Blueberry Horticulture Update

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Help us by answering a survey!

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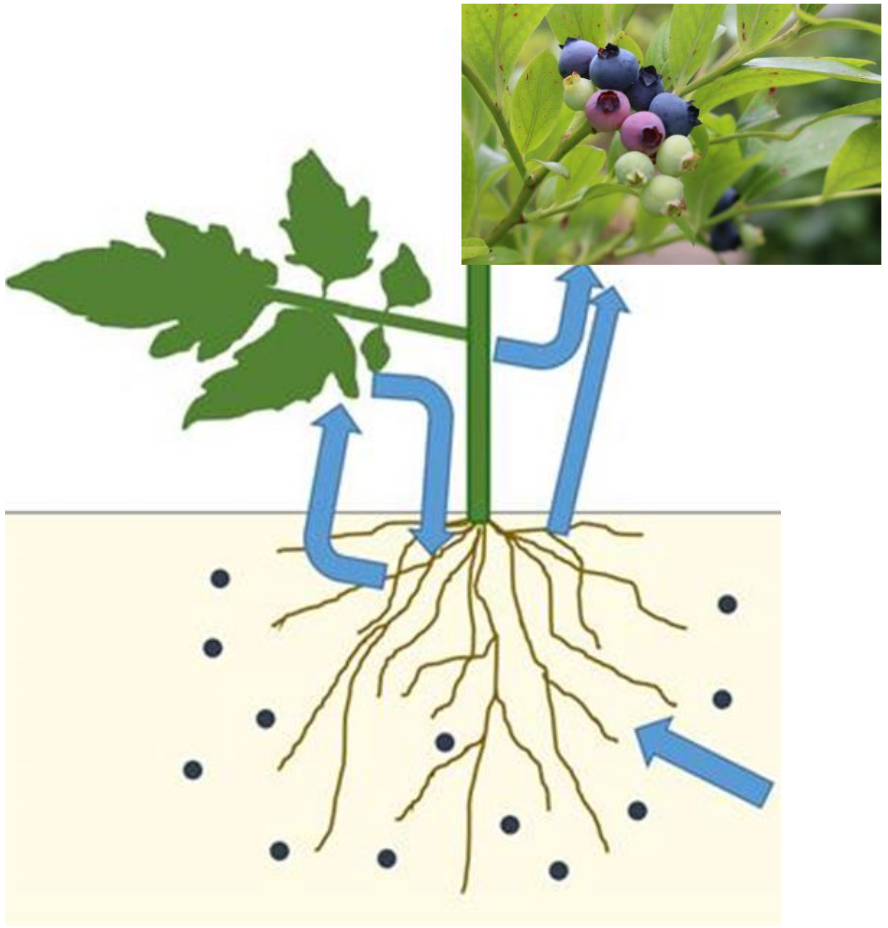
Fertilization

- How much is needed?
- What is already in the soil?
- When does the plant need it?
- How is the fertilizer taken up by the plant? Mobility of nutrient.



Fertilization

- How is the fertilizer taken up by the plant?
- N, P, K, Mg are mobile within the plant
- S, Fe, Mn, Cu, Zn are immobile within the plant
- Very immobile Ca, B
- Xylem (dead tissue, nutrients move with water)
- Phloem (alive, move sugars out of the leaves)

Nutrient	Mobility in plant	Translocated in phloem	Translocated in xylem	Deficiency symptoms on?
Nitrogen (N)	High	√	√	Older leaves
Phosphorus (P)	High	√	√	Older leaves
Potassium (K)	High	√	√	Older leaves
Calcium (Ca)	Low		√	New growth
Magnesium (Mg)	High	√	√	Older leaves
Sulfur (S)	Low-Medium	√	√	Younger leaves
Boron (B)	Low	√	√	New growth
Copper (Cu)	Low	√	√	New growth
Iron (Fe)	Low	√	√	New growth
Manganese (Mn)	Low	√	√	New growth
Molybdenum (Mo)	Medium-High	√	√	Older leaves
Zinc (Zn)	Low	√	√	New growth
Chlorine (Cl)	High	√	√	Older leaves

Fertilization

- What is already in the soil?
- Nitrogen leach
- Phosphorus low mobility
- Calcium low mobility, (foliar application)?

Nutrient	Mobility in soil
Nitrogen (N)	High (NO_3-); Medium (NH_4+)
Phosphorus (P)	Low
Potassium (K)	Low – Medium
Calcium (Ca)	Low
Magnesium (Mg)	Low
Sulfur (S)	Medium
Boron (B)	High
Copper (Cu)	Low
Iron (Fe)	Low
Manganese (Mn)	Low
Molybdenum (Mo)	Low-Medium
Zinc (Zn)	Low
Chlorine (Cl)	High

Fertilization

shment

Table 1. Fertilization of southern highbush and rabbiteye blueberries in the establishment year.

	Blueberry fertilization for 12-by-3-foot row spacing[z]		
		Granular fertilization	Fertigation
	Total N/A/yr	4 applications	6 applications	Weekly (27 weeks)
Liner[y]	40 lbs	10 lbs N	7 lbs N	1.5 lbs N
Pots[x]	54 lbs	14 lbs N	9 lbs N	2 lbs N

[z]At 12-by-3-foot spacing, there are 1,210 blueberry plants per acre. If your plant density or spacing differs, simply divide your plant density by 1,210 and multiply the total N to get the adjusted rate, for example (2904/1210)*40 lbs N = 96 lbs N per acre per year, which is the rate for a planting with 3-by-5-foot spacing.

Smith and Jacobs, 2019 [*Suggested Blueberry Fertilization Timings and Rates (uga.edu)]

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Fertilization

Years 2&3

Table 2. Fertilization of southern highbush and rabbiteye blueberries in the second and third season.

		Blueberry fertilization for 12-by-3-foot row spacing		
		Granular fertilization		Fertigation
	Total[z] N	4 applications	6 applications	Weekly (27 weeks)
2nd & 3rd	90 lbs	22.5 lbs N	15 lbs N	3.3 lbs N

[z]This rate is suggested to promote growth and push the plants into full production.

Smith and Jacobs, 2019 *Suggested Blueberry Fertilization Timings and Rates (uga.edu)

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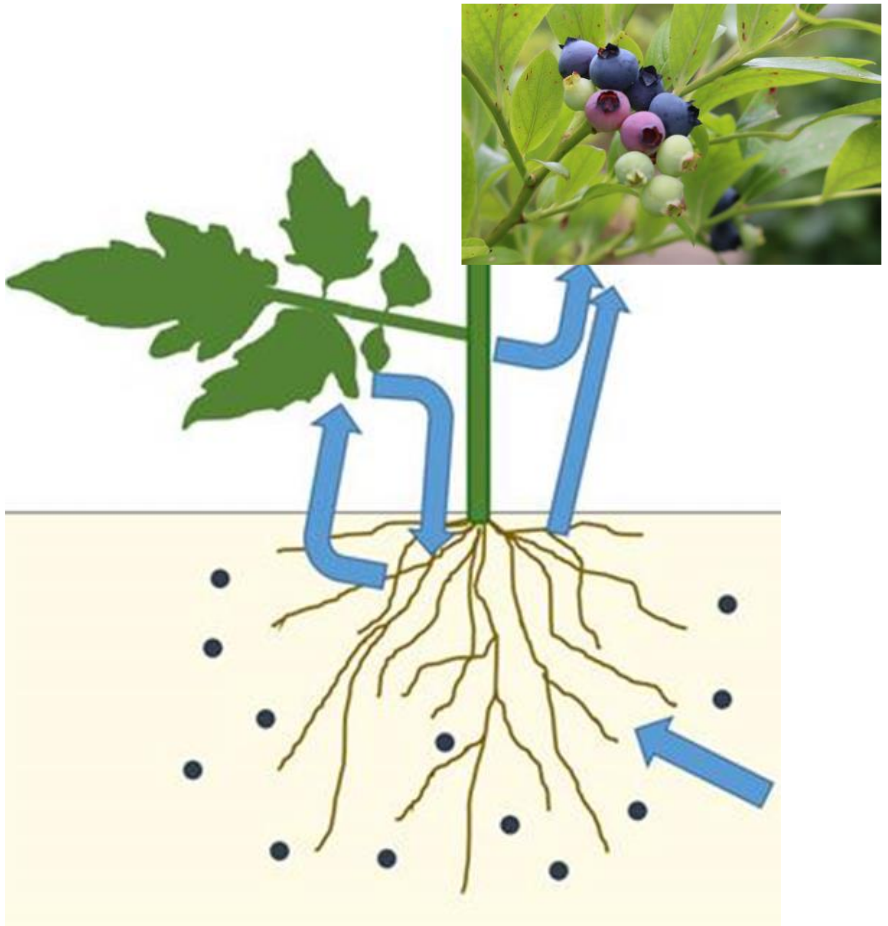
Fertilization

How much is needed?

- Phosphorus:
  - ➢Less than 20 lb. apply 240-300 lb. of phosphate to increase the P in soil by 30 lb.
- Potassium: levels lower than 100 ppm (mg/kg). Check leaf samples.



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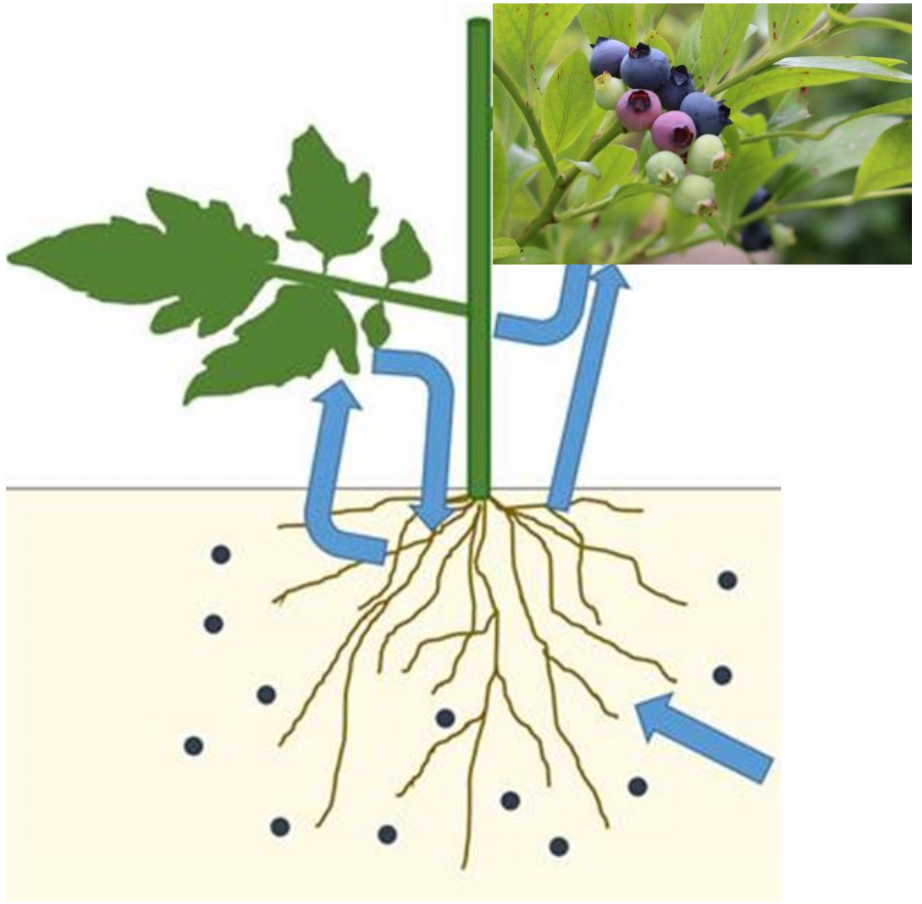
Fertilization

Krewer and NeSmith, 1999

Sufficient or normal foliar concentrations of nutrients for rabbiteye

Nutrient	Georgia (%)	Michigan (%)
N	1.20 -1.70	1.70 - 2.10
P	0.08 - 0.17	0.08 - 0.40
K	0.28 - 0.60	0.40 - 0.65



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Fertilization

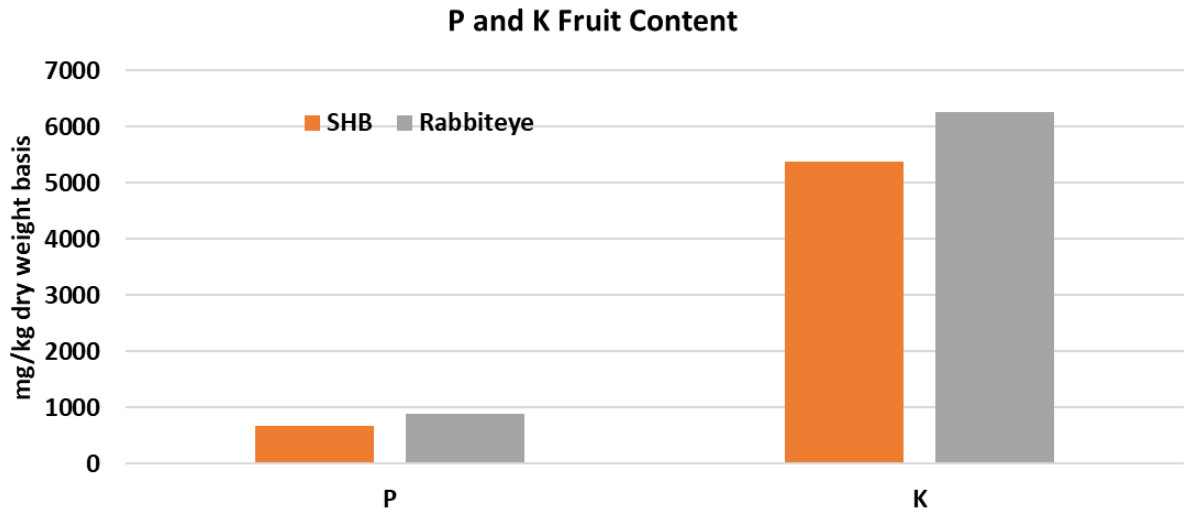
Nutrients removed per TON (fresh) of harvested fruit (range for 7 cultivars) & per ACRE of pruning wood ('Elliott' data) (Strik, in progress)

Part removed	Macronutrients (lb) N	P	K	Ca	Mg	S
Fruit (per ton harvested)	1.3 - 2.3	0.1 - 0.3	0.8 - 1.7	0.1 - 0.2	0.05 - 0.1	0.06 - 0.2
Prunings (per acre)	14.0	1.5	6.5	3.0	0.9	1.1

	Micronutrients (g/ton) B	Cu	Mn	Zn	Fe
Fruit (per ton harvested)	0.02 - 0.03	0.01 - 0.02	0.04 - 0.1	0.01 - 0.04	0.05 - 0.1
Prunings (per acre)	0.2	0.5	12.1	0.5	1.1

- Fruit data: Range provided for the cultivars; Duke, Bluecrop, Draper, Liberty, Aurora, Legacy, Elliott
- Pruning data: Mature 'Elliott' (average of two years)

Source Strik, 2021 Oregon State University



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Redesigning Blueberry Fertilization

Experimental Sites	Farm 1: Nahunta – RE – P	Farm 2: Alma – SHB – F	Farm 3: Alma – RE – V	Farm 4: Hoboken – SHB – F
Location	Nahunta	Alma	Alma	Hoboken
Variety	Premier	Farthing	Vernon	Farthing
Year of establishment	2009	2018	2013	2014
Plant Density	Twelve by 3-foot row spacing: 1210 plants per acre.	Eleven by 2.5-foot row spacing: 1584 plants per acre.	Eleven by 4-foot row spacing: 990 plants per acre.	Twelve by 3-foot row spacing: 1210 plants per acre.
P fertilization during Year 1	3.4 g P per plant per year.	4.3 g P per plant per year.	4.3 g P per plant per year.	7.9 g P per plant per year.
P fertilization during production (current)	33.8 g P per plant per year.	15.5 g P per plant per year.	16.5 g P per plant per year.	Granular 11.3 g P per plant per year. Fertigation 15.8 g P per plant per year. Total 27.1 g P per plant per year.
Reported Yield	3500 lb./acre	8500 lb./acre	8000 lb./acre	12000 lb./acre

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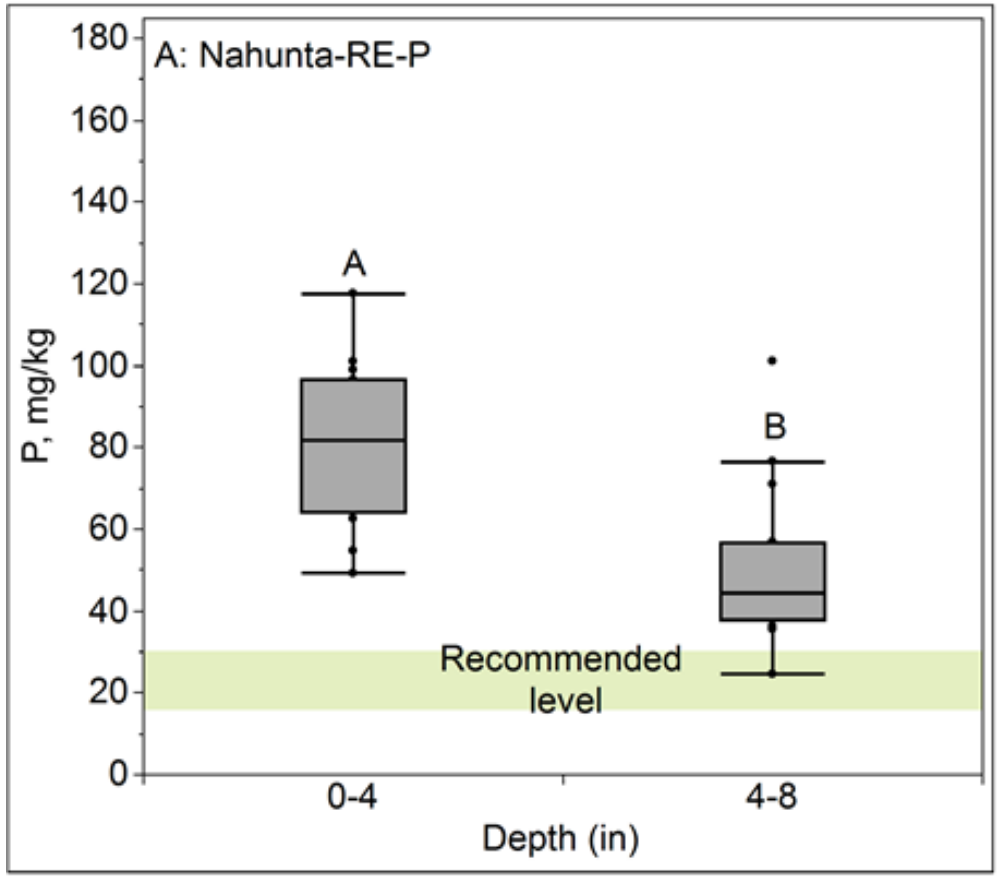
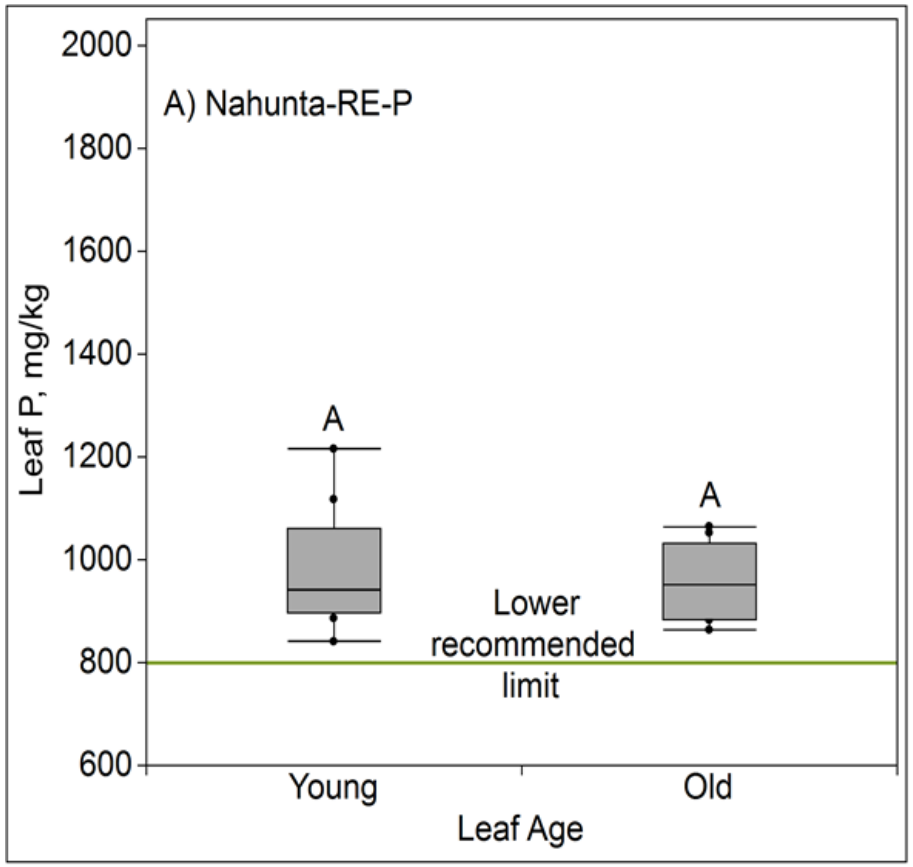
Redesigning Blueberry Fertilization





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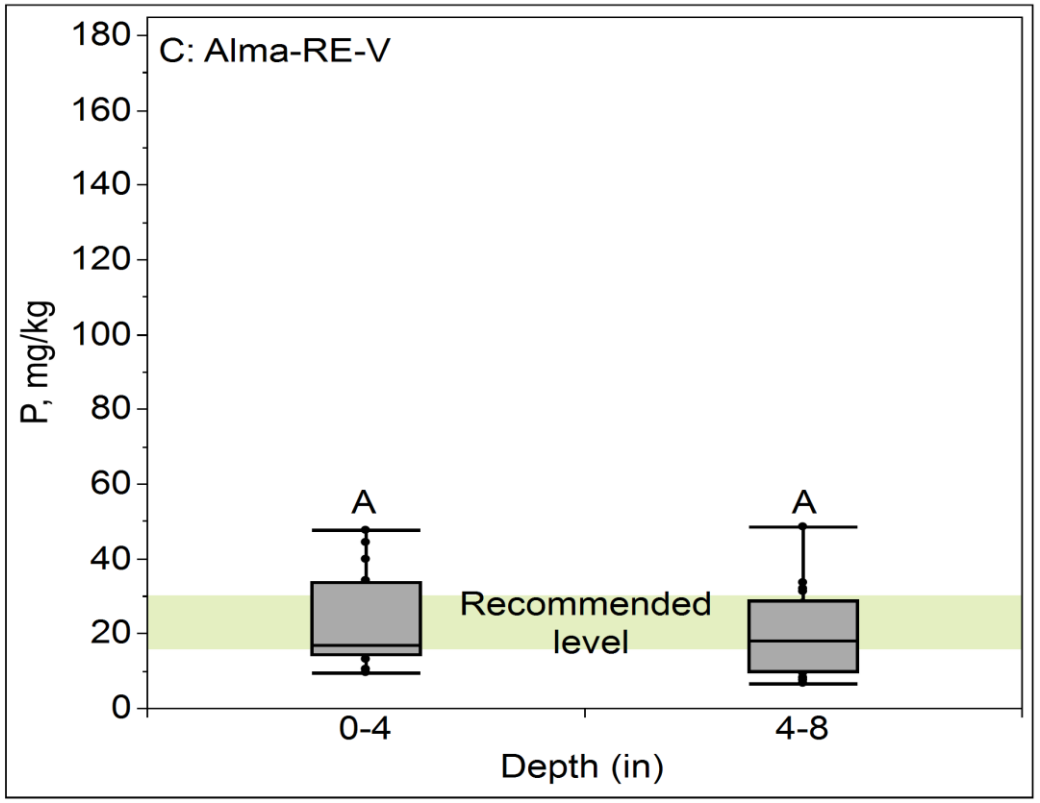

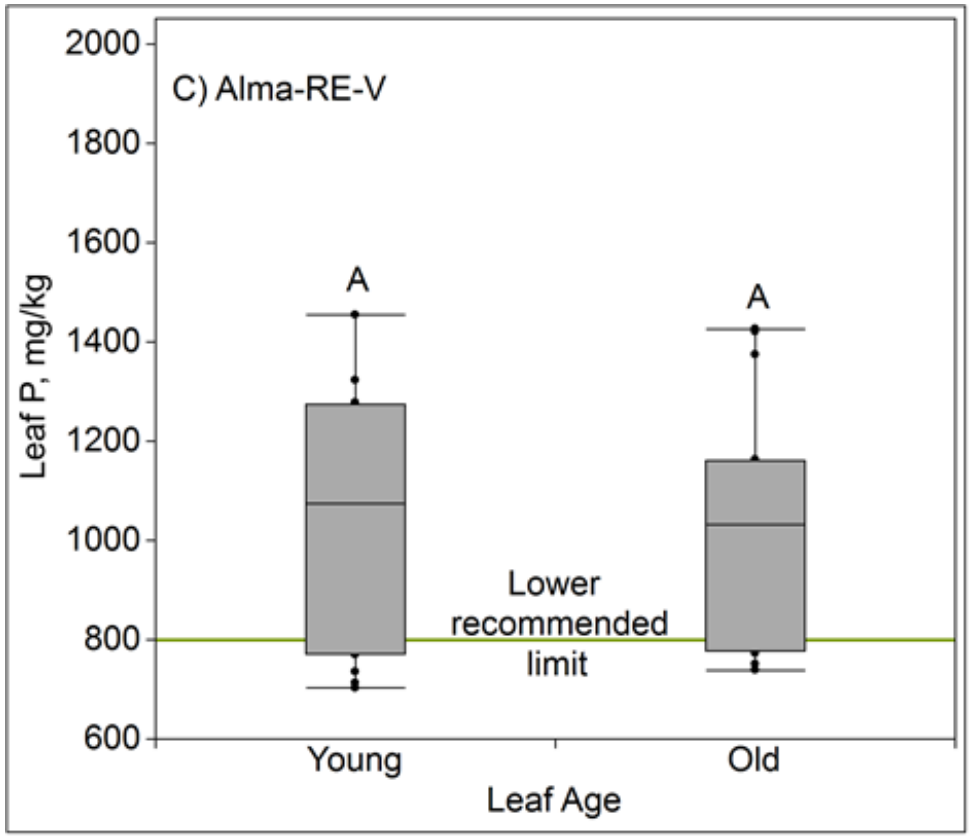

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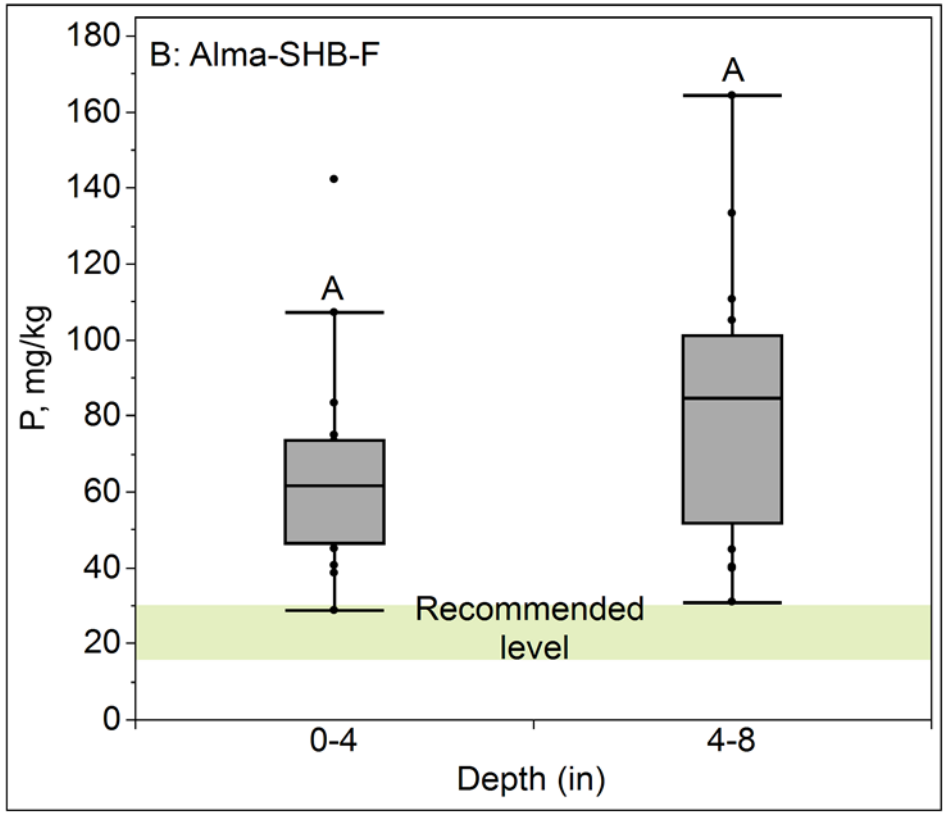

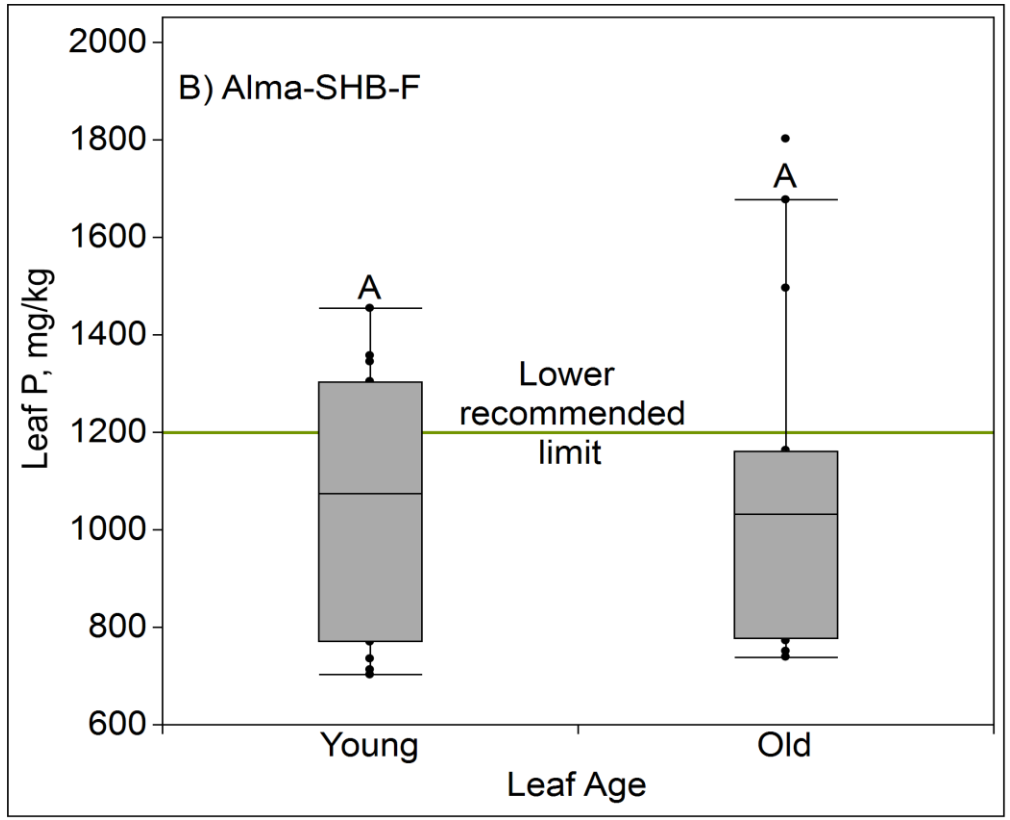

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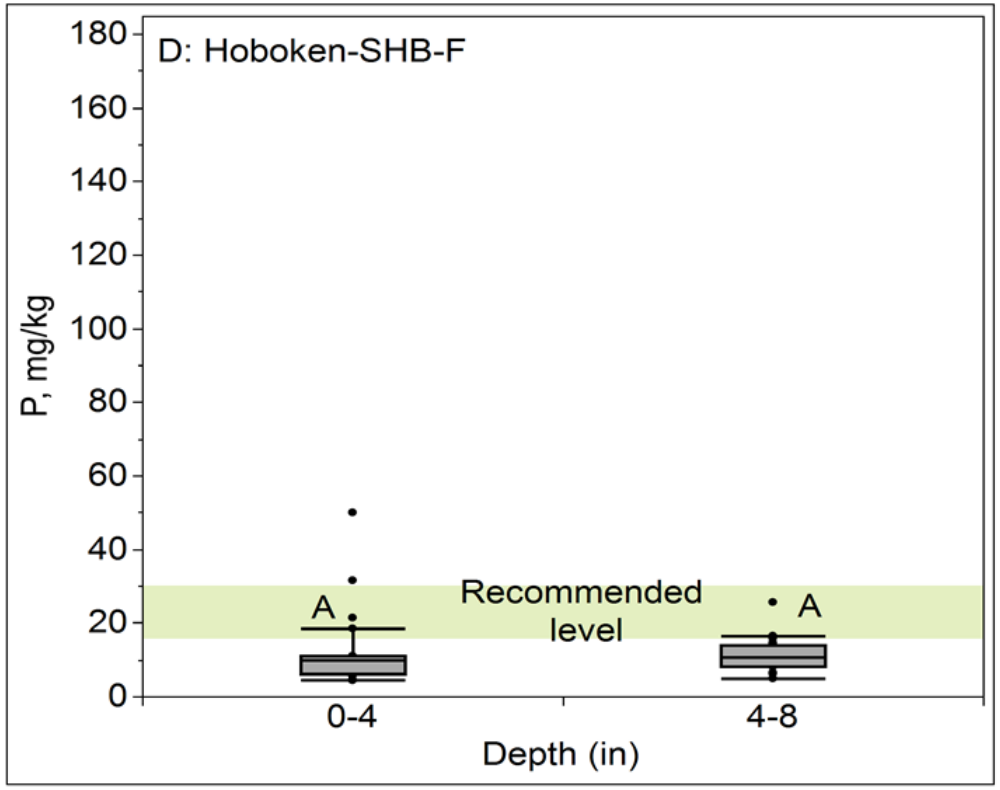
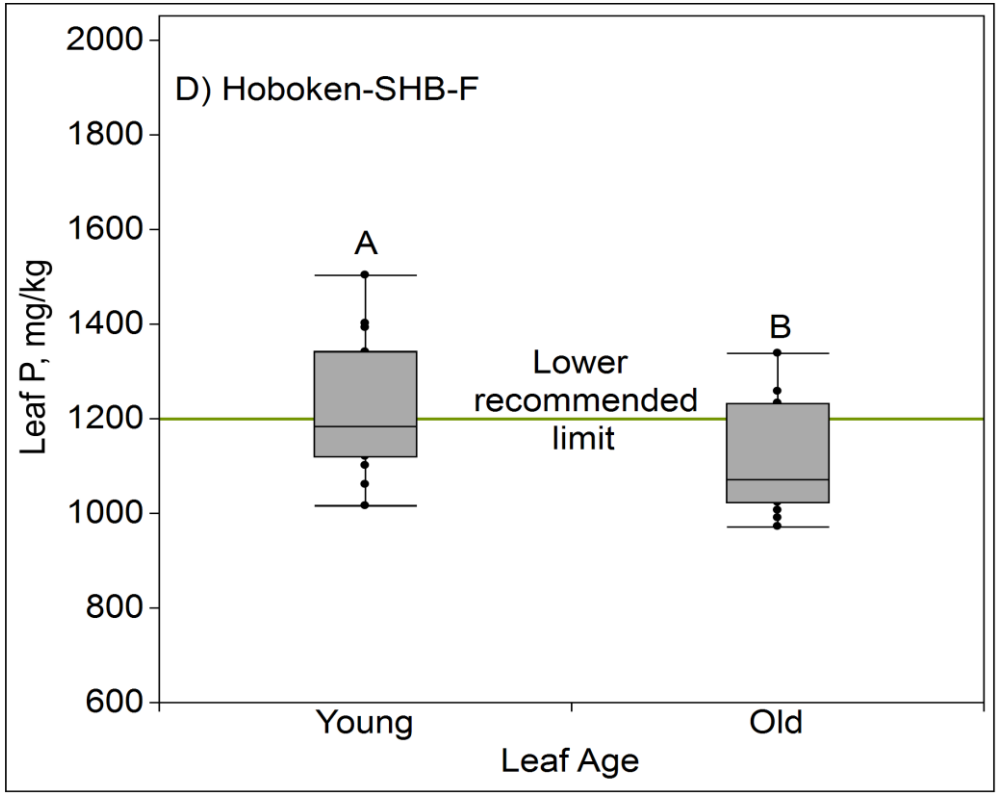
Redesigning Blueberry Fertilization





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Fall Pruning

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Fall Pruning

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Fall Pruning

	Description	Label
1	Hedge summer (after harvest)/ hand pruned fall	Hg (S) HdP (F)
2	Hedge summer (after harvest) /tip in fall (commercial practice)	Hg (S,F)
3	No hedge after harvest/hand pruned fall	HdP (F)
4	Hand pruned summer (after harvest)/hand pruned in fall	Hd P(S,F)
5	No pruned/or hedge	NoHg HdP
6	Hedge after harvest and hand pruned(summer)/ hand prune in fall	Hg(S) HdP(S,F)

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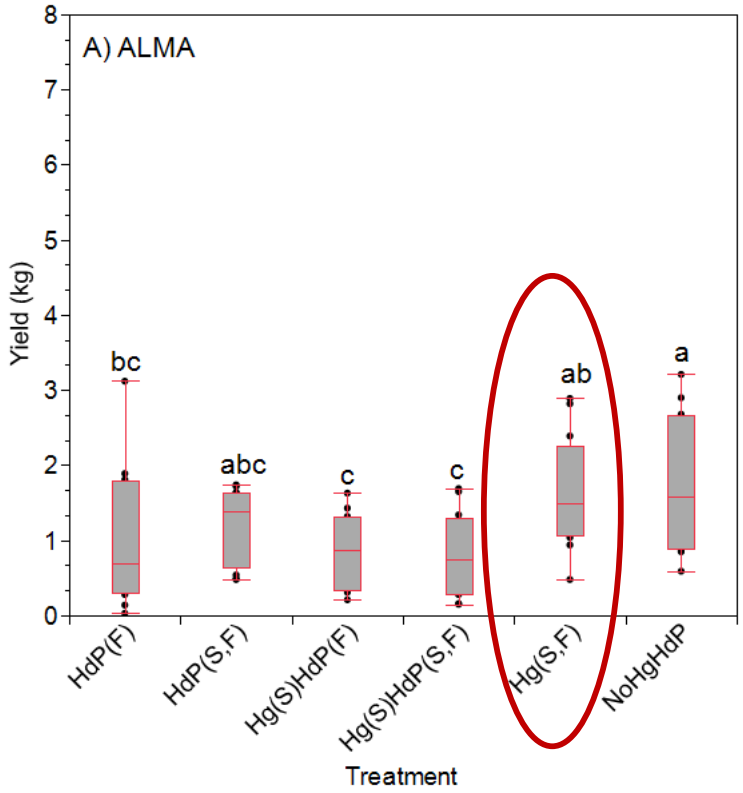
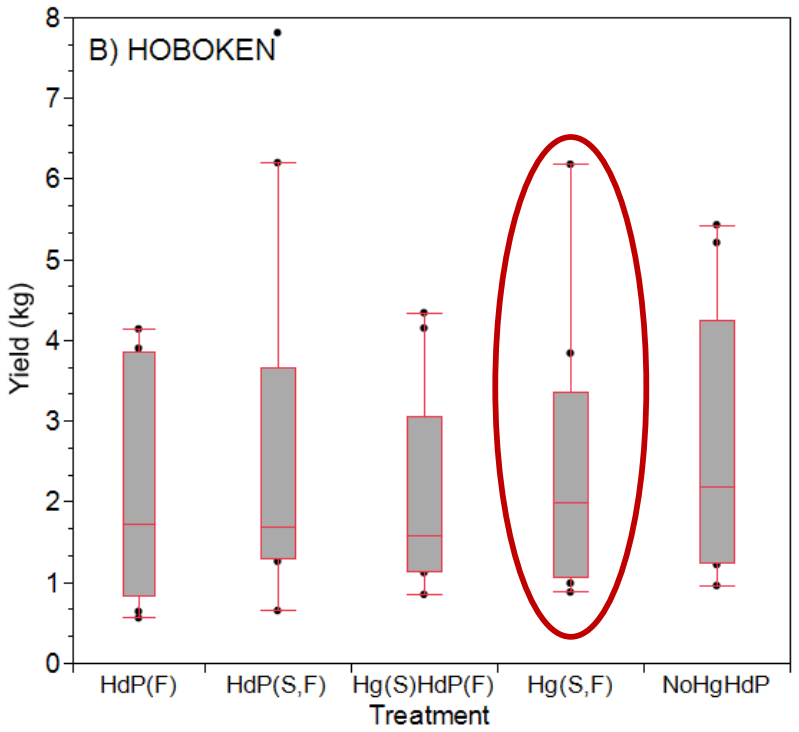
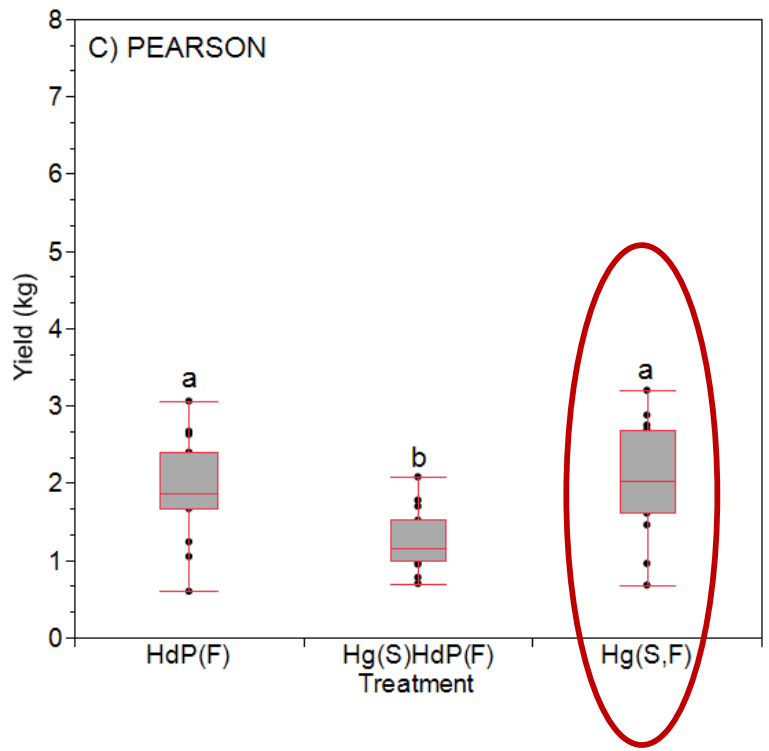
Fall Pruning - Yield







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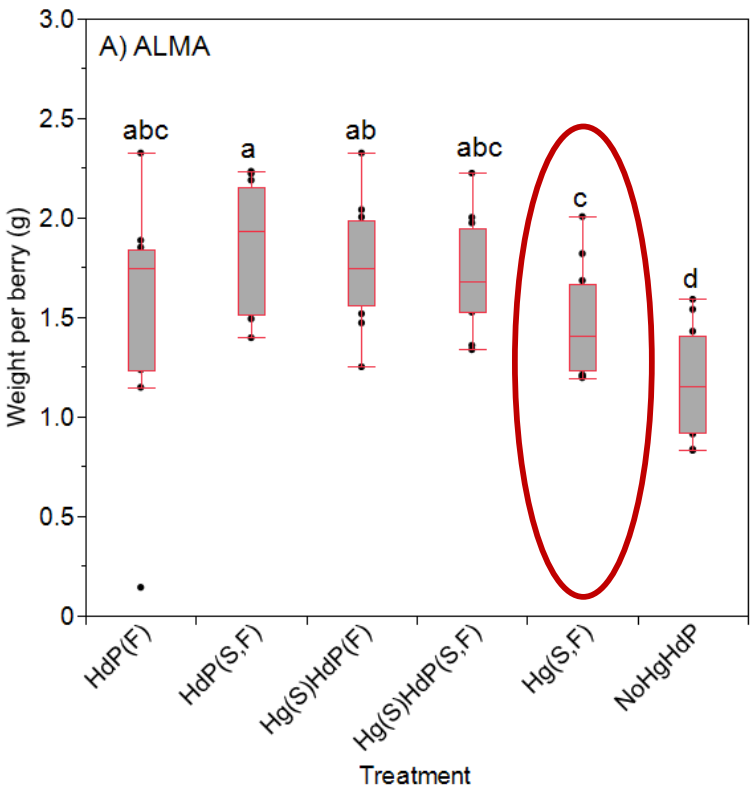
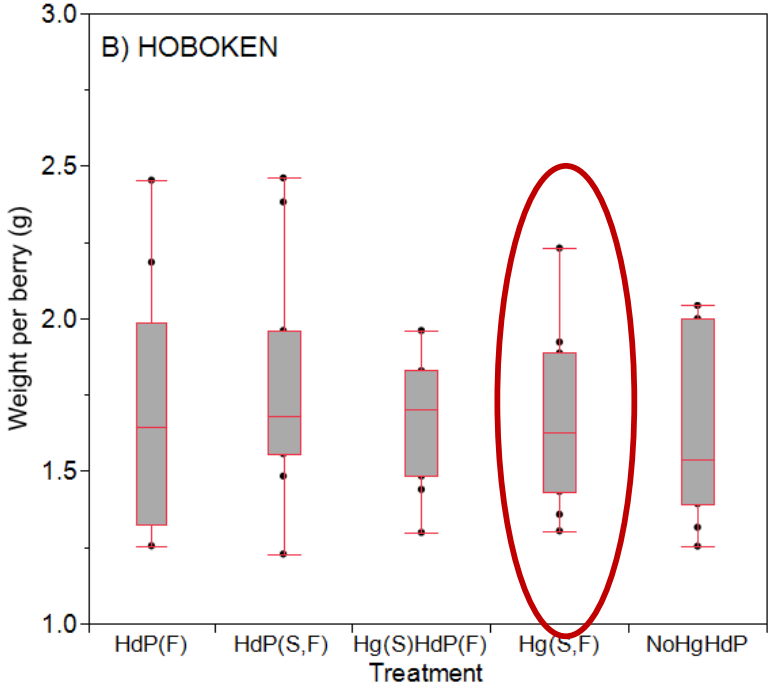
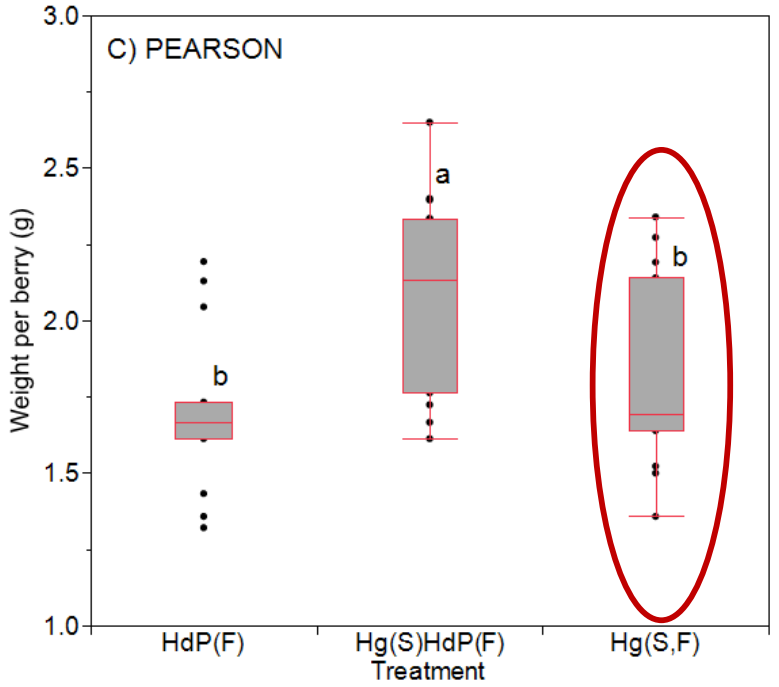
Fall Pruning - Berry Weight







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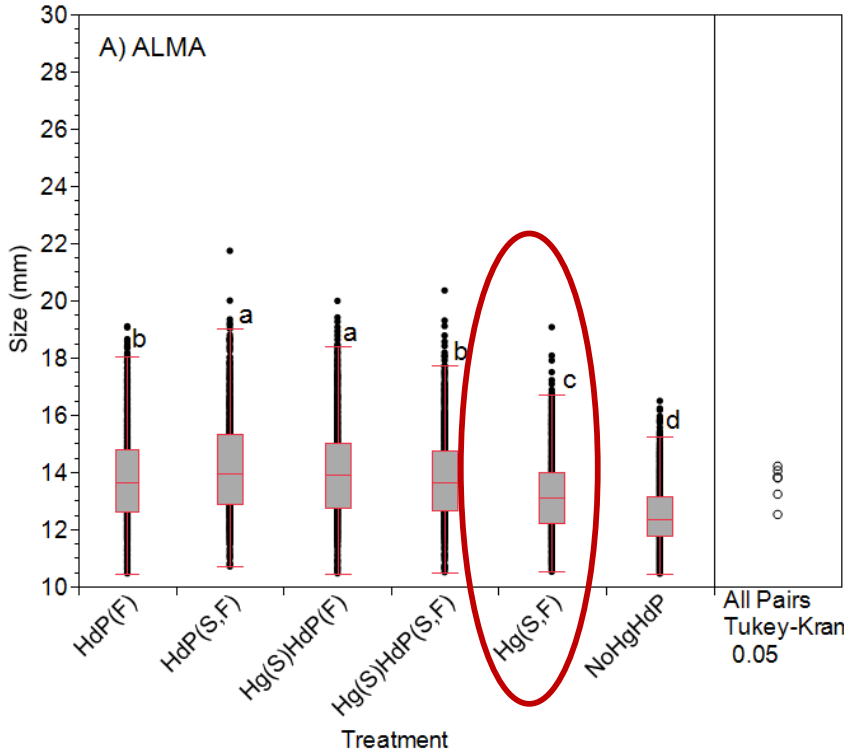
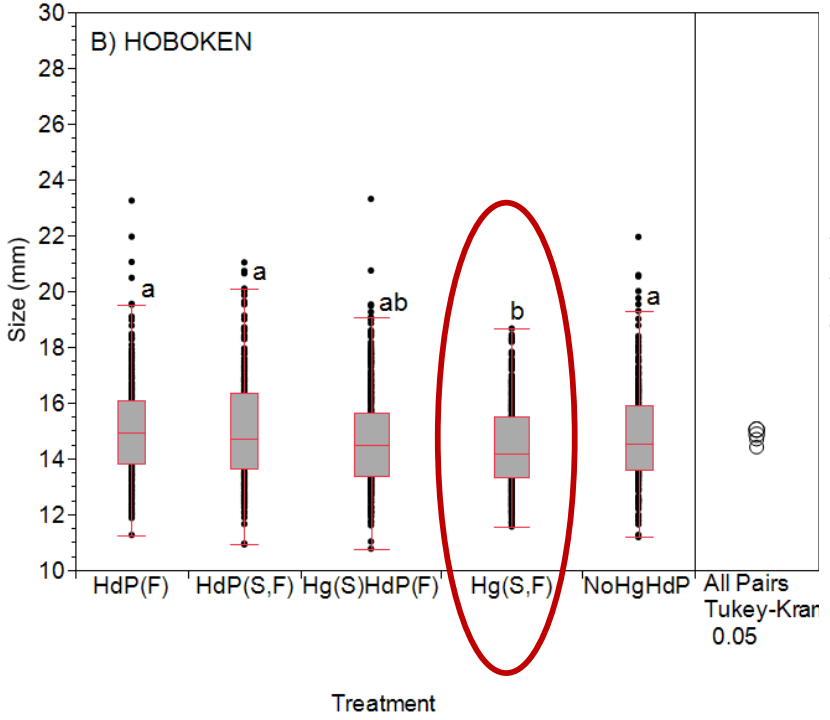
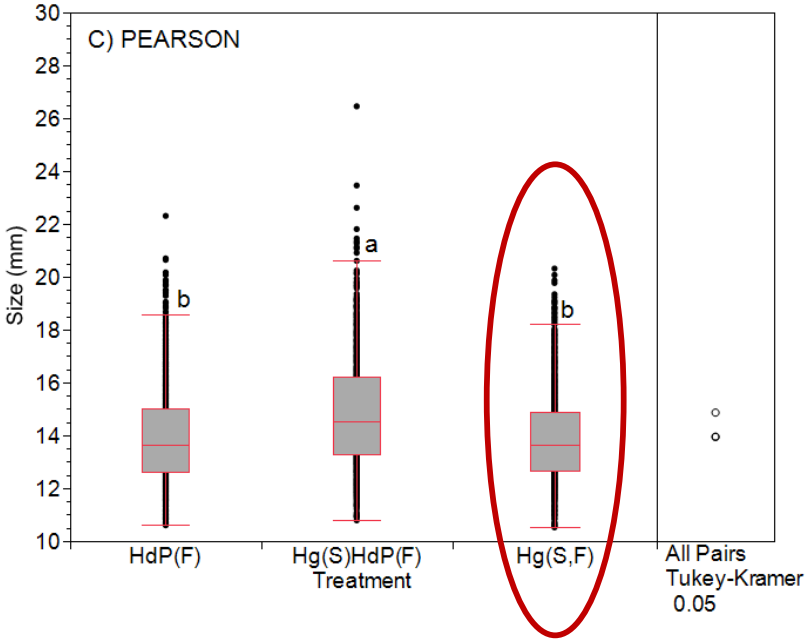
Fall Pruning - Berry Size







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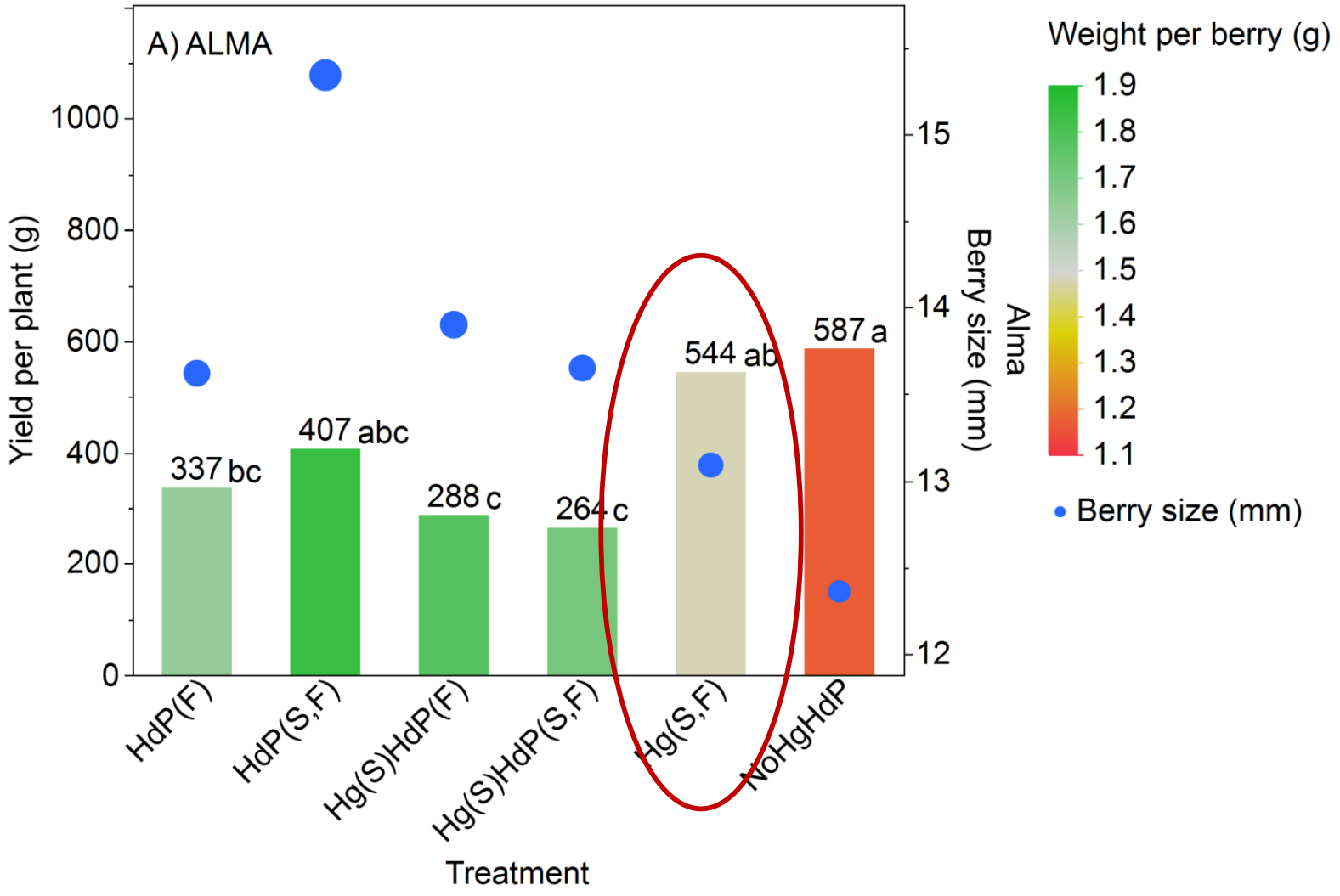
Pruning– Yield and Berry Size



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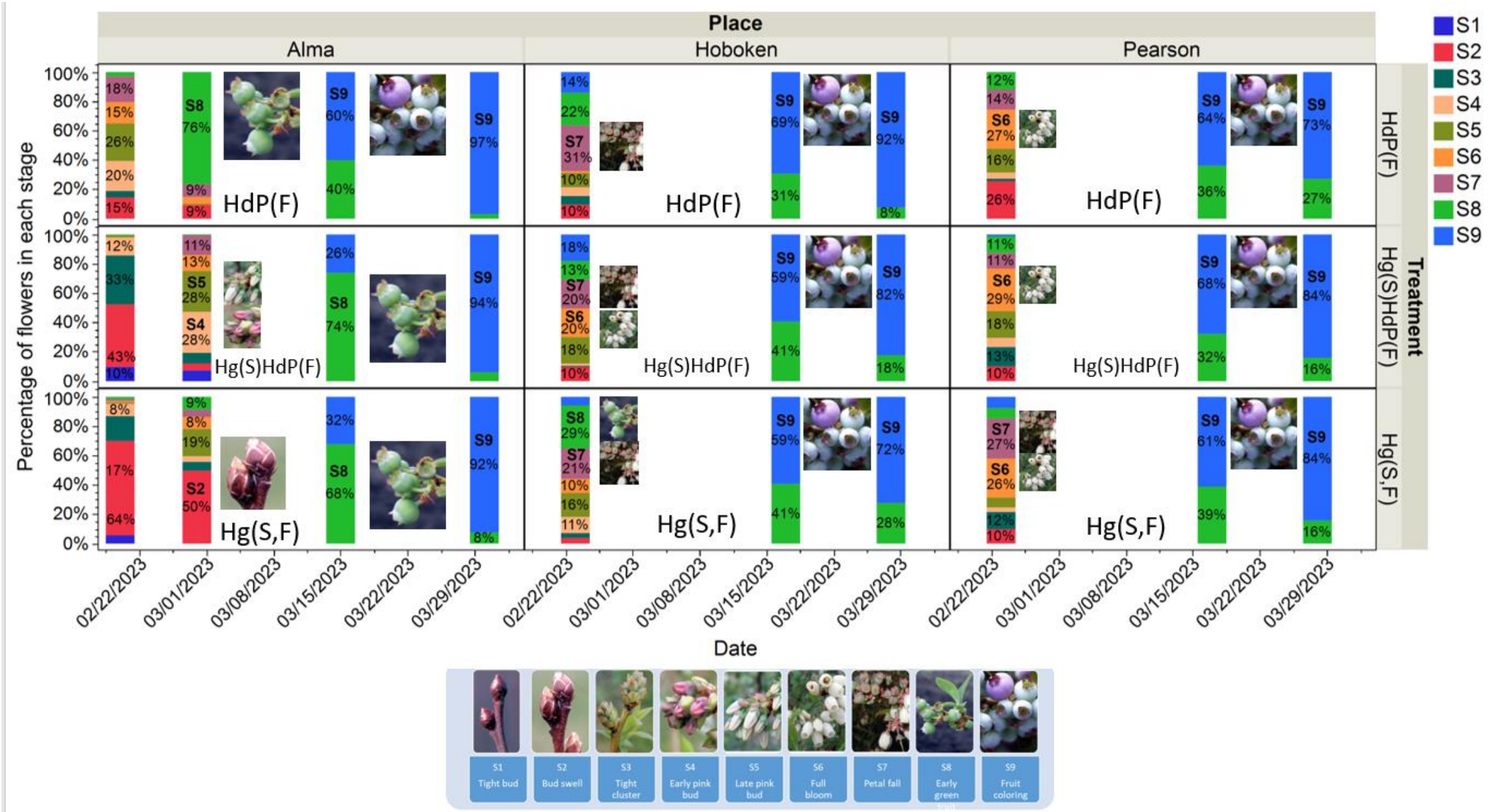
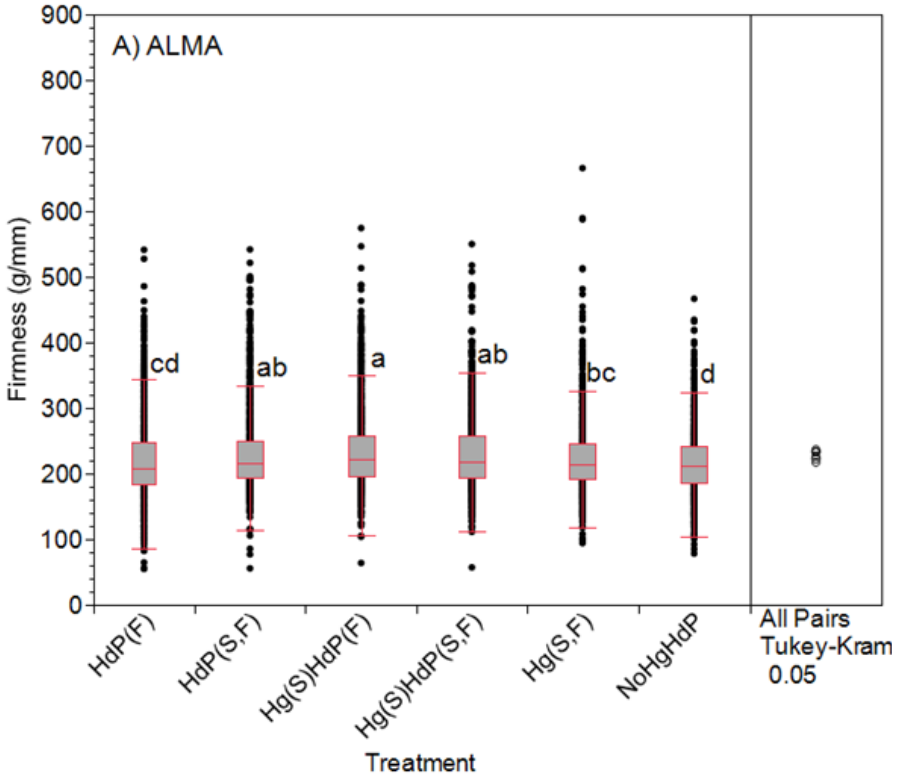
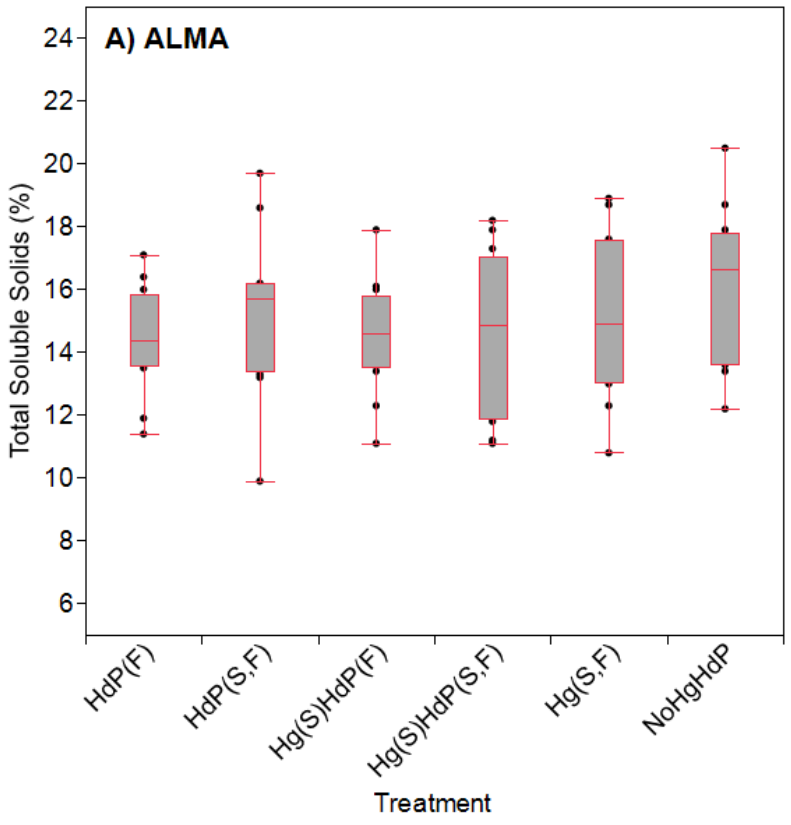
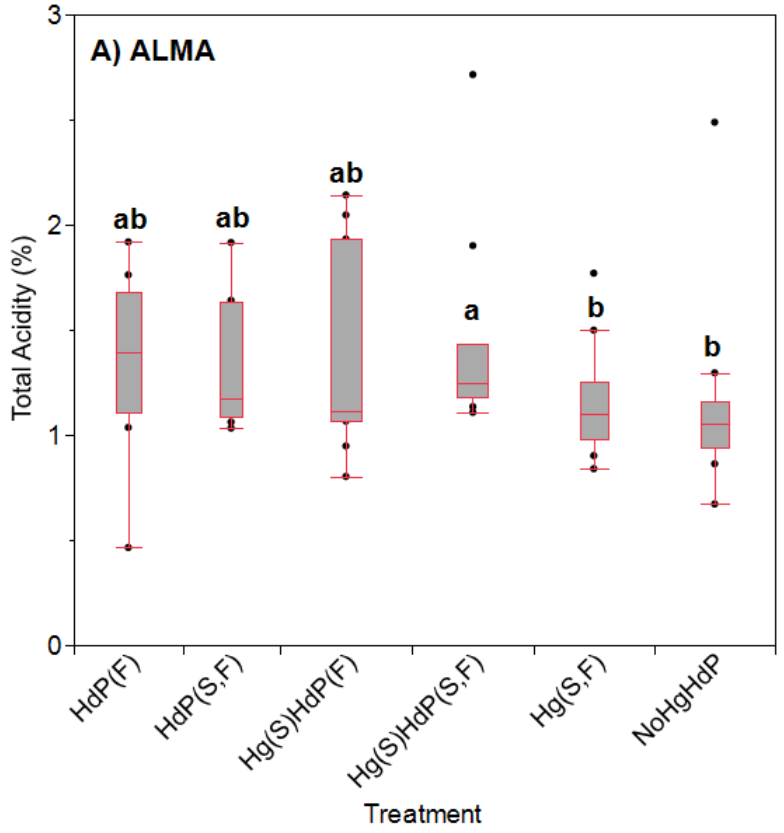
Pruning – Developmental Stages



Pruning – Fruit Quality







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Ethephon Application on SHB

- Fall application of Ethephon to rabbiteye blueberry delayed blooming by 7–10 days depending on the temperature (Krewer et al., 2005).
- In recent years, blueberry growers have applied Ethephon to delay SHB bloom.
- There is limited information on the best rate of application, the timing of application, the effect of temperature on Ethephon effectiveness, and the mechanisms by which Ethephon delays blooming.

Ethephon Application on SHB

Ethephon Treatments

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Other Rate	Other Rate Unit	Appl Timing	Appl Code	Amt Product to Measure	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
1	Ethephon	2	LB/GAL	L	200	ppm ai	0.83	ml/l	POEMCR	A	2.502 mL/mx	101	202	304	401	503
	Nonionic Surfactant	100	%	L	0.25	% v/v	2	pt/a	POEMCR	A	7.499 mL/mx					
2	Ethephon	2	LB/GAL	L	400	ppm ai	1.67	ml/l	POEMCR	A	5.004 mL/mx	102	204	302	404	501
	Nonionic Surfactant	100	%	L	0.25	% v/v	2	pt/a	POEMCR	A	7.499 mL/mx					
3	Ethephon	2	LB/GAL	L	800	ppm ai	2.67	pt/a	POEMCR	A	10.01 mL/mx	103	201	303	402	504
	Nonionic Surfactant	100	%	L	0.25	% v/v	2	pt/a	POEMCR	A	7.499 mL/mx					
4	Control											104	203	301	403	502

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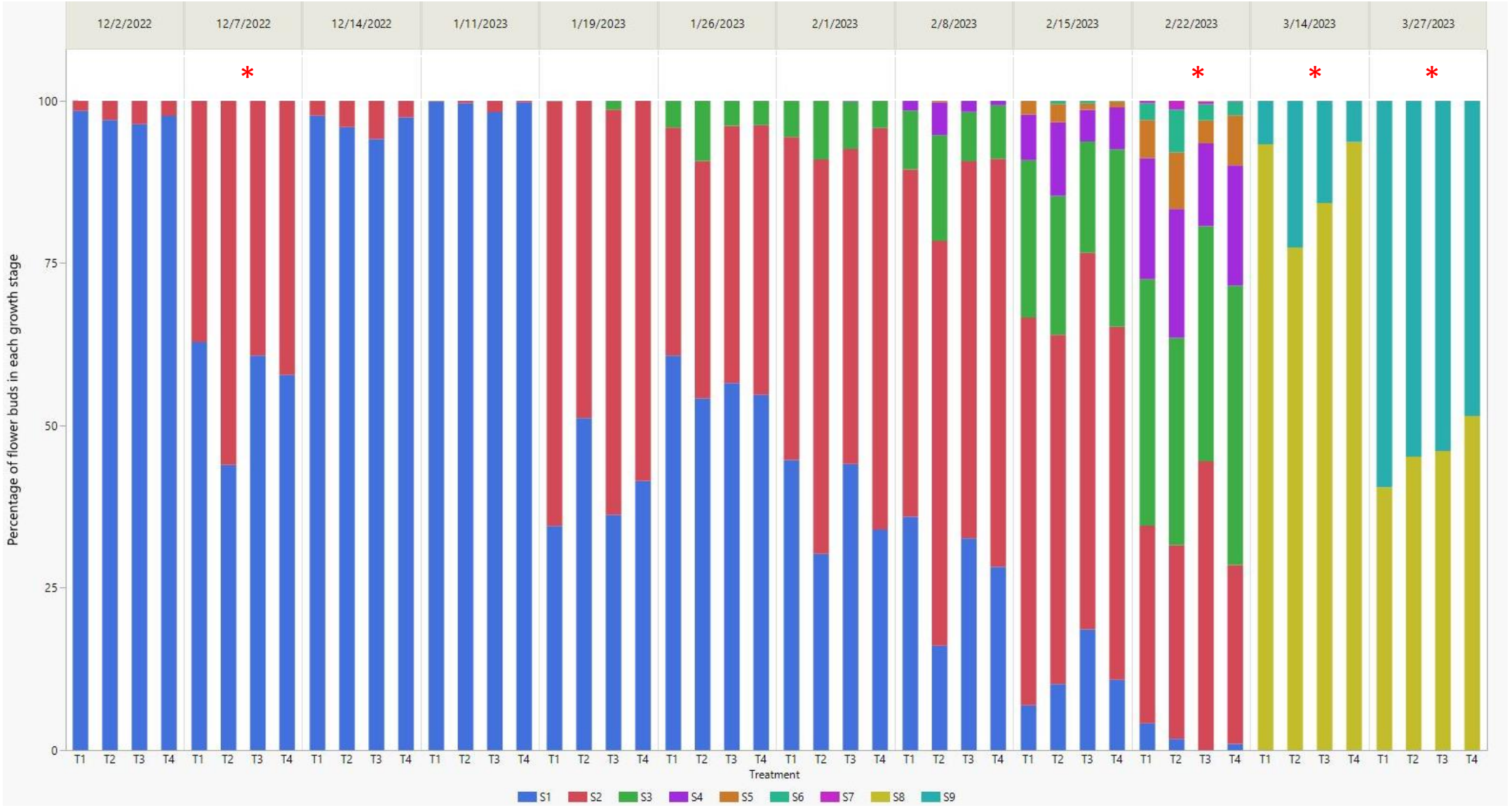
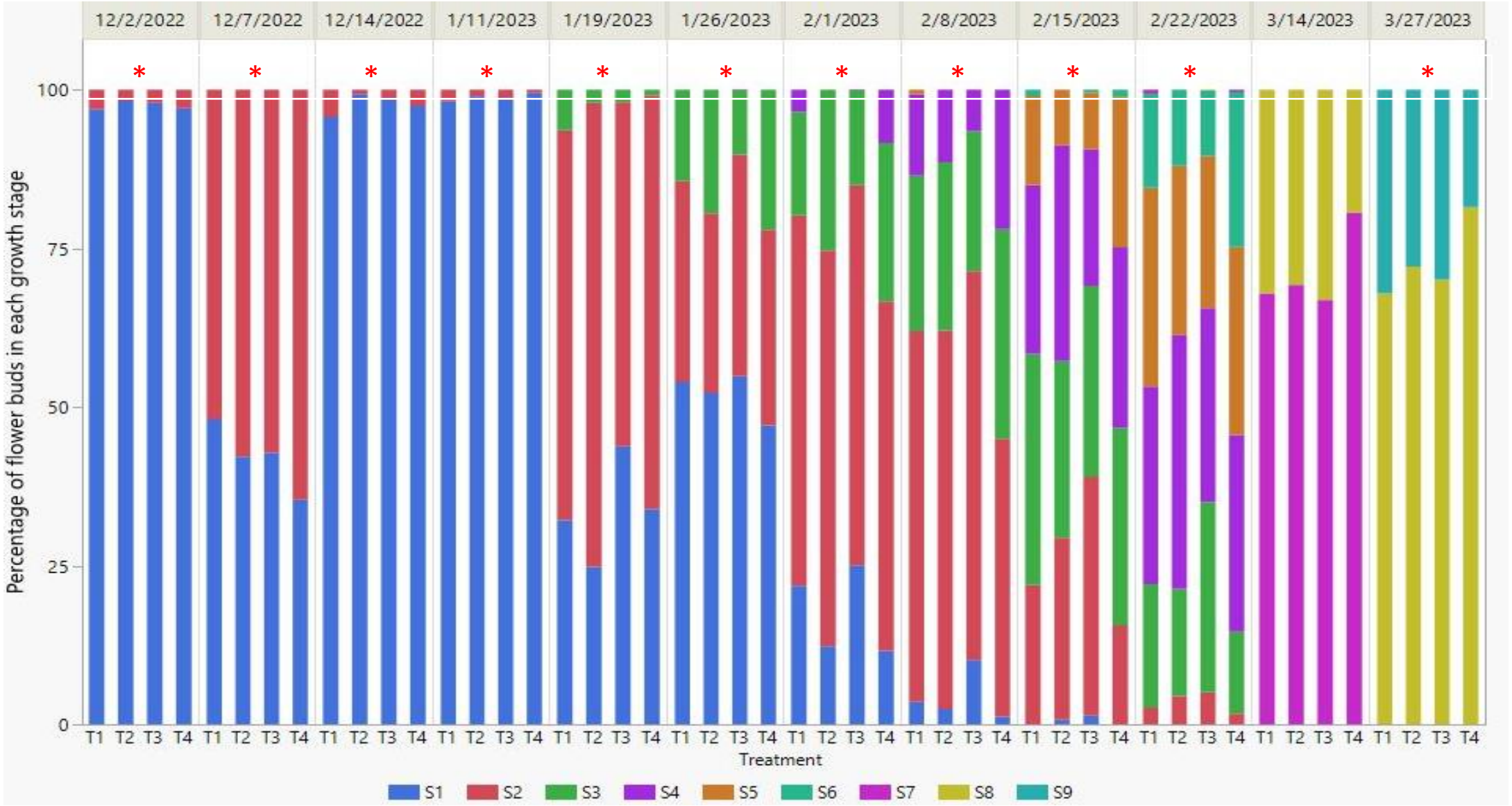
Percentages of flower buds development across all evaluated dates for ‘Farthing’



Percentages of flower buds development across all evaluated dates for ‘Georgia Dawn’

Percentages of flower buds development across all evaluated dates for the ‘Kee Crisp’



Differences of each growth stage in each evaluated date 'Farthing'

Date	Treatment	S1	S2	S3	S4	S5	S6	S7	S8	S9
12/7/2022	T1	62.8 b	37.2 a	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T2	43.9 a	56.1 b	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T3	60.7 b	39.3 a	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T4	57.8 a b	42.2 a b	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/22/2023	T1	4.1	30.4 a	37.9	18.7	5.9	2.6	0.4	0.0	0.0
2/22/2023	T2	1.7	29.8 a	31.9	19.8	8.7	6.6	1.4	0.0	0.0
2/22/2023	T3	0.0	44.4 b	36.2	12.8	3.5	2.5	0.4	0.1	0.0
2/22/2023	T4	1.0	27.5 a	43.0	18.5	7.7	2.2	0.1	0.0	0.0
3/14/2023	T1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	93.3 b	6.7
3/14/2023	T2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.4 a	22.6
3/14/2023	T3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.2 a	15.8
3/14/2023	T4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	93.6 b	6.4
3/27/2023	T1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5 a	59.5 a b
3/27/2023	T2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2 b	54.8 b
3/27/2023	T3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.1 a	53.9 a
3/27/2023	T4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.4 b	48.6 b

Higher mean percentage value

Second-highest mean percentage value

Third-highest mean percentage value

Lower mean percentage value

*Means with a common letter are not significantly different ($p > 0.05$)

*These tables show the growth stages where significant differences were identified between the analyzed dates as determined by the Kruskal Wallis test (based on **medians**).

*The tables are represented by the **means** (average of flower buds) for each treatment and date.

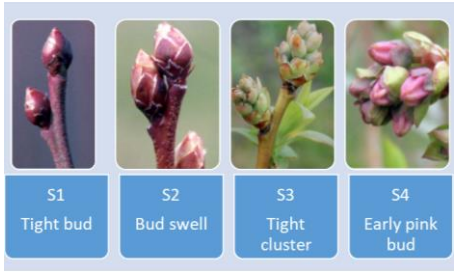
*As this experiment was analyzed based on **medians,** and we represent them as **means**, some differences may not correspond to the mean values.

*Red-colored letters indicates means that do not correspond to the median analysis.

Georgia Dawn

Date	Treatment	S1	S2	S3	S4	S5	S6	S7	S8	S9
1/11/2023	T1	97.0	3.0 ab	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T2	98.0	2.0 ab	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T3	99.6	0.4 a	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T4	93.8	5.4 b	0.7	0.0	0.1	0.0	0.0	0.0	0.0
1/19/2023	T1	31.4	62.3	5.9 b	0.4	0.0	0.0	0.0	0.0	0.0
1/19/2023	T2	29.2	68.9	1.8 a	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T3	31.9	67.0	1.1 a	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T4	27.1	62.5	7.7 b	2.7	0.0	0.0	0.0	0.0	0.0
1/26/2023	T1	37.4	38.7 c	20.4 b	3.1 ab	0.4 ab	0.0	0.0	0.0	0.0
1/26/2023	T2	60.3	25.9 ab	11.0 a	1.9 a	0.8 ab	0.0	0.2	0.0	0.0
1/26/2023	T3	52.0	35.5 b c	12.1 a	0.4 a	0.0 a	0.0	0.0	0.0	0.0
1/26/2023	T4	57.8	18.8 a	10.9 a	8.1 b	4.4 b	0.0	0.1	0.0	0.0
2/1/2023	T1	15.6	56.9	18.8	5.5 a	3.2 ab	0.0	0.0	0.0	0.0
2/1/2023	T2	8.3	65.0	17.8	8.3 ab	0.5 a	0.0	0.0	0.0	0.0
2/1/2023	T3	18.7	58.1	18.3	4.7 a	0.1 a	0.0	0.0	0.0	0.0
2/1/2023	T4	14.5	49.6	15.9	13.0 b	6.9 b	0.0	0.0	0.0	0.0
2/8/2023	T1	5.9	45.7	21.1	17.3	8.9 b	1.0	0.1	0.0	0.0
2/8/2023	T2	4.6	44.6	21.7	23.0	5.1 a	0.8	0.2	0.0	0.0
2/8/2023	T3	6.2	46.4	25.6	17.2	4.6 a	0.0	0.0	0.0	0.0
2/8/2023	T4	0.7	45.8	19.3	18.6	10.6 b	4.2	0.7	0.0	0.0
2/15/2023	T1	0.0	14.2	21.6	32.7	19.9	9.5 ab	2.1 ab	0.0	0.0
2/15/2023	T2	0.0	18.5	24.0	29.9	19.9	6.7 a	0.5 a	0.5	0.0
2/15/2023	T3	1.1	13.0	27.1	37.5	14.2	6.4 a	0.7 ab	0.0	0.0
2/15/2023	T4	0.4	8.6	24.7	31.4	16.1	12.4 b	5.0 b	1.3	0.0
2/22/2023	T1	0.0	0.0	0.5	20.4 b	29.4	26.3	15.3 b	8.1 b	0.0
2/22/2023	T2	0.0	0.0	2.1	12.9 a	33.5	30.0	16.7 b	4.9 ab	0.0
2/22/2023	T3	0.0	0.0	3.6	31.7 b	33.6	21.6	8.3 a	1.2 a	0.0
2/22/2023	T4	0.0	0.1	0.7	26.8 b	26.4	26.3	18.7 b	1.0 a	0.0
3/14/2023	T1	0.0	0.0	0.0	0.0	0.0	0.0	24.3 b	75.6	0.1
3/14/2023	T2	0.0	0.0	0.0	0.0	0.0	0.0	19.6 a	80.4	0.0
3/14/2023	T3	0.0	0.0	0.0	0.0	0.0	0.0	22.2 ab	77.8	0.0
3/14/2023	T4	0.0	0.0	0.0	0.0	0.0	0.0	19.9 a	80.1	0.0
3/27/2023	T1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5	75.5 a
3/27/2023	T2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	80.4 b
3/27/2023	T3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.2	77.8 ab
3/27/2023	T4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	80.1 b

*Means with a common letter are not significantly different ($p > 0.05$)



Higher mean percentage value

Second-highest mean percentage value

Third-highest mean percentage value

Lower mean percentage value

Kee Crisp

Date	Treatment	S1	S2	S3	S4	S5	S6	S7	S8	S9
12/2/2022	T1	96.9 a	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/2/2022	T2	98.3 ab	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/2/2022	T3	97.9 a	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/2/2022	T4	97.1 b	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T1	48.1	51.9 a	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T2	42.2	57.8 b c	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T3	42.8	57.2 ab	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2022	T4	35.4	64.6 c	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/14/2022	T1	95.7 a	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/14/2022	T2	99.2 a	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/14/2022	T3	98.5 a	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/14/2022	T4	97.5 b	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T1	98.2 a	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T2	98.9 a	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T3	98.7 a	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/2023	T4	99.4 b	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T1	32.2	61.4 a	6.4	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T2	24.8	73.1 b	2.1	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T3	43.8	54.2 a	1.9	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2023	T4	33.9	65.1 b	0.9	0.0	0.0	0.0	0.0	0.0	0.0
1/26/2023	T1	53.9	31.7	14.4 ab	0.0	0.0	0.0	0.0	0.0	0.0
1/26/2023	T2	52.2	28.3	19.5 b	0.0	0.0	0.0	0.0	0.0	0.0
1/26/2023	T3	54.9	34.9	10.1 a	0.2	0.0	0.0	0.0	0.0	0.0
1/26/2023	T4	47.1	30.8	22.1 b	0.0	0.0	0.0	0.0	0.0	0.0
2/1/2023	T1	21.8	58.3 a	16.4 ab	3.5 ab	0.0	0.0	0.0	0.0	0.0
2/1/2023	T2	12.3	62.4 b	25.3 b c	0.0 a	0.0	0.0	0.0	0.0	0.0
2/1/2023	T3	25.1	59.8 a	14.9 a	0.2 a	0.0	0.0	0.0	0.0	0.0
2/1/2023	T4	11.6	55.0 b	24.9 c	8.4 b	0.0	0.0	0.0	0.0	0.0
2/8/2023	T1	3.5	58.4	24.5 ab	12.8 a	0.8	0.0	0.0	0.0	0.0
2/8/2023	T2	2.4	59.7	26.5 b c	11.4 a	0.0	0.0	0.0	0.0	0.0
2/8/2023	T3	10.1	61.3	22.0 a	6.6 a	0.0	0.0	0.0	0.0	0.0
2/8/2023	T4	1.2	43.8	33.0 c	22.0 b	0.0	0.0	0.0	0.0	0.0
2/15/2023	T1	0.0	22.0 ab	36.4	26.6 ab	14.0 a	1.1	0.0	0.0	0.0
2/15/2023	T2	0.7	28.7 b c	27.8	34.0 b	8.8 a	0.0	0.0	0.0	0.0
2/15/2023	T3	1.4	37.6 c	30.1	21.5 a	8.9 a	0.5	0.0	0.0	0.0
2/15/2023	T4	0.0	15.6 a	31.1	28.4 b	23.6 b	1.2	0.0	0.0	0.0
2/22/2023	T1	0.0	2.6	19.5	31.1 a	31.3 b	14.9 a	0.6	0.0	0.0
2/22/2023	T2	0.0	4.5	16.9	40.0 b	26.6 a	12.0 a	0.0	0.0	0.0
2/22/2023	T3	0.0	5.1	30.0	30.5 a	24.0 a	10.3 a	0.0	0.2	0.0
2/22/2023	T4	0.0	1.7	12.9	31.0 ab	29.6 b	24.4 b	0.4	0.0	0.0
3/27/2023	T1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.9 a	32.1
3/27/2023	T2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.1 b	27.9
3/27/2023	T3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.0 a	30.0
3/27/2023	T4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.5 b	18.5

Higher mean percentage value

Second-highest mean percentage value

Third-highest mean percentage value

Lower mean percentage value

*Means with a common letter are not significantly different ($p > 0.05$)

*These tables show the growth stages where significant differences were identified between the analyzed dates as determined by the Kruskal Wallis test (based on **medians**).

*The tables are represented by the **means** (average of flower buds) for each treatment and date.

*As this experiment was analyzed based on **medians,** and we represent them as **means**, some differences may not correspond to the mean values.

*Red-colored letters indicates means that do not correspond to the median analysis.

GENERAL REMARKS

- Reducing P fertilization could be a possibility to reduce fertilizer cost.
- Pruning increased berry size without affecting yield, which can lead to premium prices.
- Ethephon delays bloom for ‘Georgia Dawn.’

TOPICS OF RESEARCH

- Calcium and Boron: relation with fruit quality and “black bud”
- Sap analysis
- Nutrient deficiencies
- Aluminum toxicity
- New amendments

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Georgia Blueberries

SWEET GEORGIA BLUES

QUESTIONS ?

UNIVERSITY OF GEORGIA
EXTENSION

Small Fruit Program (uga.edu)

Thank you!

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