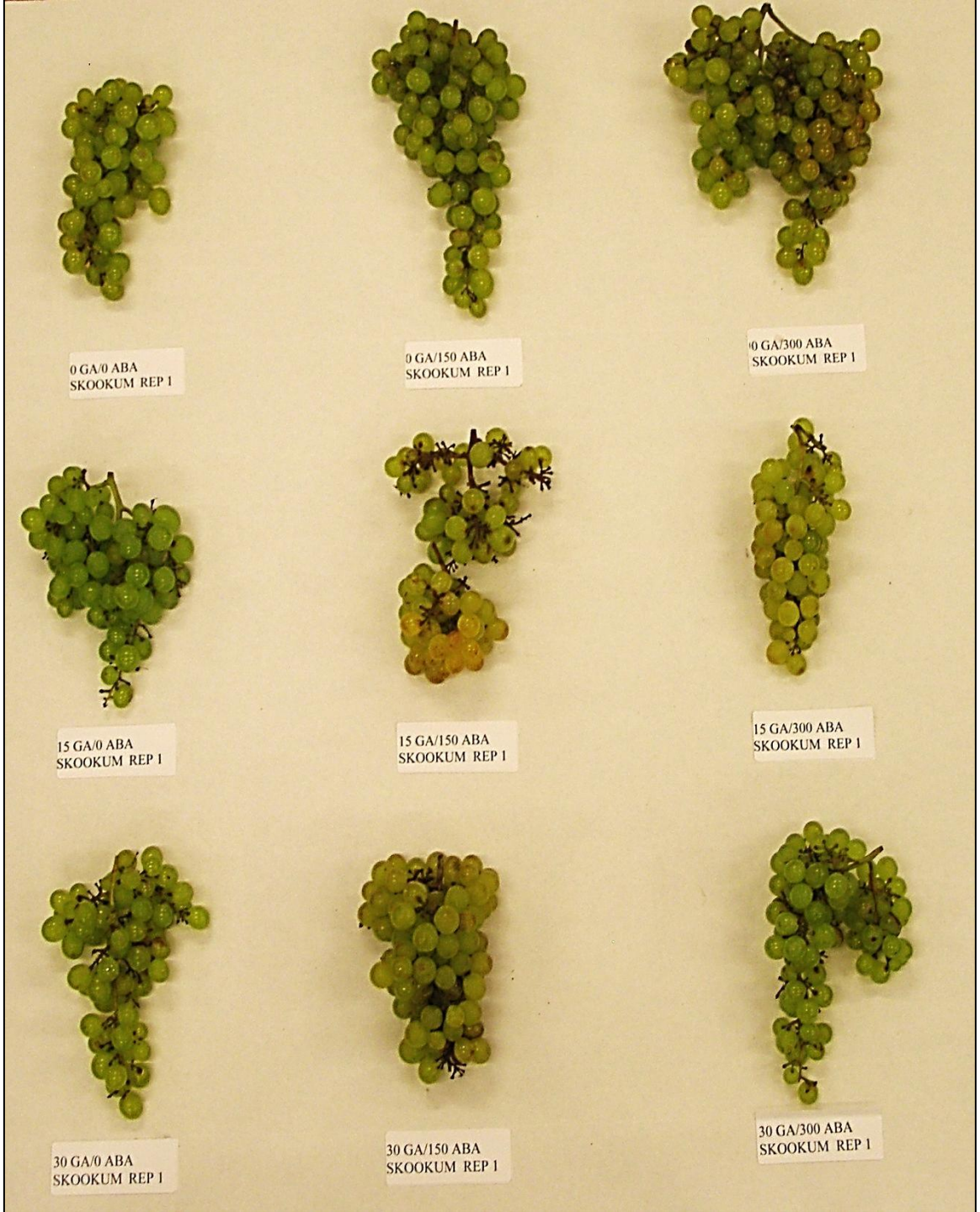


Lambert clusters 2013—note substantial increased cluster and berry size with GA top to bottom



Lambert clusters 2014—note once again substantial increased cluster and berry size with GA top to bottom

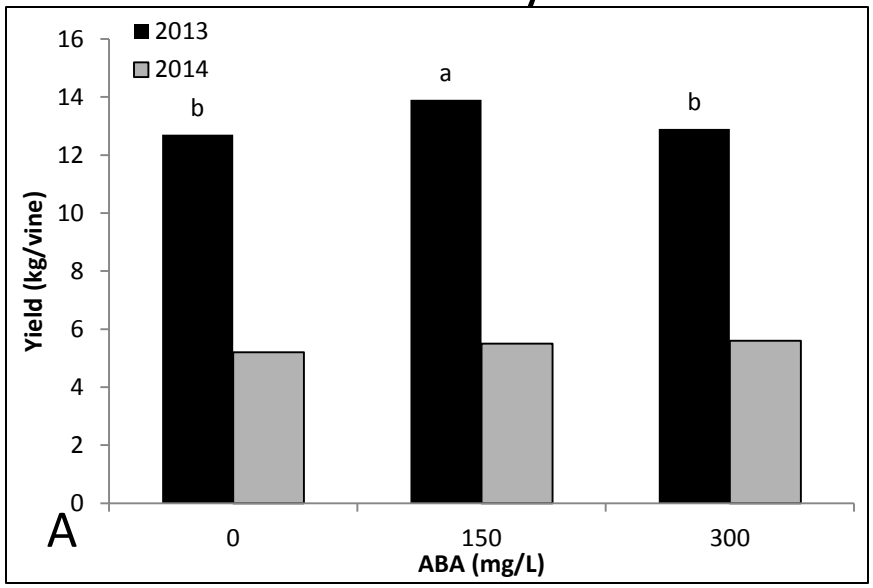
Lambert Skookum clusters 2013—note some increased cluster and berry size with GA top to bottom

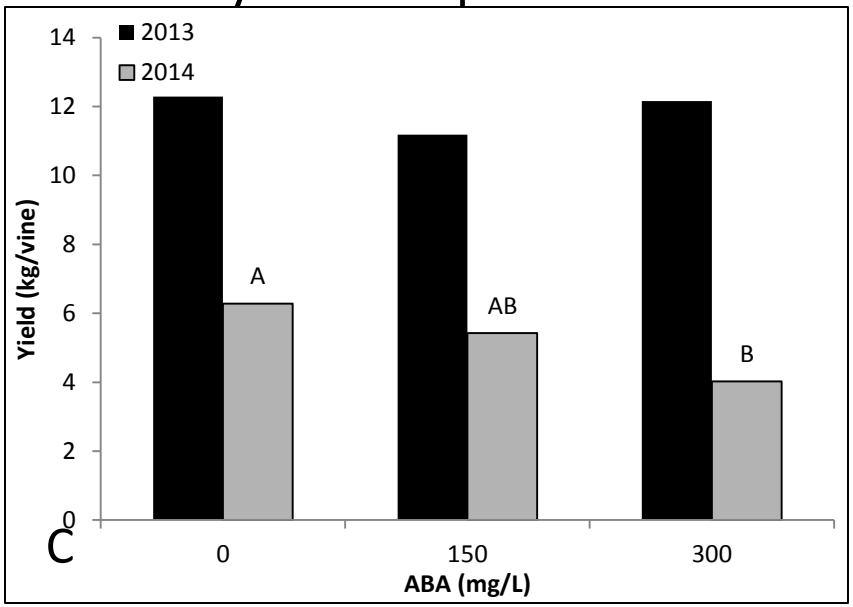


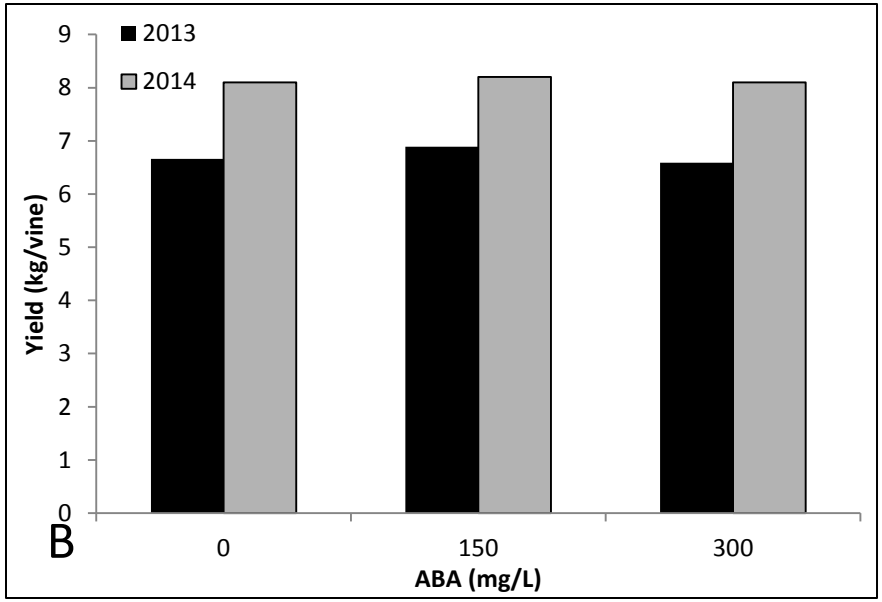
Lambert Skookum clusters 2014—note again some increased cluster and berry size with GA top to bottom

Yield vs. ABA

Generally ABA had few effects on yield components







Yield per vine 2013-14: A: Hipple; B: Lambert; C: Lambert Skookum. Note slight increased yield with ABA one of two seasons (Hipple) and a decrease in Skookum in 2014.

GA vs. Berry Composition

Table 1A. Impact of gibberellic acid concentrations on berry composition of Sovereign Coronation, Hipple Farms, Vineland, ON, 2013-14.

Treatment	Soluble solids (ºBrix)		Titratable acidity (g/L)		pH		Colour Intensity		Anthocyanins (mg/L)	
Gibberellic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	14.8	16.4	11.5	11.8	3.01	3.00	**0.322a**	1.401	**282.1a**	381.9
15	14.6	16.3	11.6	11.8	3.03	2.98	**0.295b**	1.225	**219.2b**	348.7
30	14.2	16.2	11.6	12.2	3.01	2.98	**0.271c**	1.366	**185.9b**	390.9
Significant p	NS	NS	NS	NS	NS	NS	<0.0001	NS	0.02	NS
Significance & trend	0.02L	NS	NS	NS	NS	NS	0.03 L	NS	0.006L	NS

Table 2A. Impact of gibberellic acid concentrations on berry composition of Sovereign Coronation, Lambert Farms, Virgil, ON, 2013-14.

Treatment	Soluble solids (ºBrix)		Titratable acidity (g/L)		pH		Colour Intensity		Anthocyanins (mg/L)	
Gibberellic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	**17.3a**	**16.2 a**	12.3	**13.3 ab**	3.25	3.07	**0.683a**	**1.457a**	**260.7a**	**429.2a**
15	**16.9b**	**15.3 b**	12.4	**13.6 a**	3.23	3.07	**0.601b**	**1.184b**	**214.0ab**	**337.5b**
30	**16.9b**	**16.3 a**	12.1	**13.2 b**	3.19	3.07	**0.548b**	**1.212b**	**179.6b**	**375.1ab**
Significant p	0.03	<0.0001	NS	0.05	NS	NS	0.005	0.04	0.05	0.009
Significance & trend	0.02L	<0.0001Q	NS	NS	NS	NS	0.001L	NS	0.02L	NS

ABA vs. Berry Composition

Some enhancement of anthocyanins and color at one site

Table 1B. Impact of abscisic acid concentrations on berry composition of Sovereign Coronation, Hipple Farms, Vineland, ON, 2013-14.

Treatment	Soluble solids (°Brix)		Titratable acidity (g/L)		pH		Colour Intensity		Anthocyanins (mg/L)	
Abscisic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	14.7	16.4	**11.4b**	11.7	3.01	**2.95b**	**0.313a**	1.353	**256.2a**	370.8
150	14.3	16.3	**11.9a**	12.1	3.02	**3.01a**	**0.255b**	1.288	**163.4b**	375.6
300	14.6	16.2	**11.4b**	12.0	3.02	**3.00a**	**0.319a**	1.350	**266.2a**	375.3
Significant p	NS	NS	0.01	NS	NS	0.0003	<0.0001	NS	0.005	NS
Significance & trend	NS	NS	NS	NS	NS	0.001L	0.005Q	NS	0.001Q	NS

Table 2B. Impact of abscisic acid concentrations on berry composition of Sovereign Coronation, Lambert Farms, Virgil, ON, 2013-14.

Treatment	Soluble solids (°Brix)		Titratable acidity (g/L)		pH		Colour Intensity		Anthocyanins (mg/L)	
Abscisic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	17.2	16.1	12.0	13.5	3.23	**3.05 b**	0.599	1.323	198.7	376.1
150	16.9	15.9	12.4	13.3	3.19	**3.08 a**	0.594	1.359	227.2	402.8
300	17.0	15.7	12.3	13.4	3.25	**3.07 ab**	0.634	1.167	226.9	361.8
Significant p	NS	NS	NS	NS	NS	0.03	NS	NS	NS	NS
Significance & trend	NS	0.04L	NS	NS	NS	0.05L	NS	NS	NS	NS

GA and ABA-Skookum Seedless

ABA increased Brix, GA reduced TA, both increased pH

Table 3A. Impact of gibberellic acid concentrations on berry composition of Skookum Seedless, Lambert Farms, Virgil, ON, 2013-14.

Treatment	Soluble solids (°Brix)		Titratable acidity (g/L)		pH	
Gibberellic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	**18.5a**	**17.7 b**	**5.8a**	**9.1 a**	**3.31b**	**3.32 c**
15	**17.6b**	**17.8 b**	**5.7a**	**9.2 a**	**3.32b**	**3.38 b**
30	**18.7a**	**18.4 a**	**5.1b**	**8.6 b**	**3.37a**	**3.40 a**
Significant p	<0.0001	0.005	<0.0001	0.02	<0.0001	<0.0001
Significance & trend	<0.0001Q	NS	<0.0001L 0.05Q	NS	<0.0001L 0.04Q	<0.0001L

Table 3B. Impact of abscisic acid concentrations on berry composition of Skookum Seedless, Lambert Farms, Virgil, ON, 2013-14.

Treatment	Soluble solids (°Brix)		Titratable acidity (g/L)		pH	
Abscisic acid (mg/L)	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
0	**18.1b**	17.6 b	**5.4b**	9.2	**3.35a**	3.32 b
150	**18.5a**	18.1 a	**5.3b**	8.9	**3.34a**	3.40 a
300	**18.3ab**	17.6 b	**5.9a**	9.1	**3.32b**	3.31 b
Significant p	0.0481	0.009	0.05	NS	0.01	<0.0001
Significance & trend	0.03Q	0.01Q	0.03Q	NS	0.004L	<0.0001Q

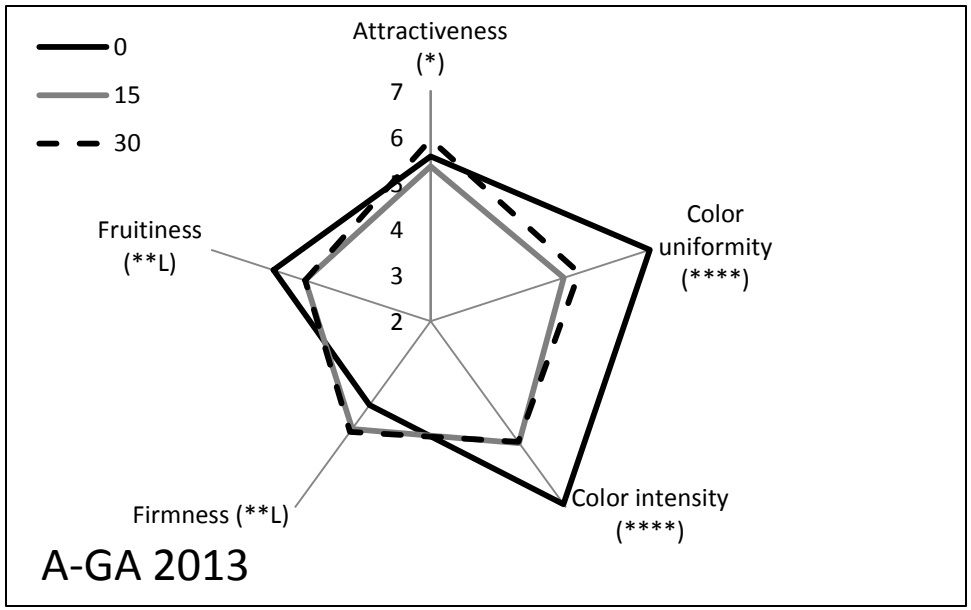
Sensory Analysis

- Performed ca. one week after harvest in both seasons
- Visual descriptors (Coronation): Cluster attractiveness, color uniformity, color intensity; (Skookum): Cluster attractiveness, visual liking, golden color
- Textural, Flavor, taste descriptors: Skin friability, skin thickness, juice release, flesh firmness, juiciness, fruity, labrusca (Coronation only), sweetness, acidity, overall liking

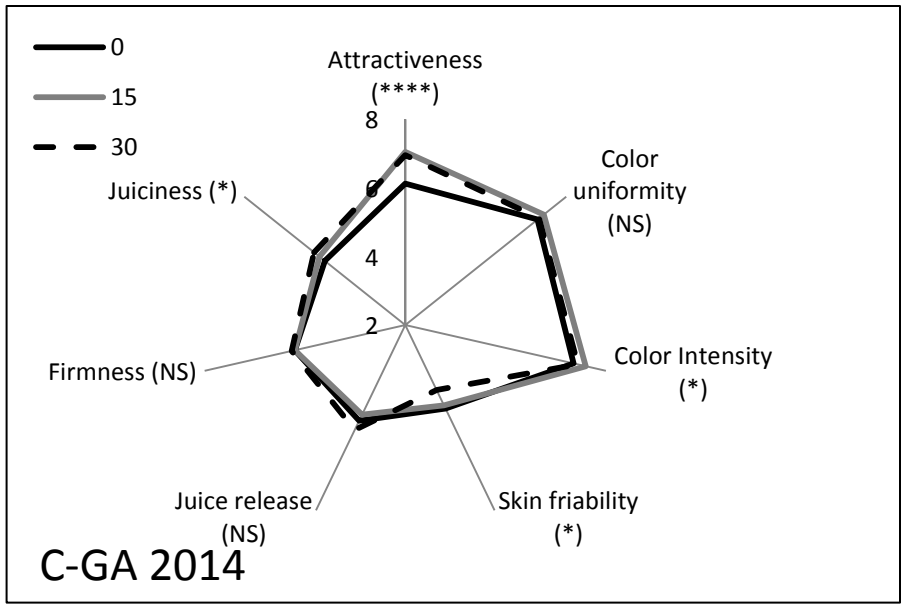
Sensory Hipple 2013

Treatment	Cluster Attractiveness	Color Uniformity	Color Intensity	Flesh Firmness	Fruity flavor	Acidity	Astringency	Overall Liking
Gibberellic acid (mg/L)								
0	**5.57ab**	**7.00a**	**6.91a**	**4.25b**	**5.58a**	5.09	**3.19b**	5.00
15	**5.36b**	**5.04b**	**5.27b**	**4.89a**	**4.86b**	5.38	**3.46ab**	4.59
30	**5.94a**	**5.39b**	**5.24b**	**4.97a**	**4.86b**	5.33	**3.67a**	4.58
Significant p	0.1112	<0.0001	<0.0001	0.0067	0.0022	0.3333	0.0819	0.0878
Significance & trend	0.6206	0.1078	0.1235	0.0065 linear	0.0061 linear	0.1573	0.0088 linear	0.1345
Abscisic acid (mg/L)								
0	**4.50c**	**5.04b**	**5.02b**	4.84	**4.78b**	5.40	**3.76a**	4.54
150	**5.75b**	**6.16a**	**6.10a**	4.77	**5.30a**	5.34	**3.33b**	4.84
300	**6.62a**	**6.25a**	**6.30a**	4.50	**5.22ab**	5.06	**3.23b**	4.80
Significant p	<0.0001	<0.0001	<0.0001	0.3882	0.0621	0.2304	0.0332	0.3548
Significance & trend	0.0065 linear	0.2195	0.2364	0.1823	0.0747	0.0452 linear	0.0031 linear	0.3743
Interaction	<0.0001	0.0184	0.0010	0.3402	0.3376	0.6607	0.9338	0.7319

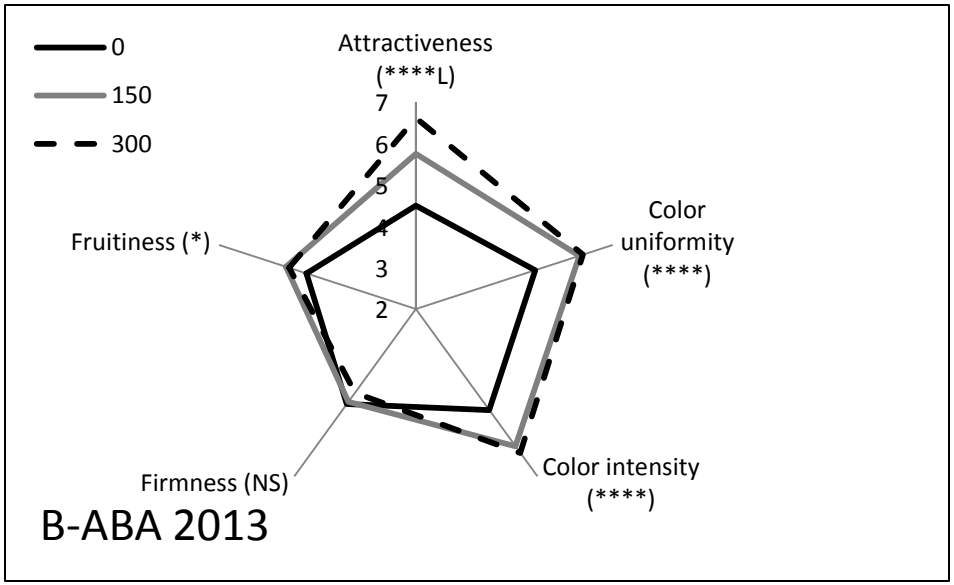
Sensory Hipple 2013-14



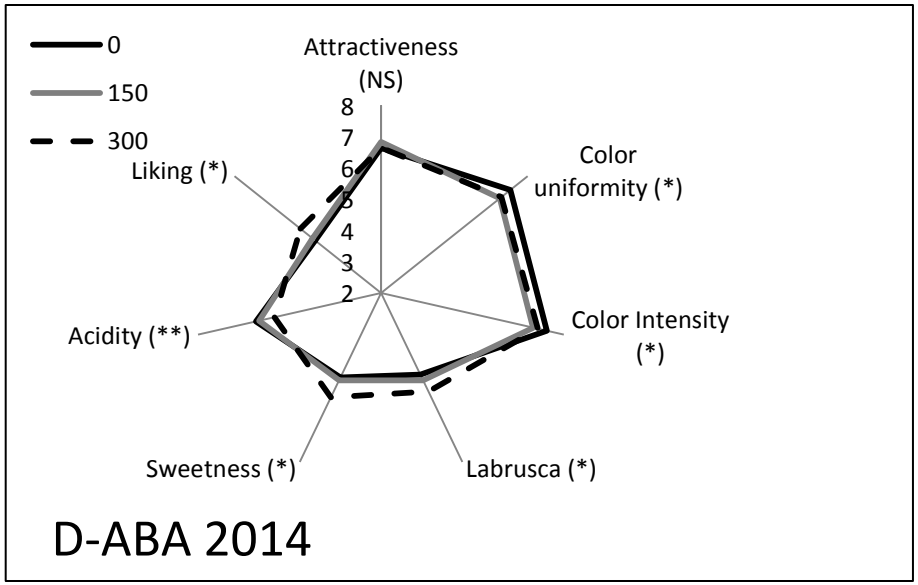
A-GA 2013



C-GA 2014



B-ABA 2013



D-ABA 2014

Sensory Lambert 2013

Treatment	Cluster Attractiveness	Color Uniformity	Color Intensity	Skin Thickness	Juice release	Flesh Firmness	Juiciness	Fruity flavor	Labrusca flavor	Overall Liking
Gibberellic acid (mg/L)										
0	5.65	6.41	6.47	5.41	5.65	5.01	**5.25b**	5.65	**4.83b**	5.59
15	6.11	6.53	6.73	5.80	6.00	4.95	**5.42b**	5.56	**5.10ab**	5.65
30	6.00	6.50	6.57	5.98	6.15	5.04	**6.19a**	5.89	**5.60a**	5.96
Significant p	0.8200	0.9850	0.9309	0.1927	0.1721	0.9146	0.0050	0.4750	0.0260	0.2264
Significance & trend	0.6461 ns	0.9062 ns	0.8849 ns	0.0778 ns	0.0699 ns	0.8960 ns	0.0022 linear	0.3935 ns	0.0083 linear	0.1118 ns
Abscisic acid (mg/L)										
0	5.51	5.92	5.90	5.83	6.00	5.11	5.67	5.60	**5.03ab**	5.80
150	6.15	6.84	7.01	5.80	5.76	4.86	5.39	5.58	**4.93b**	5.54
300	6.12	6.69	6.87	5.51	6.04	5.03	5.79	5.92	**5.57a**	5.86
Significant p	0.6376	0.4229	0.2289	0.6340	0.5152	0.5394	0.3511	0.4172	0.0517	0.3083
Significance & trend	0.4268 ns	0.3082 ns	0.1685 ns	0.3938 ns	0.8636 ns	0.7373 ns	0.6661 ns	0.2735 ns	0.0544 linear	0.7812 ns
Interaction	0.5538	0.4960	0.4062	0.8664	0.4249	0.3456	0.7723	0.9593	0.4753	0.9665

Sensory Lambert 2014

Treatment	Cluster Attractive-ness	Color Uniformity	Color Intensity	Juice release	Juiciness	Fruity flavor	Labrusca flavor	Overall Liking
GA (mg/L)								
0	**6.48 b**	6.98	**7.20b**	**51.5b**	**51.5b**	48.7	**51.1b**	47.9
15	**6.87 a**	7.26	**7.63a**	**53.1ab**	**53.3ab**	50.0	**52.9b**	48.0
30	**6.87 a**	7.19	**7.53a**	**55.2a**	**54.2a**	50.6	**56.1a**	49.6
Significant p	**0.010**	NS	**0.007**	**0.050**	**0.050**	NS	**0.002**	NS
Significance & trend	**0.009 L**	NS	**0.021 L** **0.030 Q**	**0.022 L**	**0.024 L**	NS	**0.0006 L**	NS
ABA (mg/L)								
0	6.64	6.98	**7.18 b**	52.6	53.1	49.7	52.8	48.9
150	6.73	7.21	**7.56 a**	53.2	52.1	49.2	52.8	47.1
300	6.85	7.23	**7.63 a**	53.9	53.8	50.4	54.5	49.6
Significant p	NS	NS	**0.003**	NS	NS	NS	NS	NS
Significance & trend	NS	NS	**0.002 L**	NS	NS	NS	NS	NS
Interaction	NS	0.008	0.007	NS	NS	NS	NS	NS

No effects: Skin thickness, skin friability, flesh firmness, sweetness, acidity

Skookum Sensory 2013

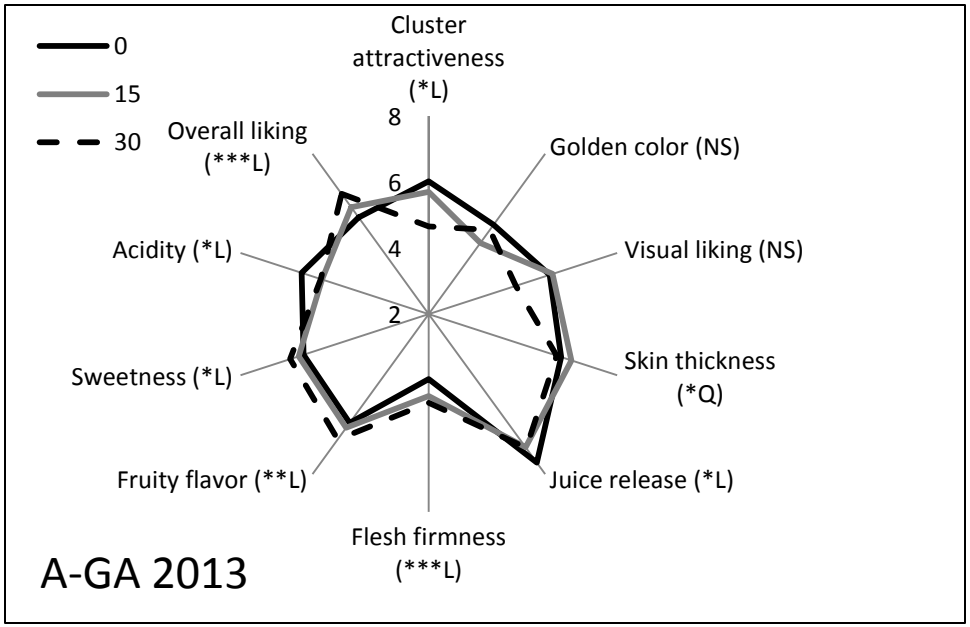
Treatment	Cluster Attractive-ness	Golden color	Visual liking	Skin Thickness	Juice release	Flesh Firmness	Fruity flavor	Sweetness	Acidity	Length of finish	Overall Liking
Gibberellic acid (mg/L)											
0	**6.02a**	5.34	5.85	**6.22ab**	**7.57a**	**3.97b**	**6.08b**	5.99	**6.05a**	5.96	5.62
15	**5.70ab**	4.66	5.94	**6.55a**	**6.99b**	**4.49a**	**6.26ab**	6.15	**5.40b**	6.28	6.00
30	**4.65b**	5.15	4.77	**6.08b**	**7.02b**	**4.69a**	**6.70a**	6.42	**5.44b**	6.09	6.50
Significant p	0.0746	0.4262	0.1518	0.0848	0.0242	0.0009	0.0257	0.1558	0.0399	0.1811	0.0025
Significance & trend	0.0304 linear	0.7100 ns	0.1069 ns	0.5089 ns 0.0344 Q	0.0201 linear	0.0003 linear	0.0091 linear	0.0591 linear	0.0319 linear	0.4682 ns	0.0006 linear
Abscisic acid (mg/L)											
0	4.84	**5.32a**	5.03	6.31	7.27	**4.11b**	6.40	**6.44a**	5.58	**5.95b**	5.86
150	5.46	**5.94a**	5.45	6.32	7.22	**4.54a**	6.51	**6.15ab**	5.56	**6.38a**	6.16
300	6.06	**3.90b**	6.08	6.22	7.09	**4.50a**	6.12	**5.96b**	5.76	**6.01b**	6.09
Significant p	0.1430	0.0023	0.2797	0.8460	0.7186	0.0318	0.1993	0.1037	0.7012	0.0320	0.3982
Significance & trend	0.0509 linear	0.0122 L 0.0077 Q	0.1167 ns	0.6476	0.4407	0.0283 linear	0.2057 ns	0.0361 linear	0.4986 ns	0.7249 ns 0.0099 Q	0.3113 ns
Interaction	0.1484	0.0140	0.3782	0.5314	0.9096	0.1243	0.7313	0.7236	0.8081	0.0331	0.3396

Skookum Sensory 2014

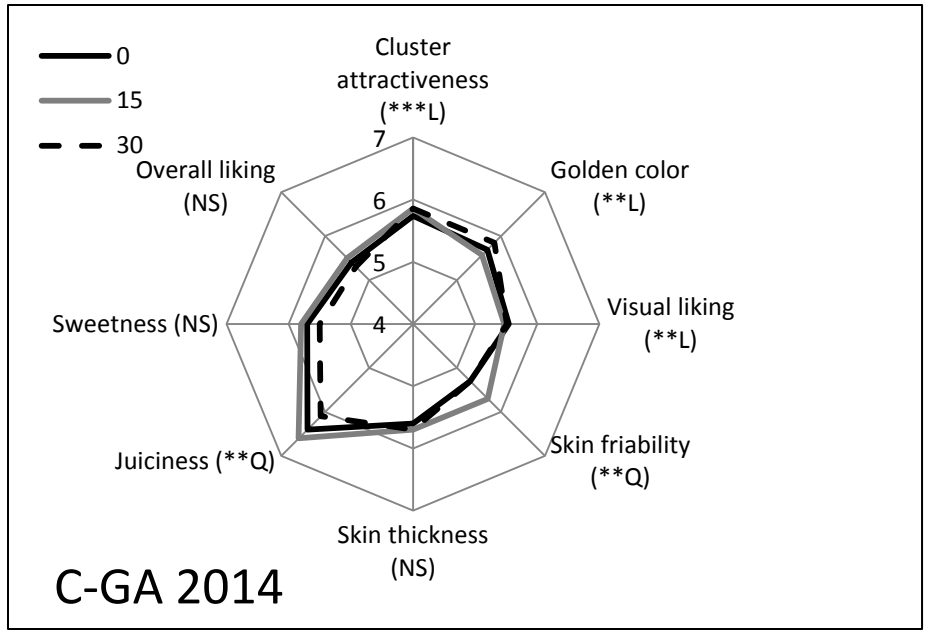
Treatment	Cluster Attractiveness	Golden Color Uniformity	Visual Liking	Skin Friability	Skin Thickness	Juiciness	Sweetness	Overall Liking
GA (mg/L)								
0	**6.49a**	5.69	**6.16a**	**53.6b**	54.9	**62.4b**	55.8	50.7
15	**5.86b**	5.57	**5.47b**	**57.2a**	56.9	**65.6a**	58.3	55.3
30	**5.86b**	5.85	**5.51b**	**53.0b**	56.9	**60.9b**	55.2	53.3
Significant p	**0.0008**	NS	**0.001**	**0.026**	NS	**0.008**	NS	NS
Significance & trend	**0.001 L**	NS	**0.003 L**	**0.008 Q**	NS	**0.003 Q**	NS	NS
ABA (mg/L)								
0	**5.74b**	**5.69ab**	**5.54b**	53.3	**55.9ab**	64.2	**56.7ab**	54.0
150	**5.99b**	**5.46b**	**5.45b**	56.0	**54.6b**	62.8	**58.8a**	55.8
300	**6.48a**	**5.96a**	**6.15a**	54.5	**58.3a**	62.0	**53.8b**	49.5
Significant p	**0.0005**	**0.050**	**0.002**	NS	**0.050**	NS	**0.050**	NS
Significance & trend	**0.0001**	**0.049 Q**	**0.004 L** **0.036 Q**	NS	NS	NS	NS	NS
Interaction	0.032	NS	0.003	NS	0.037	NS	NS	NS

No effects: Flesh firmness, fruity flavor, acidity

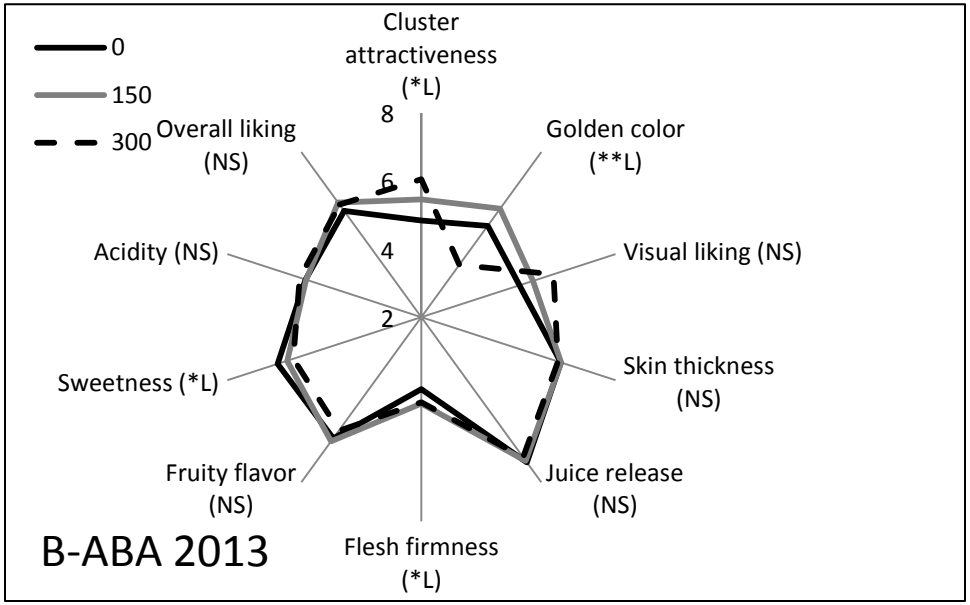
Skookum Sensory 2013



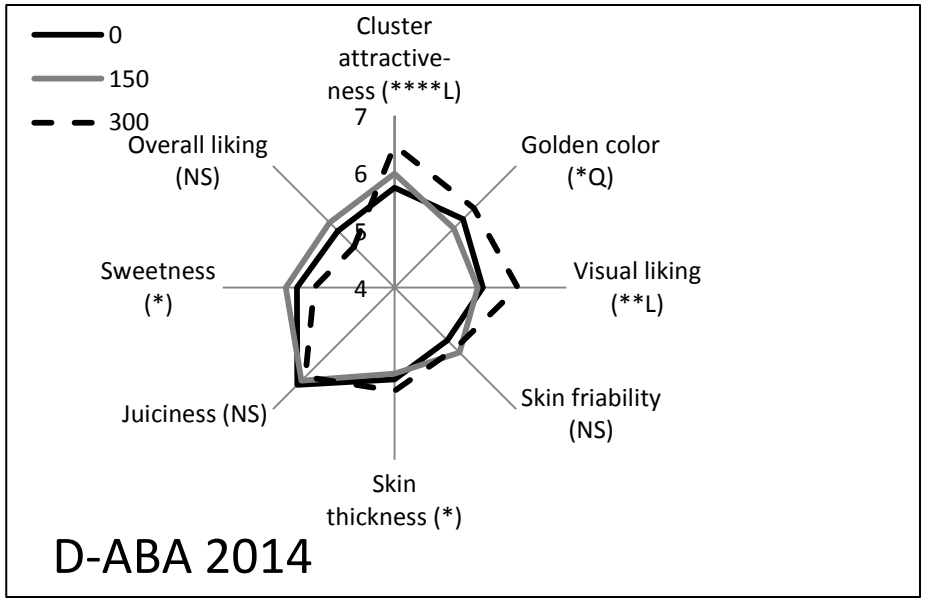
A-GA 2013



C-GA 2014



B-ABA 2013



D-ABA 2014

Summary & Conclusions

- GA had an expected effect on Coronation—increased yield, cluster weight, berry weight, all linear relative to GA concentration
- The impact on Skookum is not readily explainable
- ABA had few effects on yield components but did increase color and anthocyanins at one site
- Sensory effects were mixed; some positive responses included increased cluster attractiveness, color uniformity and color intensity, and enhanced fruity flavor

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Growing Forward 2

AAC
agricultural adaptation council

Ontario

Canada

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