Early-season flooding for insect pest control

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A century of flooding

- **1911**: the WSCGA annual meeting minutes detail the use of flooding to control “miller moths.”
- **The rub**: growers need to strike a balance between pest suppression and crop loss due to flooding injury.
- **Our objective**: document the degree of pest suppression and plant damage associated with a 30-40 hour spring flood, applied as close to bloom as possible

Hypotheses

- **Black-headed fireworm** (BHFW) and **cranberry fruitworm** (CFW) populations will be suppressed by the floods, such that densities will be equivalent to unflooded, sprayed beds.
- **Sparganothis** populations (Sparg) will not be suppressed (based on past lab data).
- **Vines will be "set back"** by the floods (based on years of observation by growers).

Large-scale field study initiated

- 46 beds across 11 Wisconsin marshes
- Replicated by site: 23 pairs of flooded/non-flooded beds
- 3 varieties: *Ben Lear*, *Stevens*, and *GH1*

Phenological stage: 90-95% roughneck
(early hooking at bed edges)

Complete submergence

Flood timing needed to be as late as possible (to allow BHFW eggs to hatch)

Site-specific DD accumulations ranged from 514 to 759 DDs (mean: 580 DDs)

Critical dates and DD totals

Site	BL	ST	GH1	Water up	Drained	Duration	BHFW DD s	GDDs
1		●	●	5/25/2011	5/26/2011	32	372	514
2		●	●	5/25/2011	5/27/2011	45	372	514
3	●		●	5/25/2011	5/27/2011	43	372	514
4	●			5/25/2011	5/27/2011	48	379	524
5			●	5/26/2011	5/27/2011	31	349	511
6	●	●		5/26/2011	5/27/2011	30	372	514
7		●		5/30/2011	6/1/2011	46	418	594
8	●	●	●	6/1/2011	6/2/2011	42	466	650
9		●		6/3/2011	6/5/2011	31	510	702
10		●		6/2/2011	6/3/2011	36	482	670
11	●	●		6/5/2011	6/7/2011	30	560	759
Total/Ave						**37.5**	**418.81**	**582.18**

Field sampling methods

- Water sampling
  - Dissolved O_2
  - Temperature
  - Turbidity
  - pH
  - Hardness
- Insect sampling
  - Sweeps
  - Pheromone trapping
  - Berry collections
  - Dvac'ing
  - "Trash" collections
- Plant sampling
  - Chlorophyll
  - Upright lengths
  - Hooks
  - Flowers
  - Harvest

Flood durations ranged from 31 to 48 hours—temperature and dissolved O_2 were measured at start/end of floods

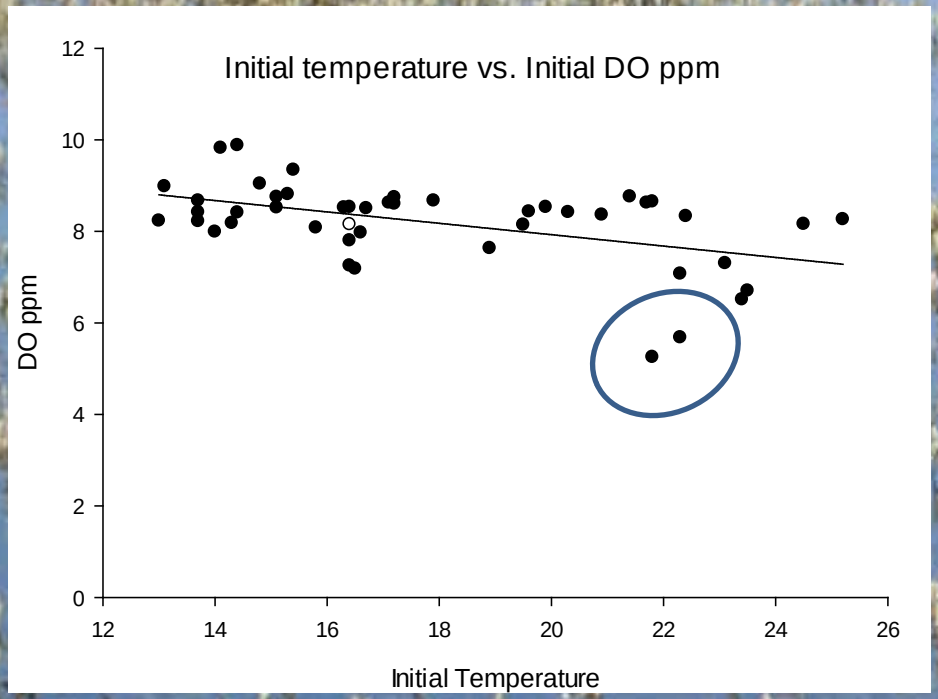
Wisconsin floodwater characteristics

	Initial	Final	*P*
Temperature (°C)	17.90 (64.2°F)	18.64 (65.4°F)	0.066
DO (ppm)	**8.18**	**7.70**	**0.048**
DO (% saturation)	86.20	81.81	0.140

Cool, well-oxygenated water flooded the marshes.

Cool, oxygenated water drained out, but outflow was significantly less oxygenated than inflow.

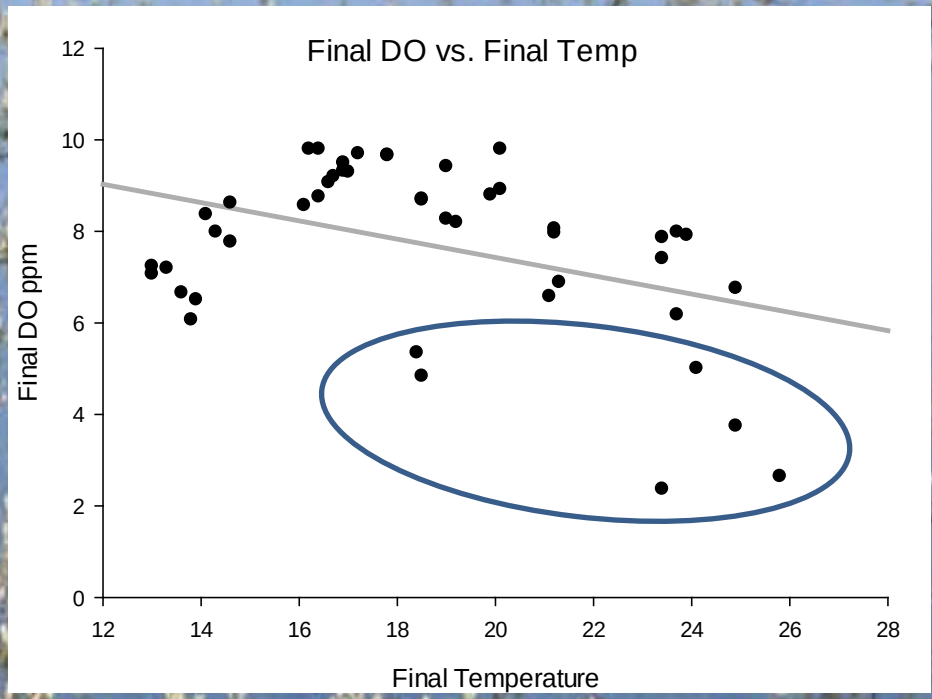
Initial



Initial DO ppm = 10.414 - (0.124 * Init temp)

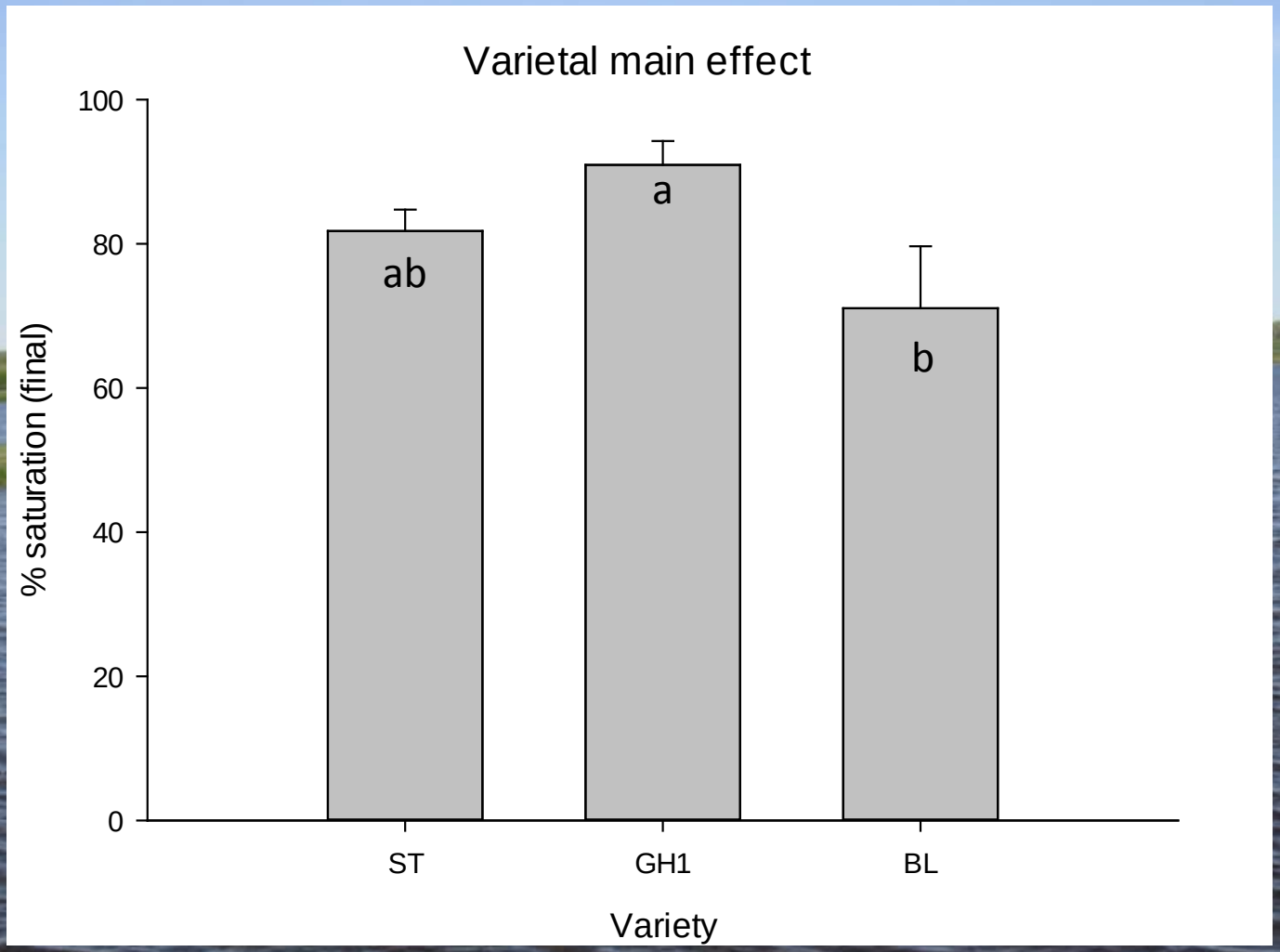
$R^2 = 0.238$ $P < 0.001$

Final



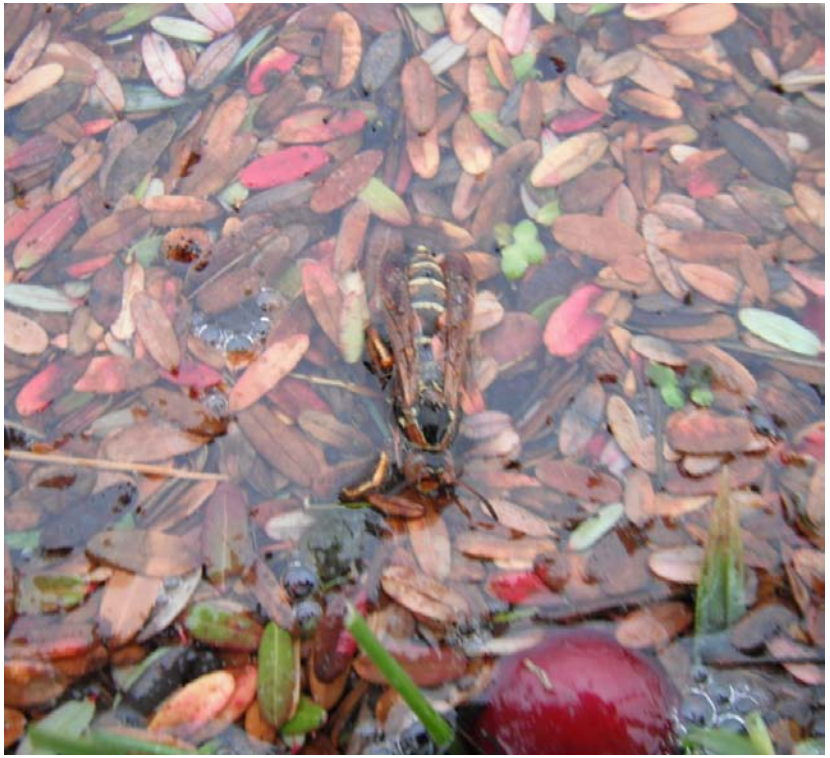
Final DO ppm = 11.426 - (0.200 * Final temp)

$R^2 = 0.163$ $P = 0.005$



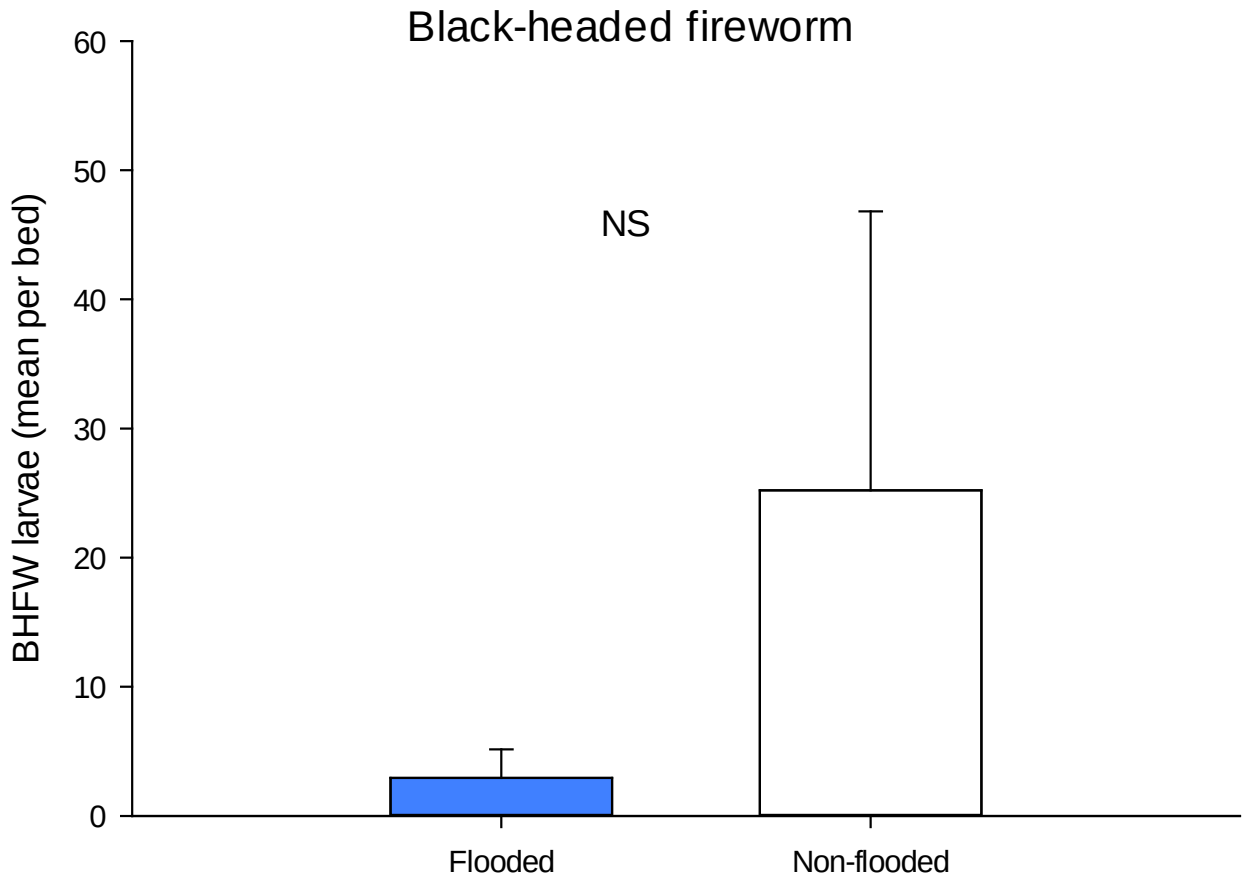
(Some beds consumed more O_2 than others)

Insect sampling

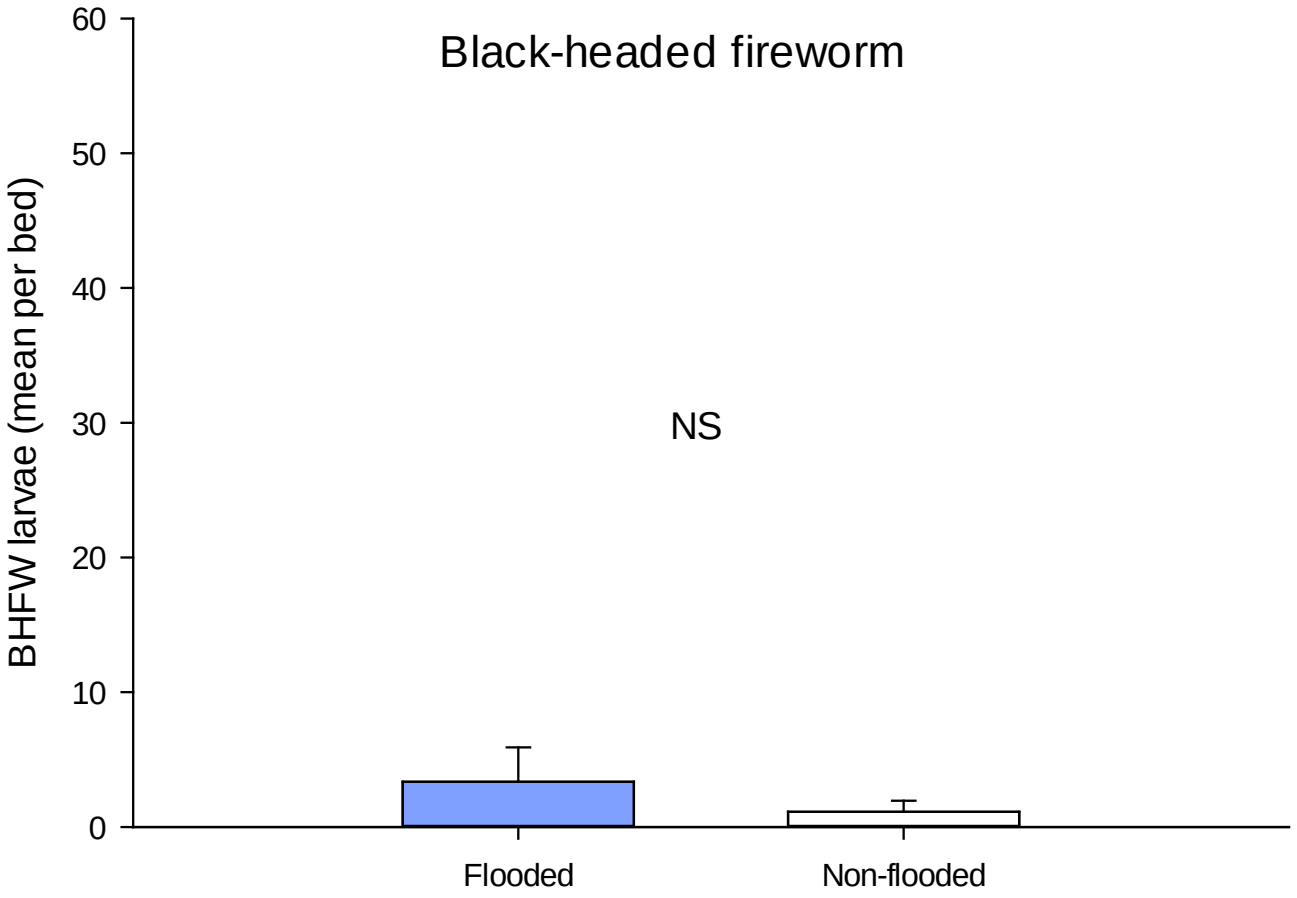


sweeps
pheromone trapping
berry scoring

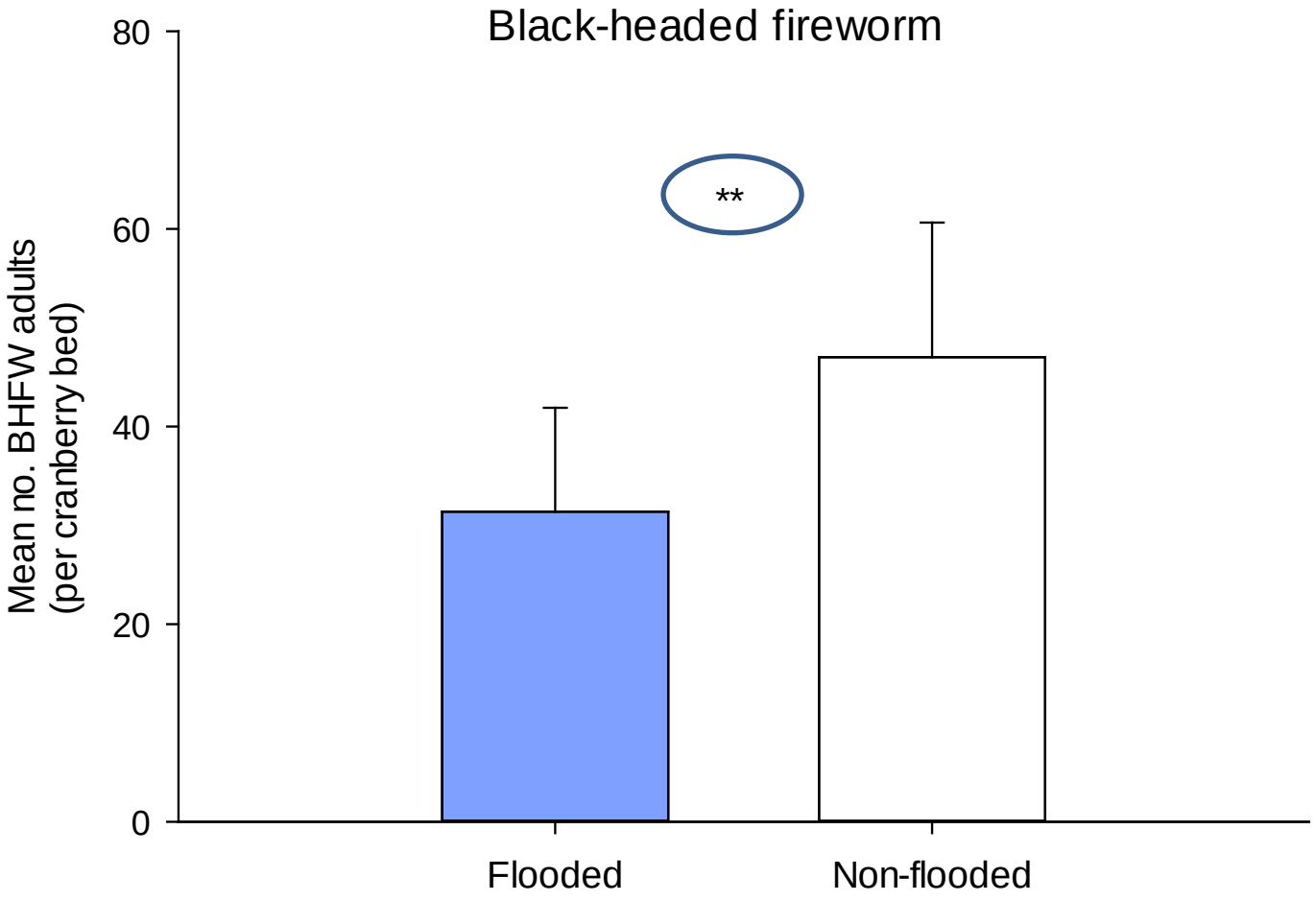
Black-headed fireworm (BHFW): sweeps Week 1 post-flood



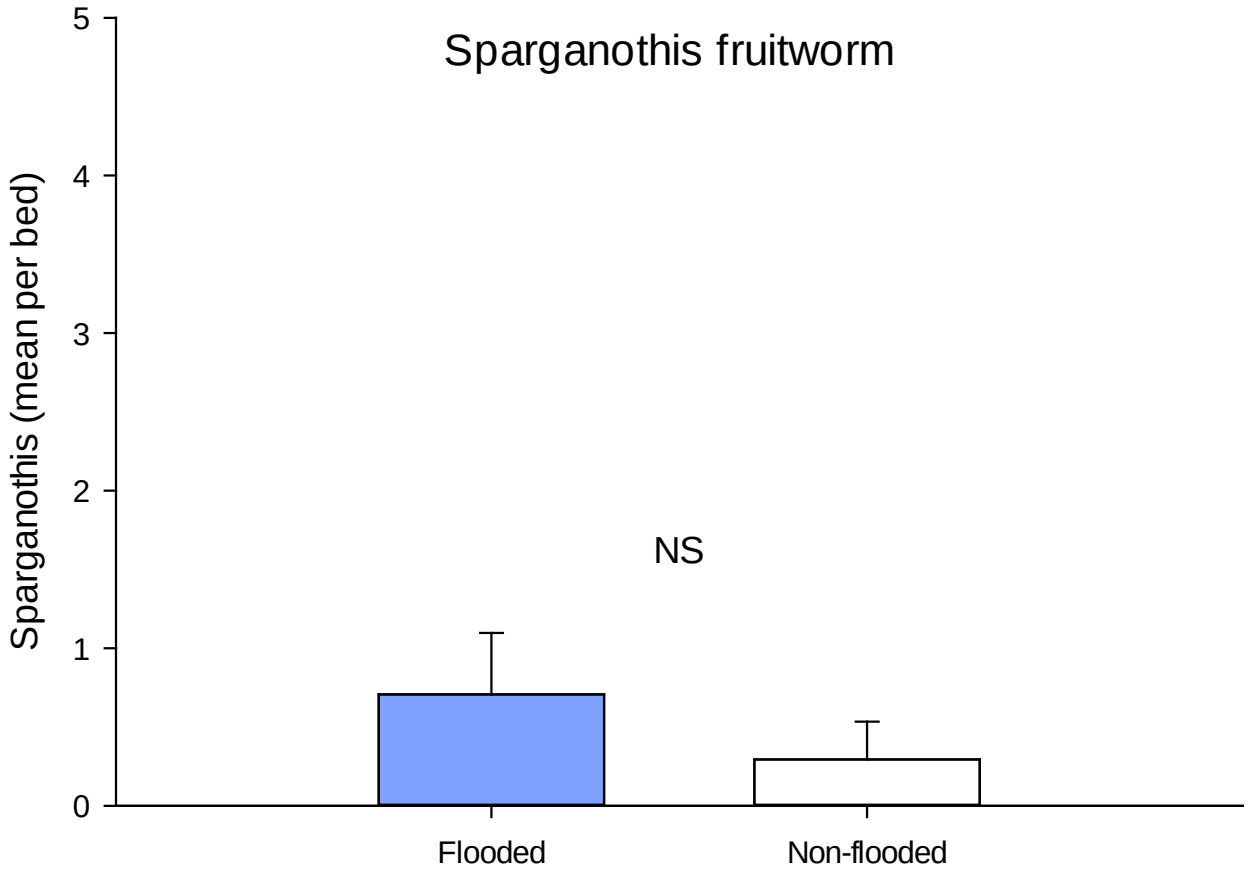
BHFW: sweeps
Week 2



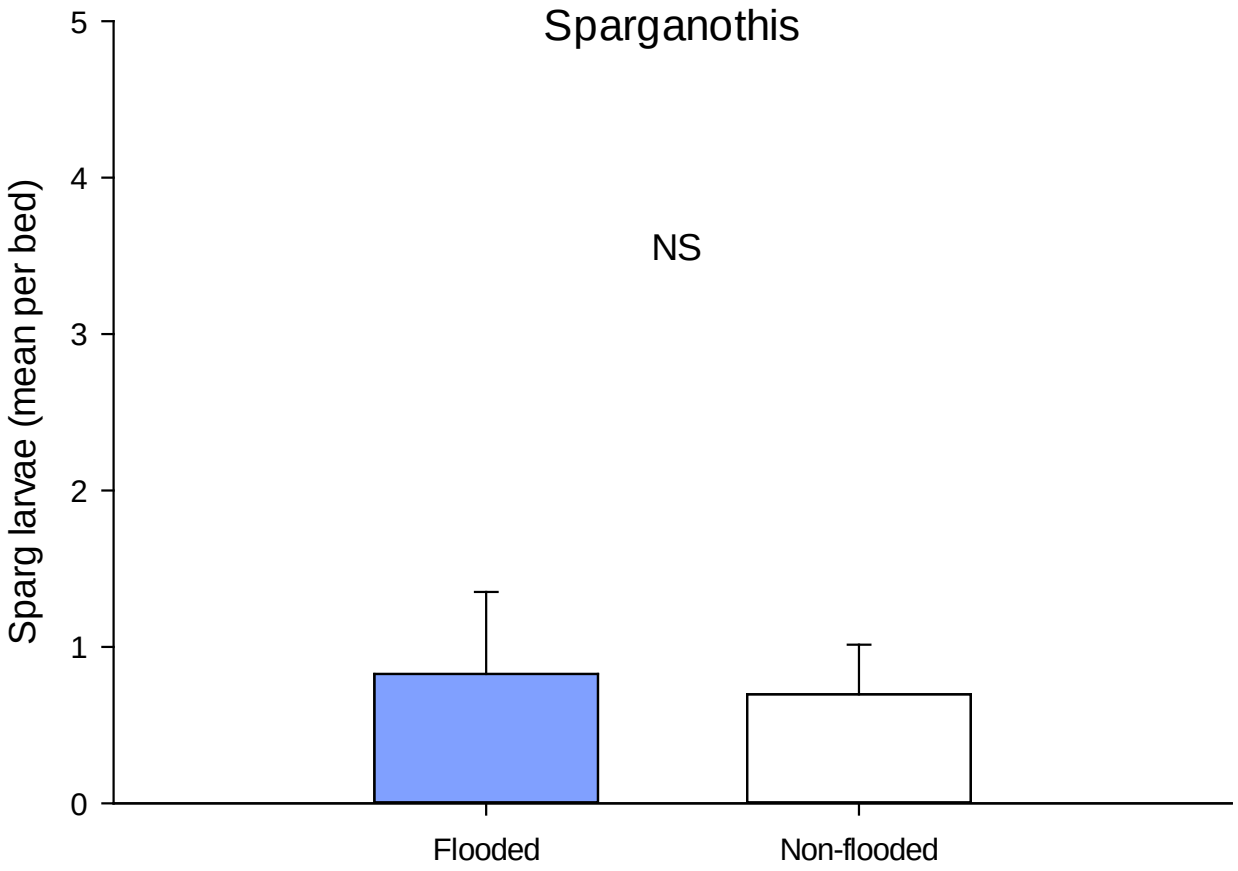
Pheromone-based trapping



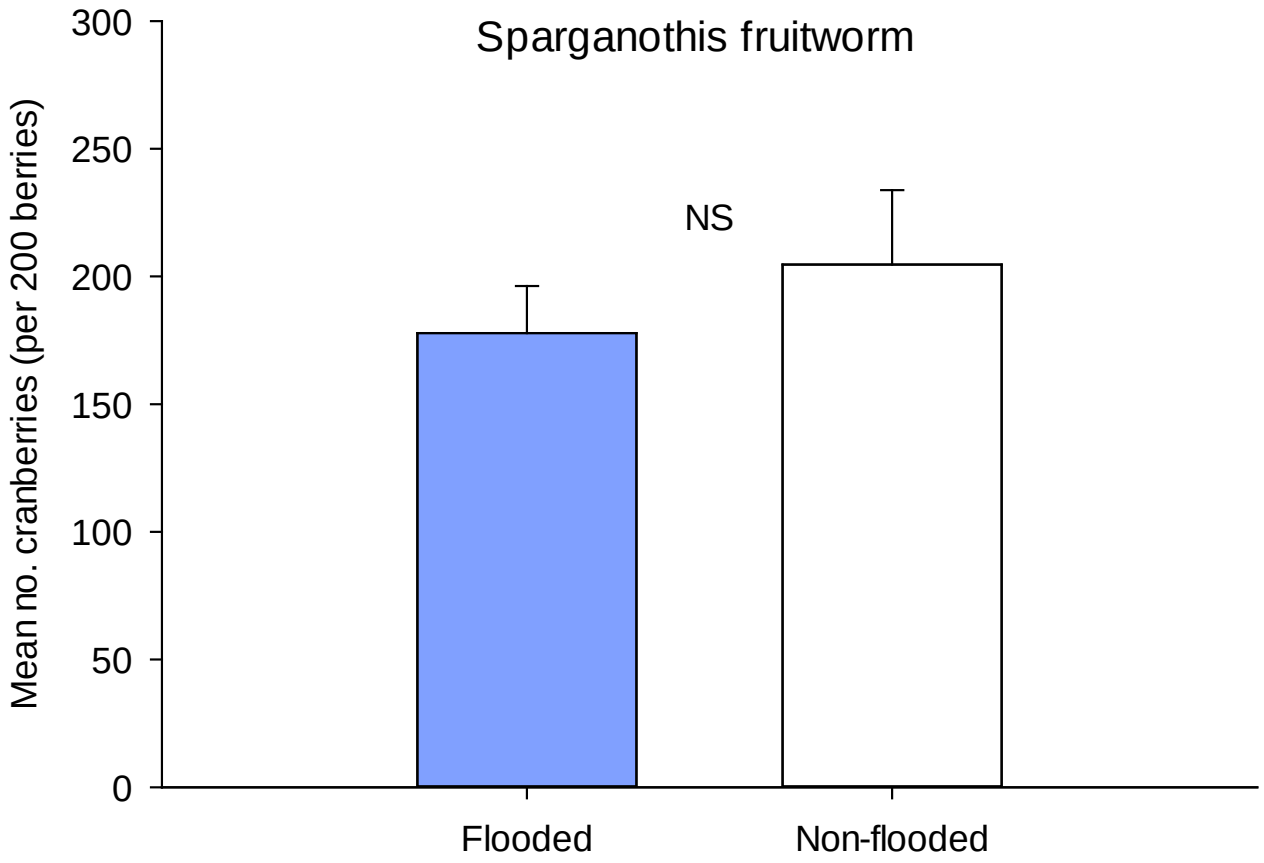
Sparganothis: sweeps
Week 1



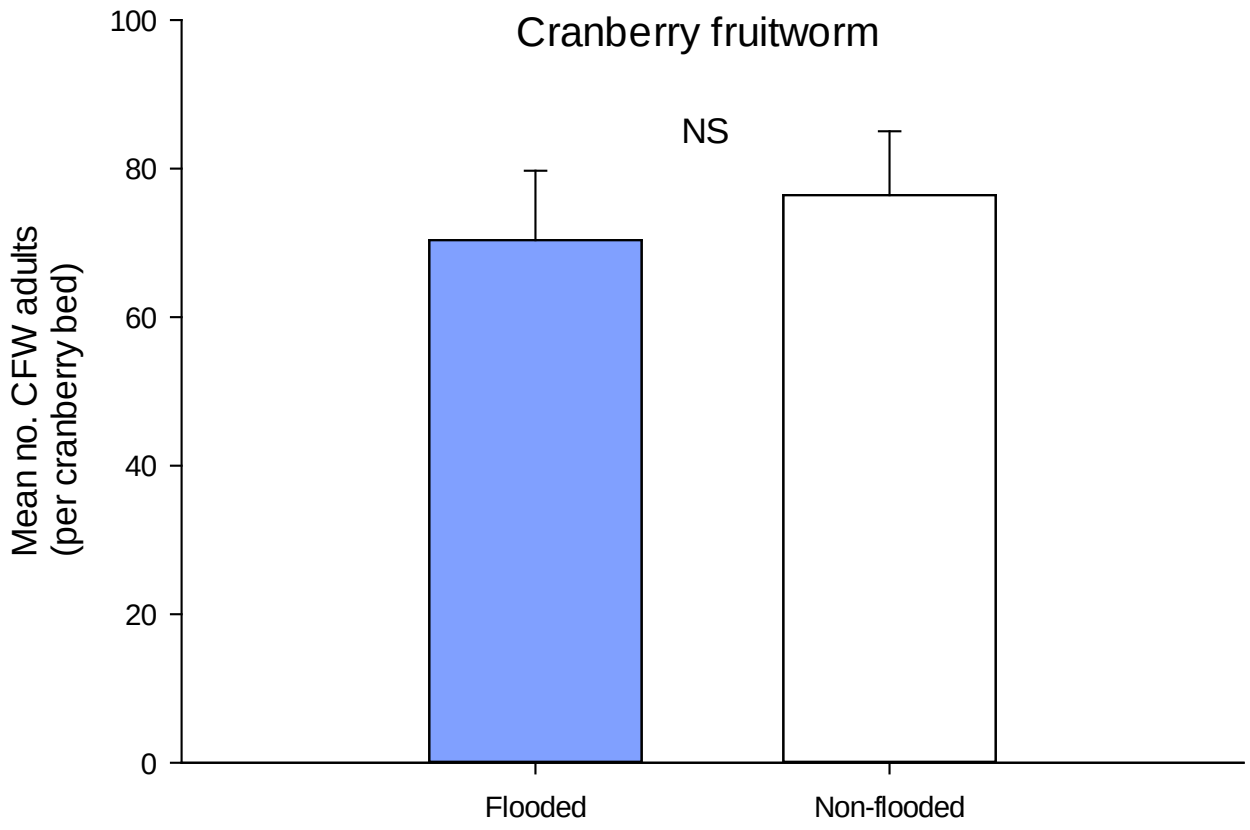
Sparganothis: sweeps
Week 2



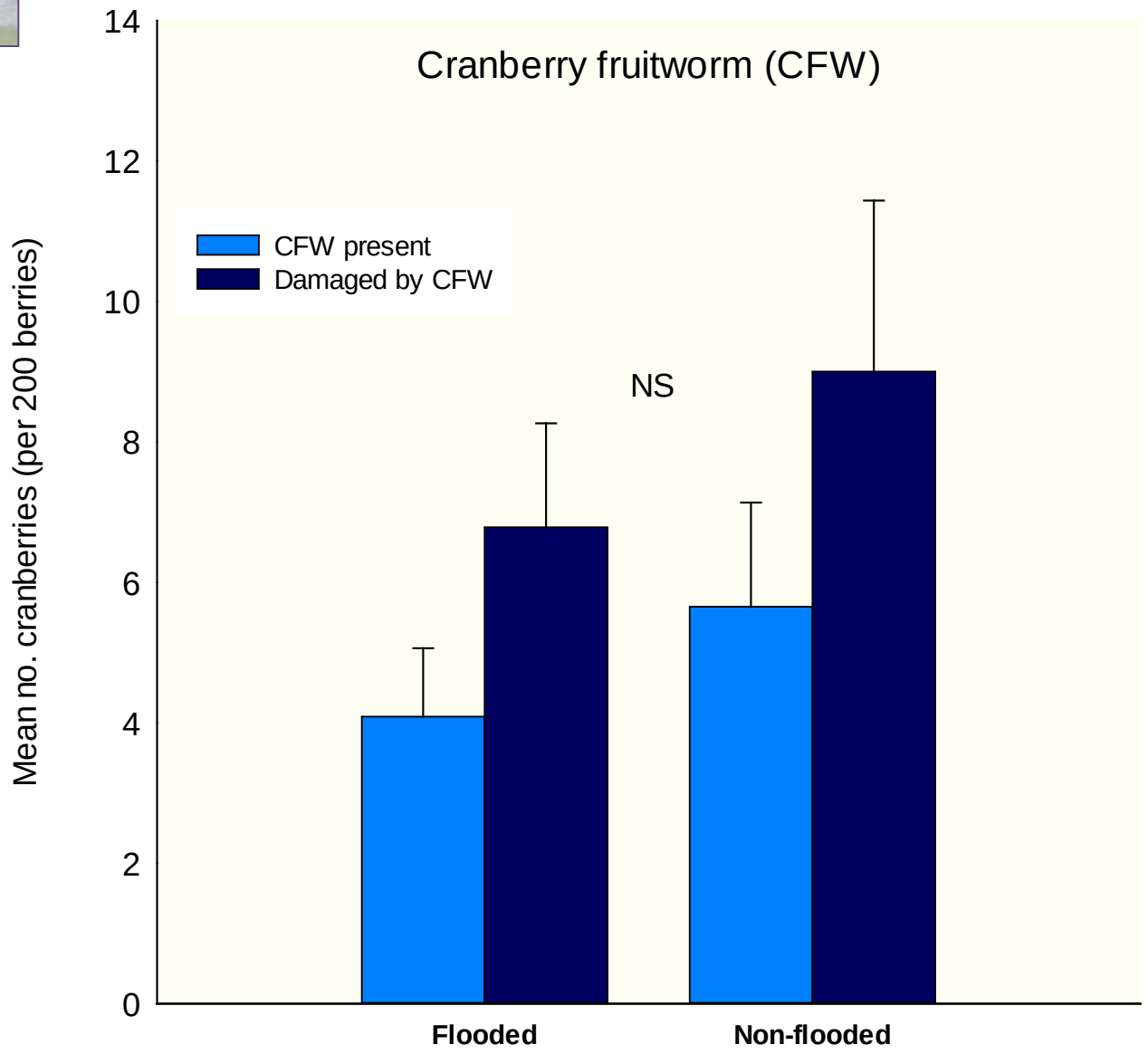
Pheromone-based trapping



Pheromone-based trapping



CFW Berry-scoring: 200 fruit/bed

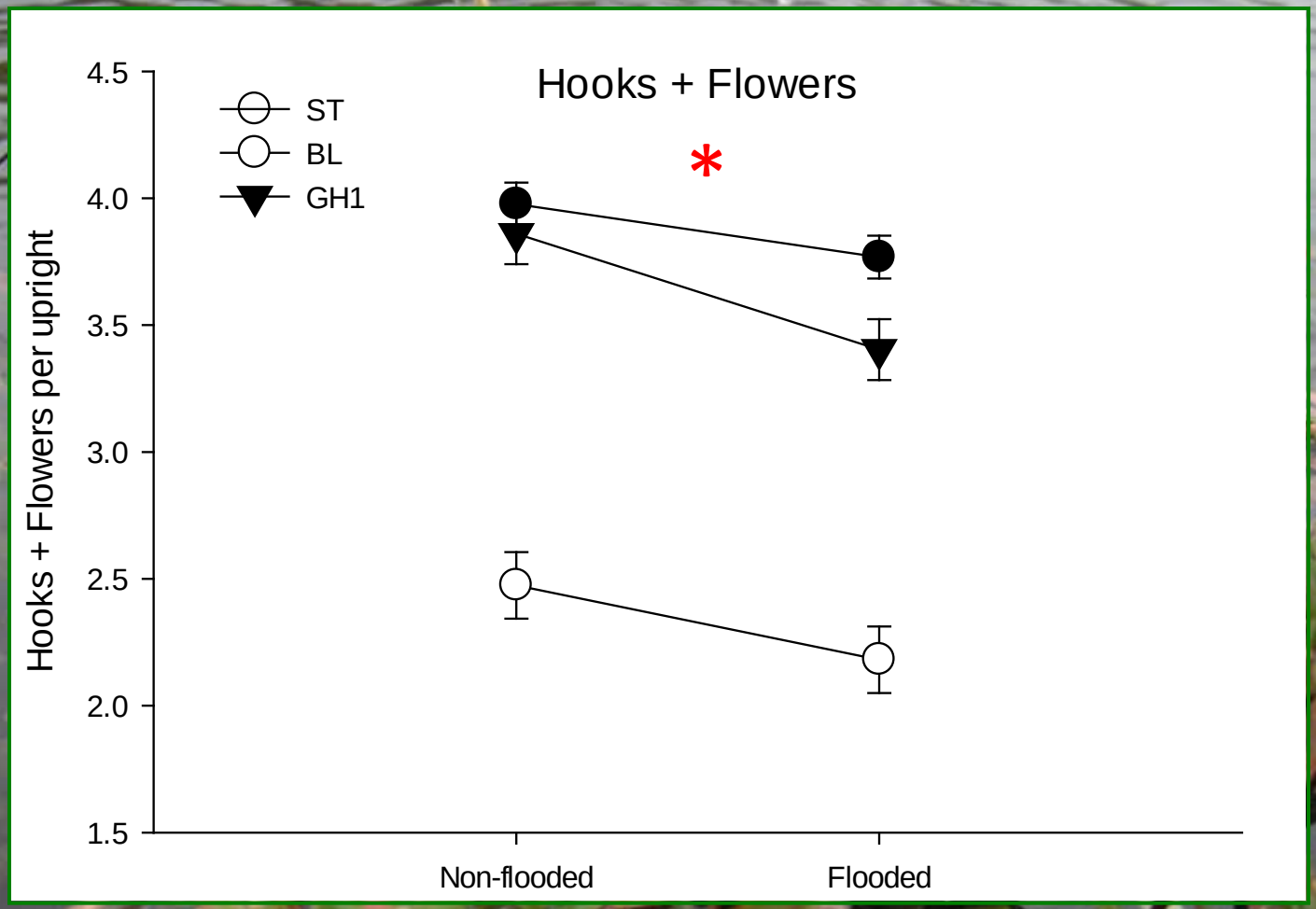

Cranberry fruitworm (CFW)
Mean no. cranberries (per 200 berries)
14
12
10
8
6
4
2
0
CFW present
Damaged by CFW
NS
Flooded
Non-flooded

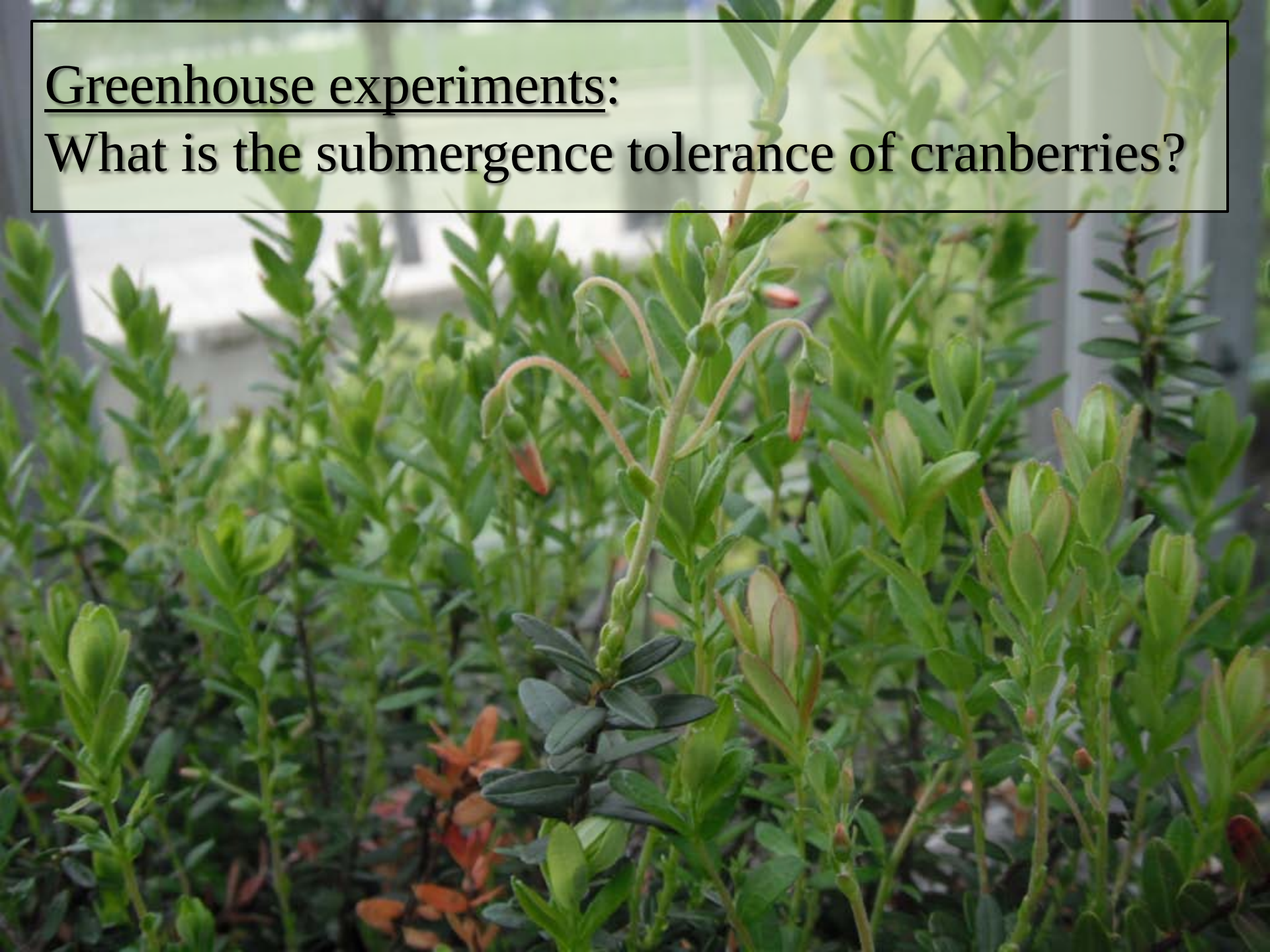
Plant sampling

Early-season:

	Flooded	Non-flooded	*P*
Week 1: Chlorophyll (SPAD)	**9.40**	**10.84**	**0.029**
Week 2: Upright lengths (mm)	45.36	46.65	0.342
Week 3: Hooks/upright	2.58	2.72	0.420
Week 4: Hooks + Flowers/upright	**3.83**	**4.16**	**0.016***

Variety P < 0.001
Flood P < 0.001
Var x Flood P = 0.487





Greenhouse experiments:

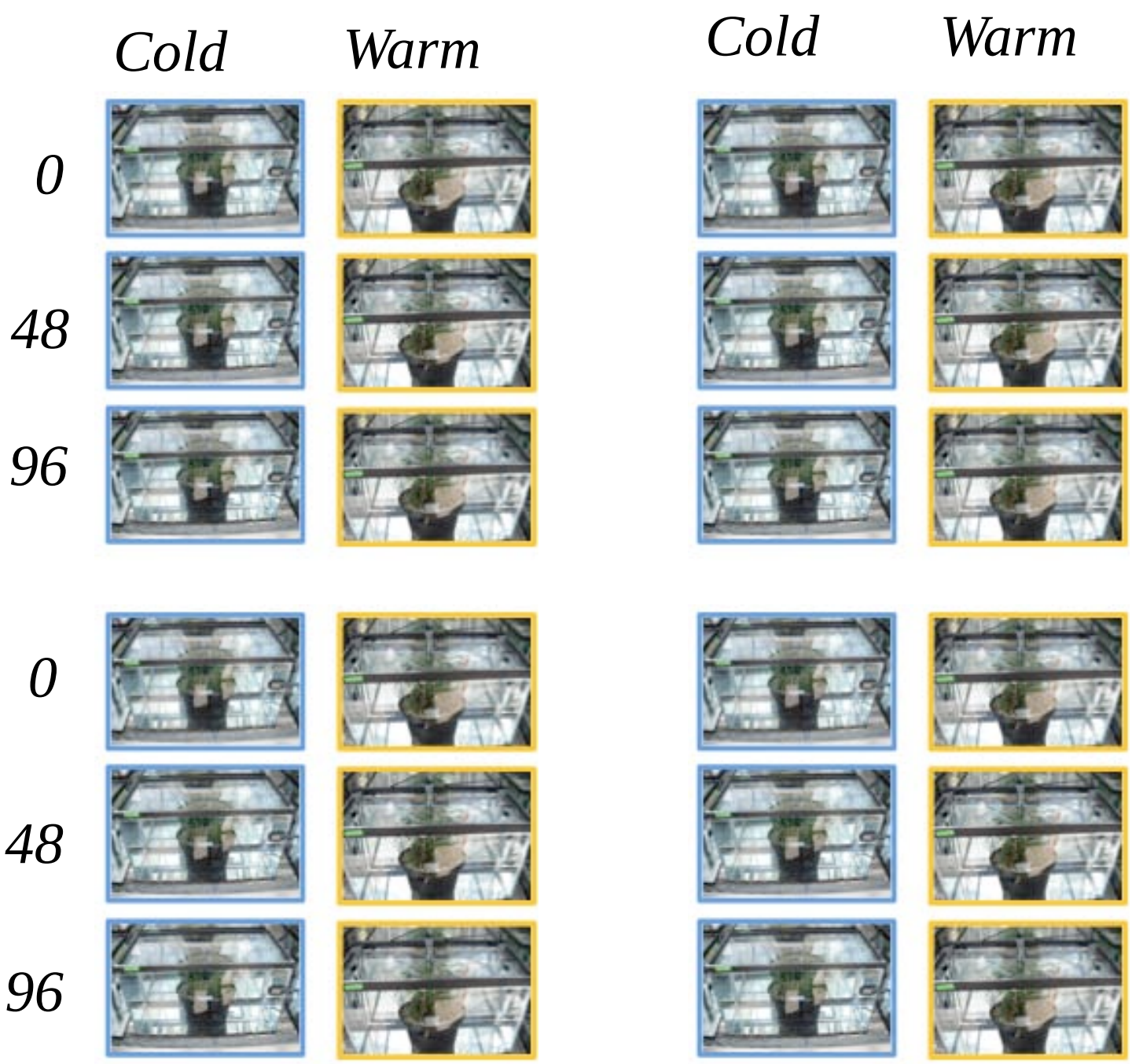
What is the submergence tolerance of cranberries?

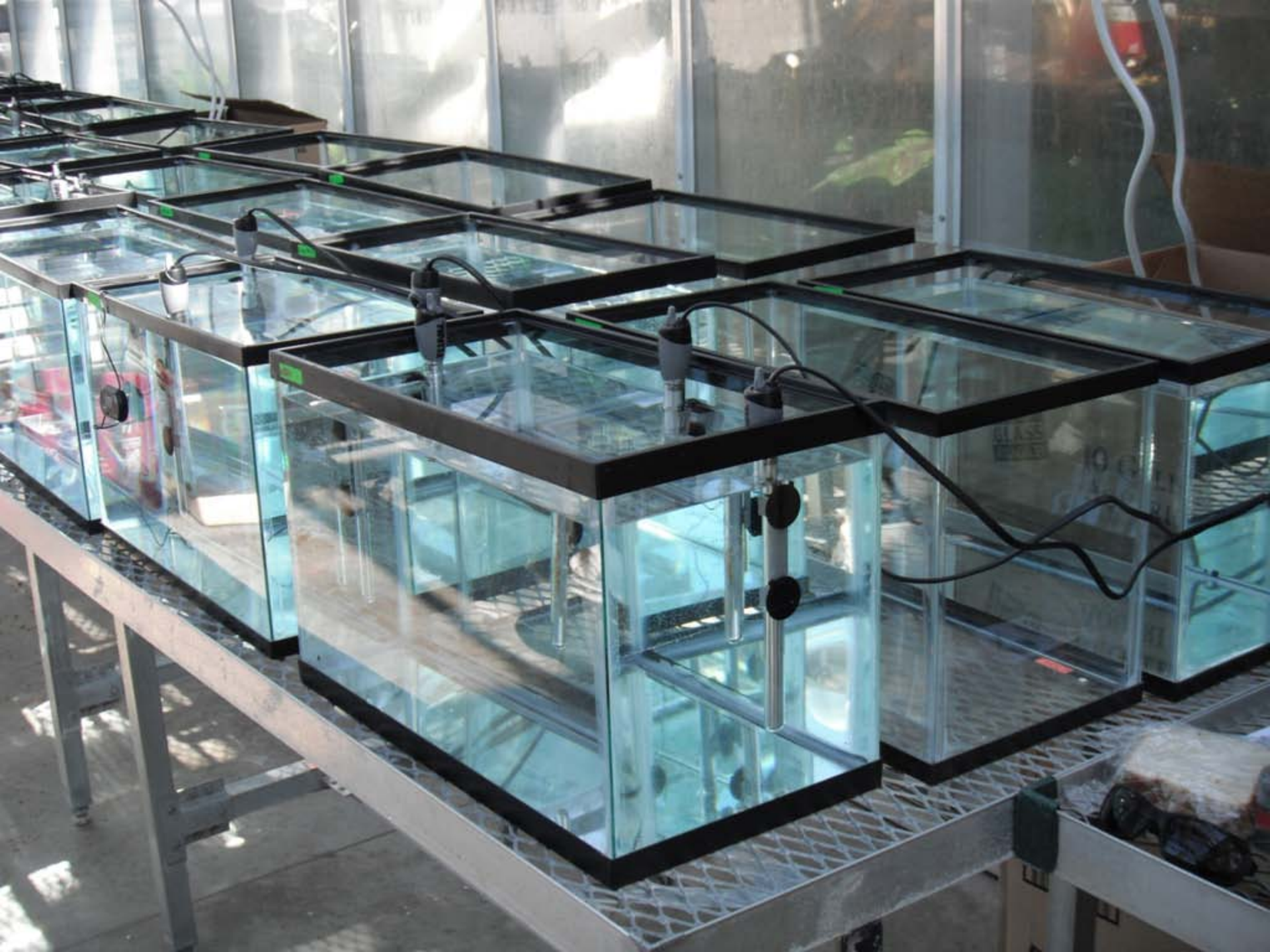
Potting up overwintered sods


COLD 96-1

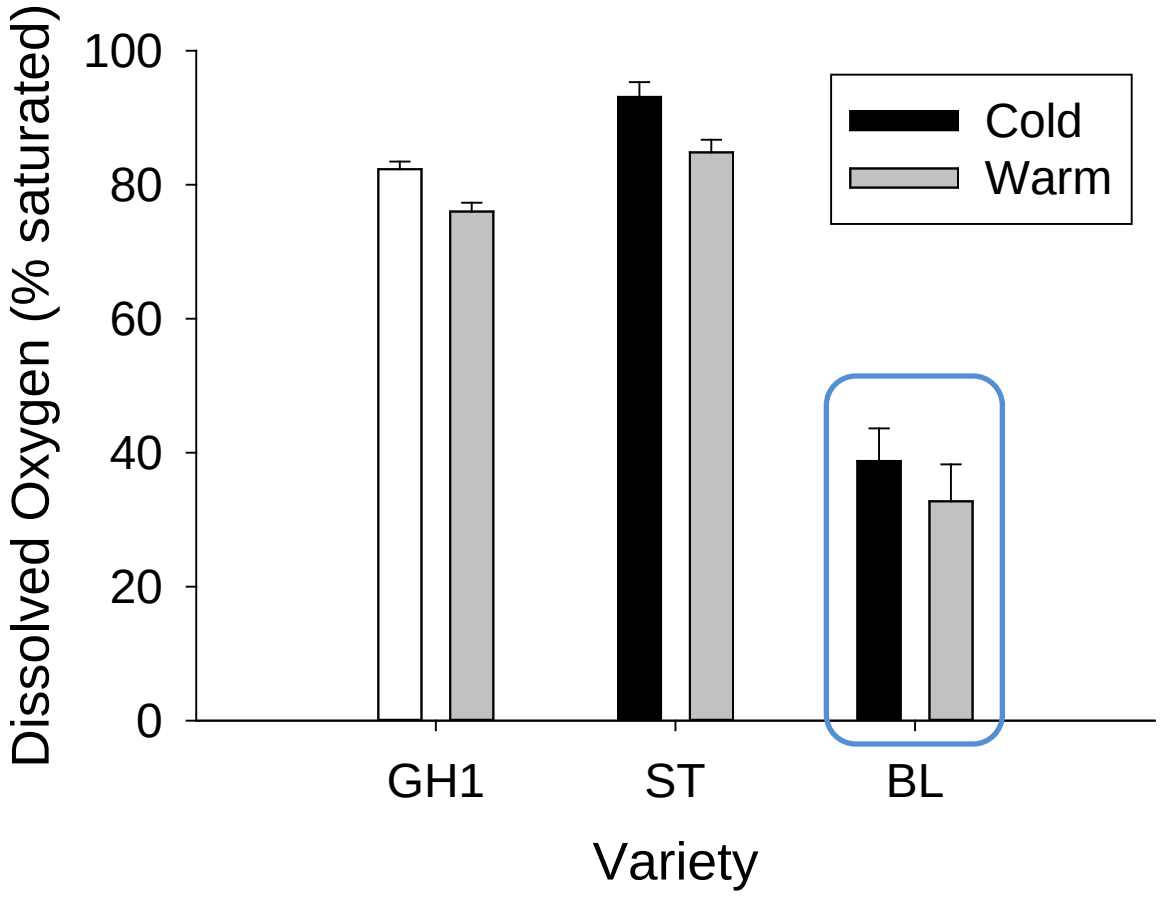
Temperature

Duration	*Cold*	*Warm*
0 hours		
48 hours		
96 hours		


Cold
Warm
Cold
Warm
0
48
96
0
48
96



Dissolved O_2



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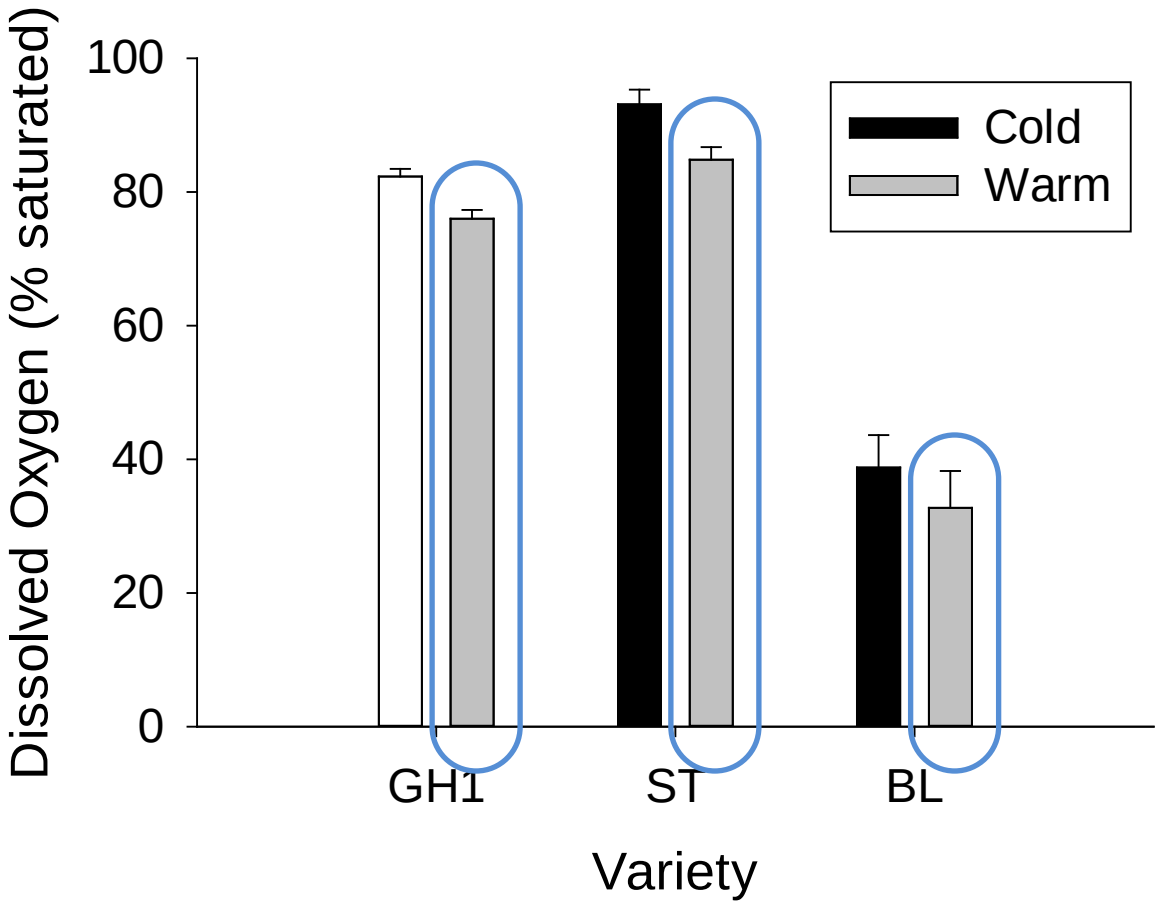
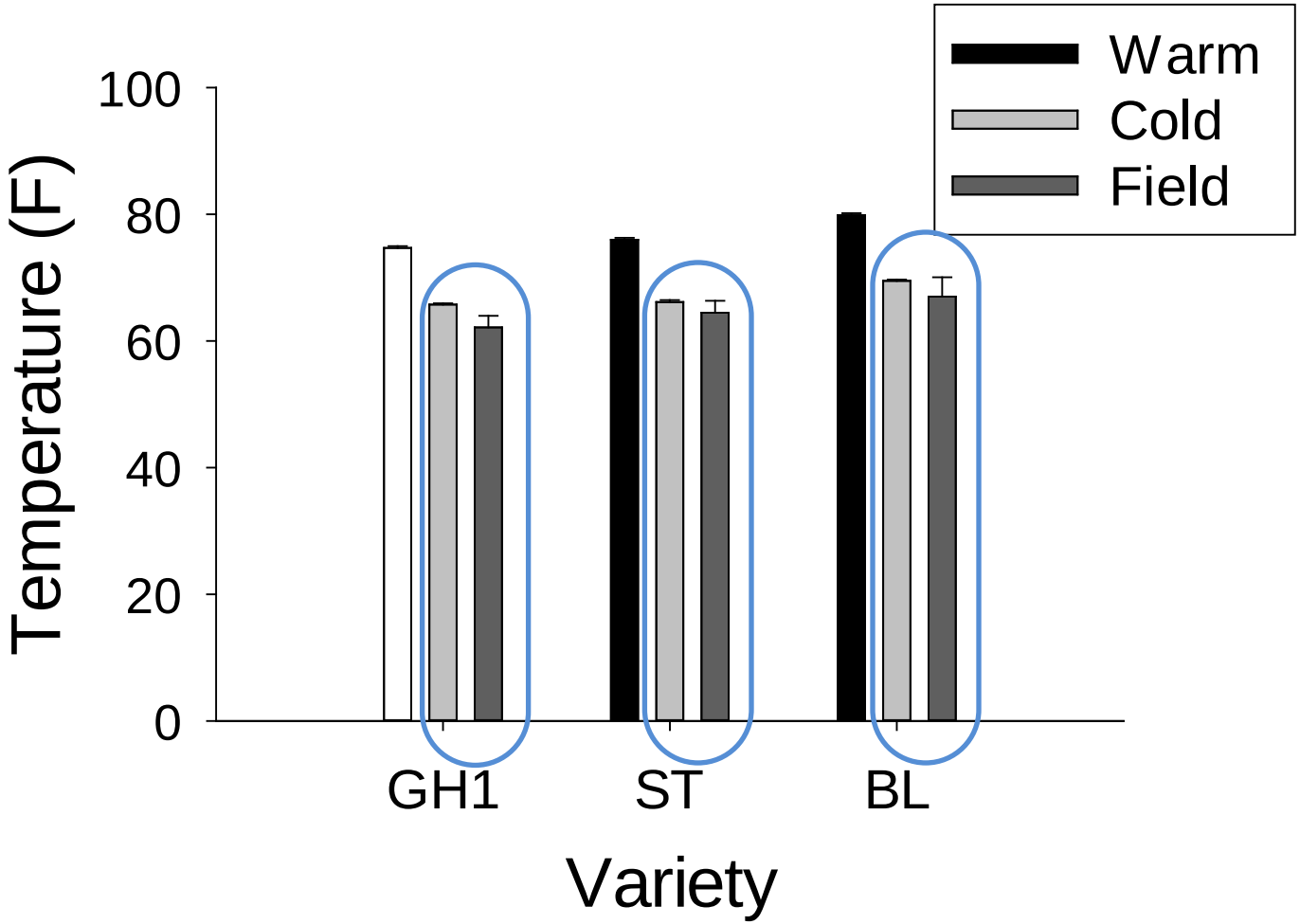
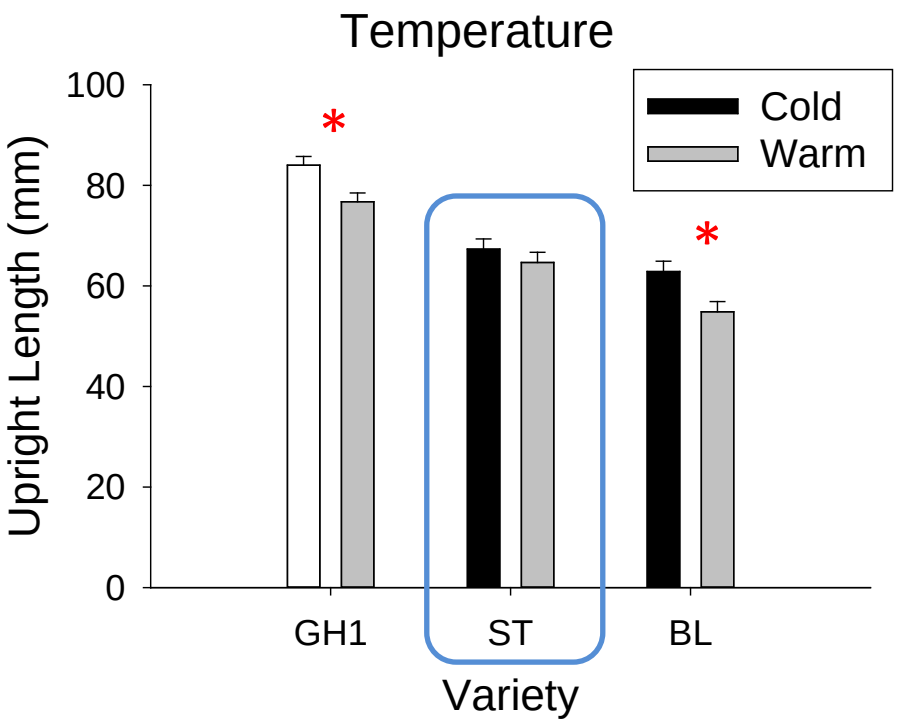
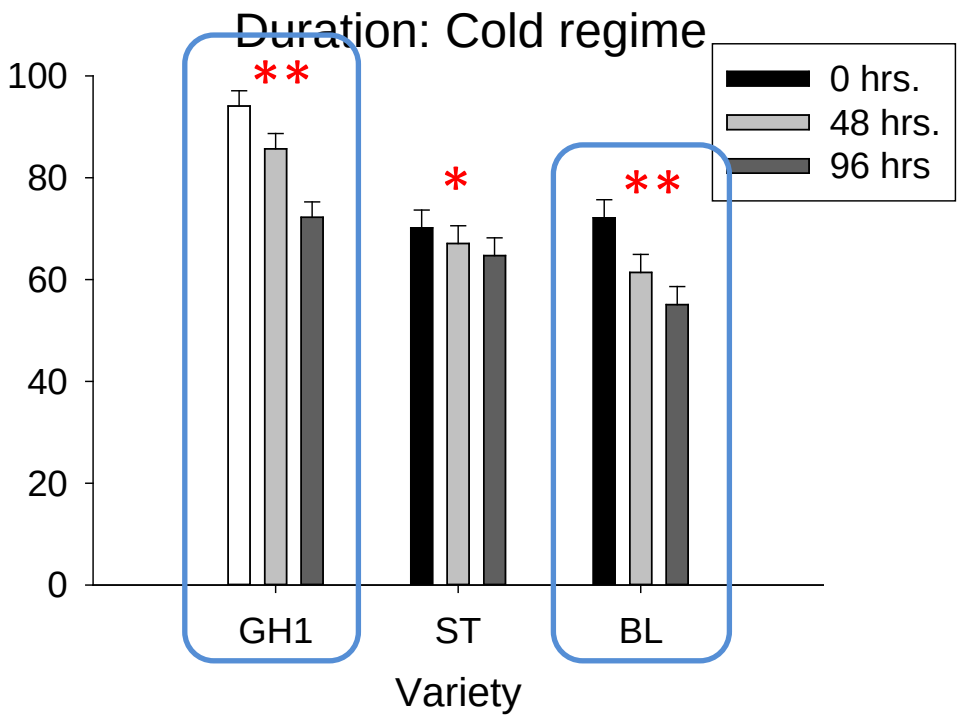


H_20 Temps: Greenhouse vs Field

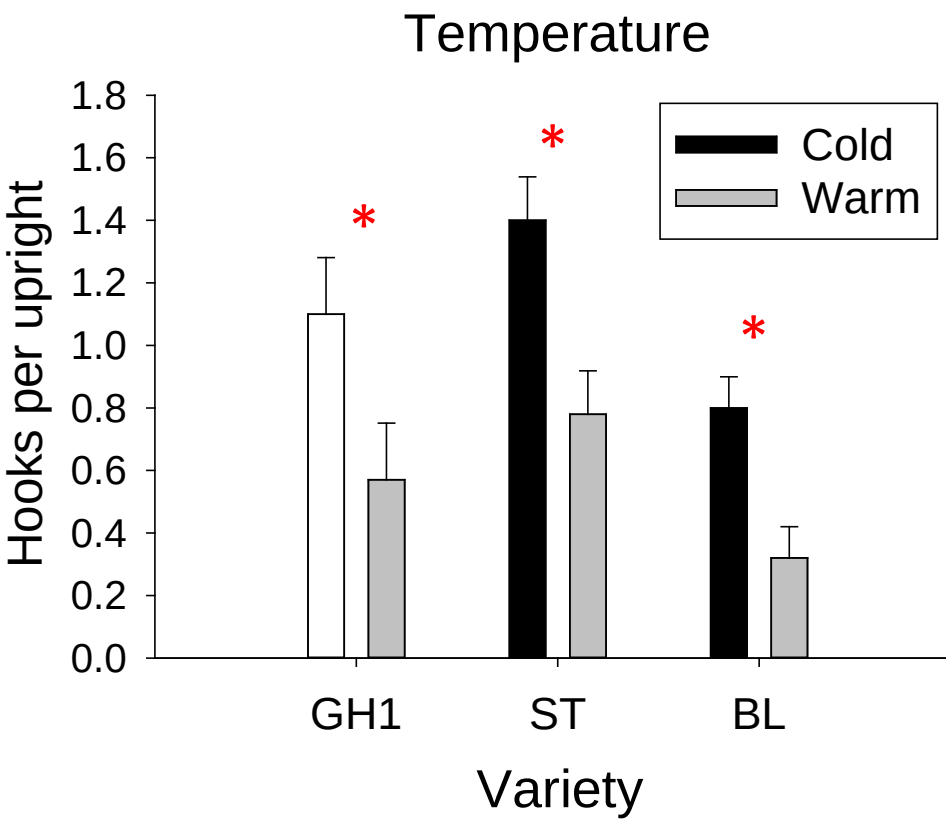


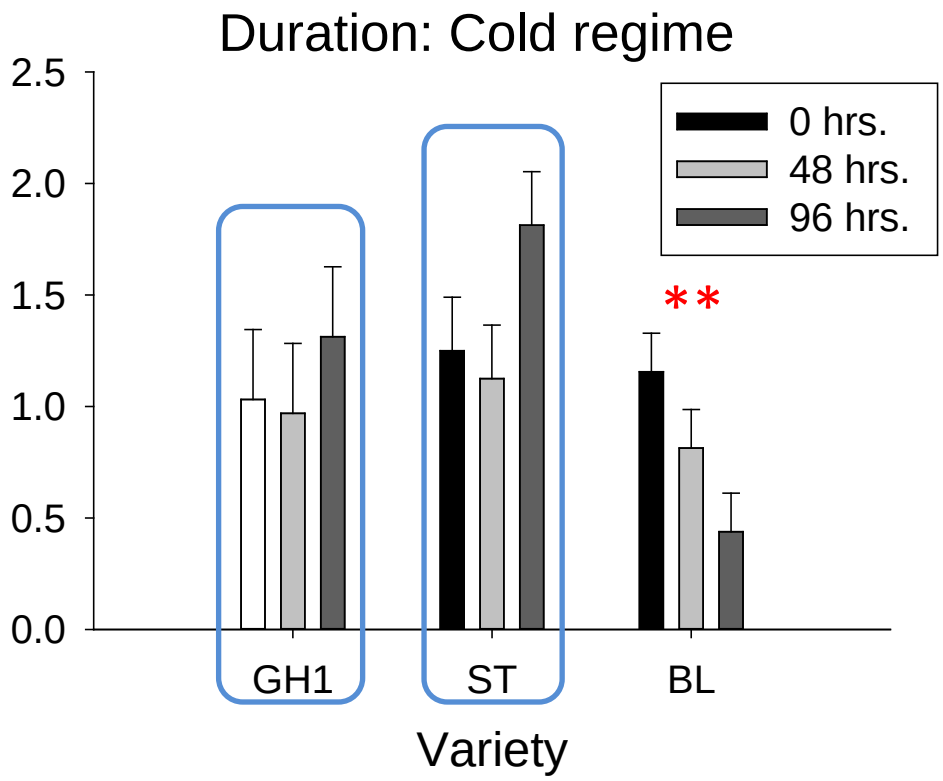
Upright length at 7 DAT



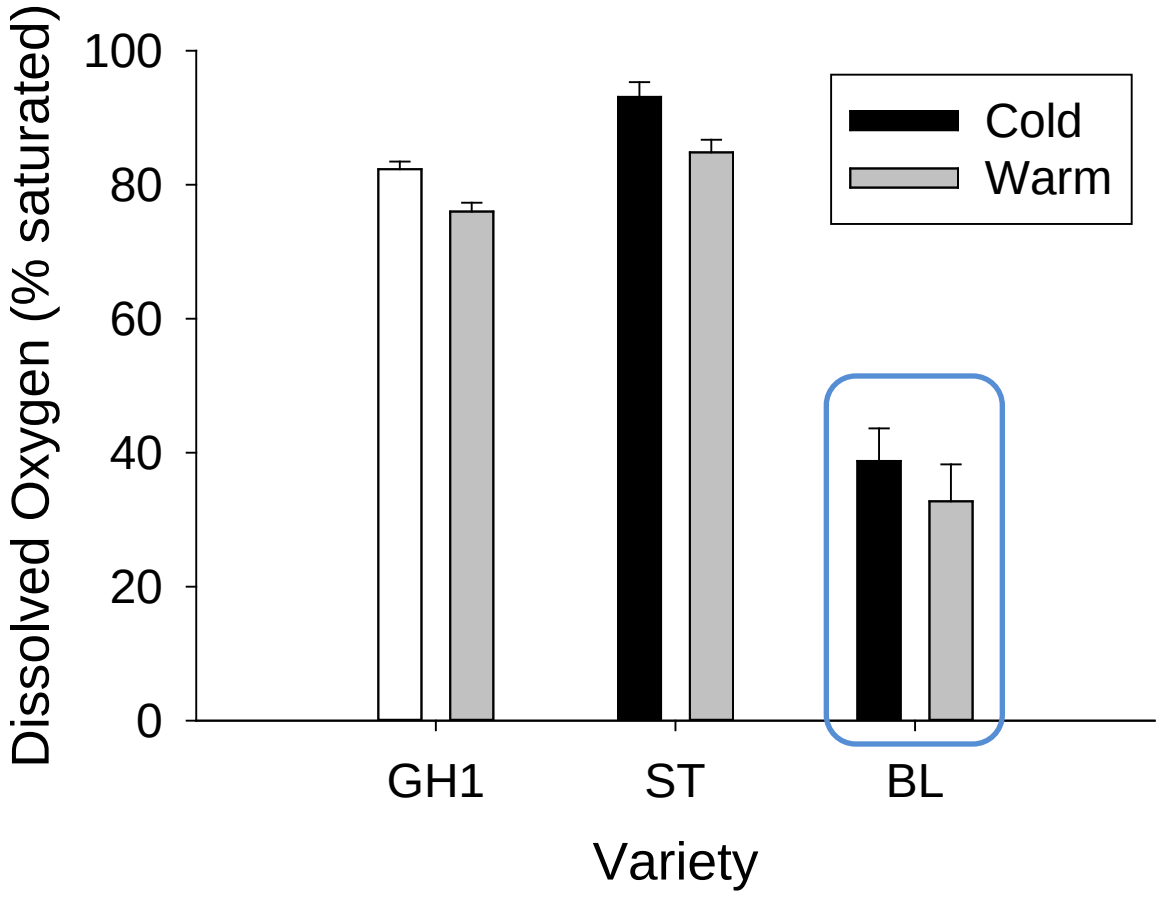


Hooks per upright at 49 DAT





Dissolved O_2



What did we learn?

1) **GH1** & **Stevens**: no effect at 48 or 96 hrs of flooding
2) **BL**: negatively affected at 48 and 96 hrs of flooding
3) **BL:** dissolved oxygen half that of **GH1** and **Stevens**

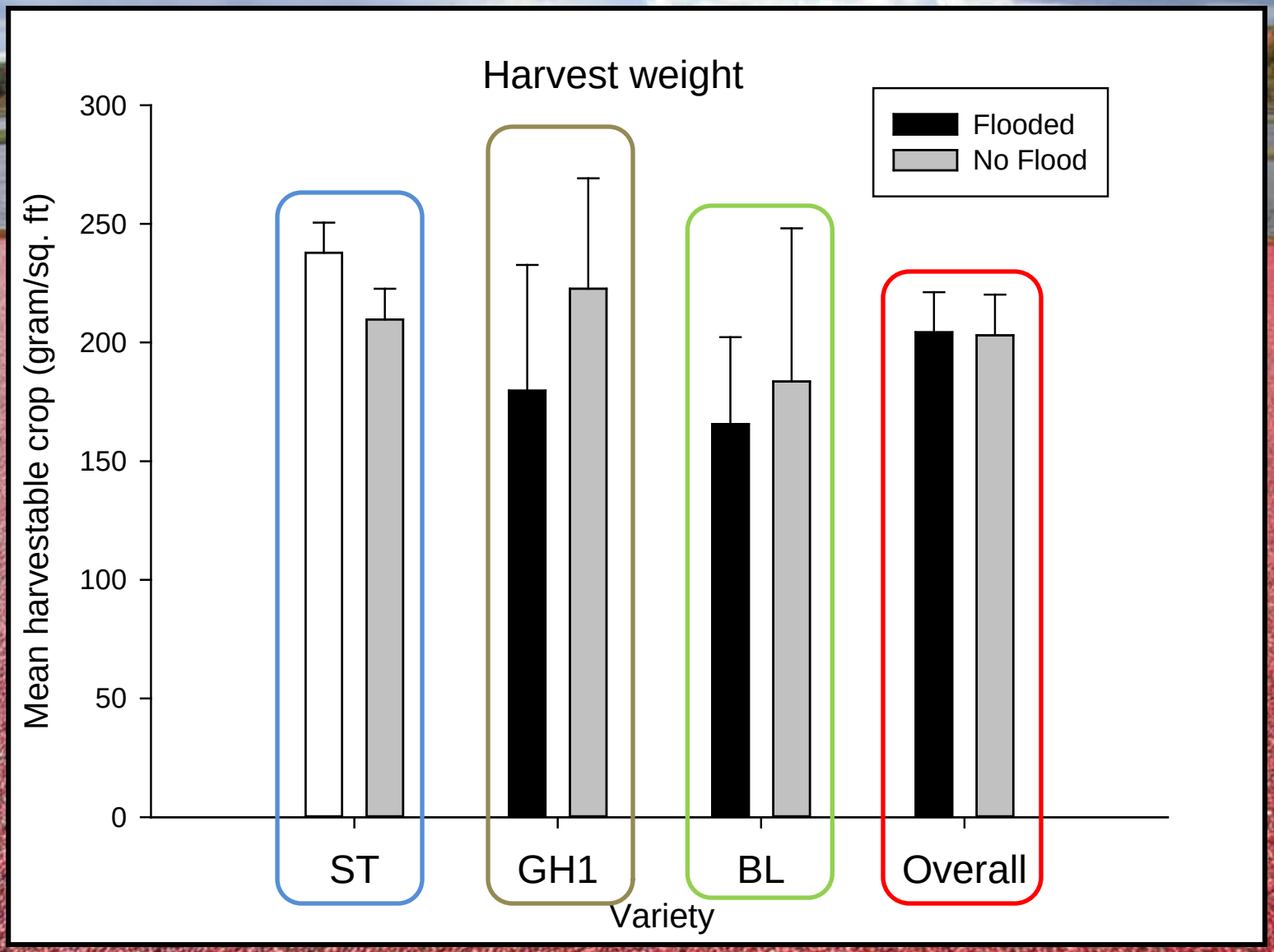
Conclusion	New question
In cold water, dissolved oxygen level—rather than duration of flood—determines effects on plant.	*Does age of bed affect oxygen levels in flood water?*

Harvest

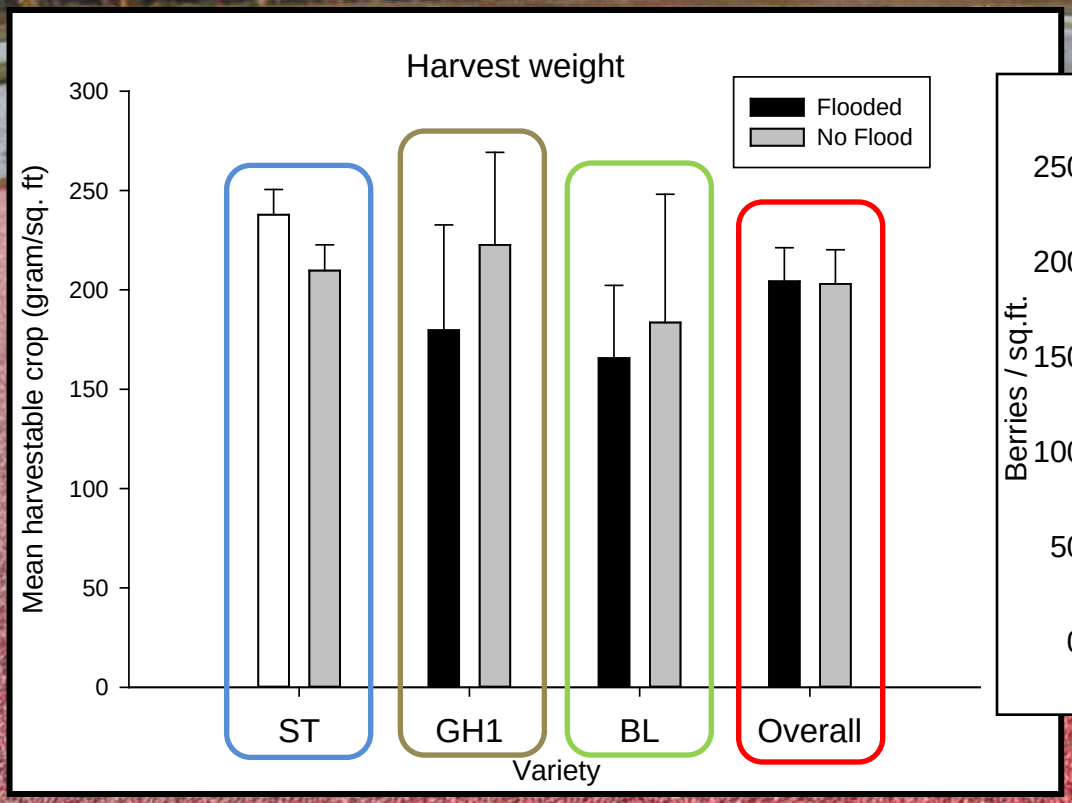
Harvest weight (grams/ft.^{2})

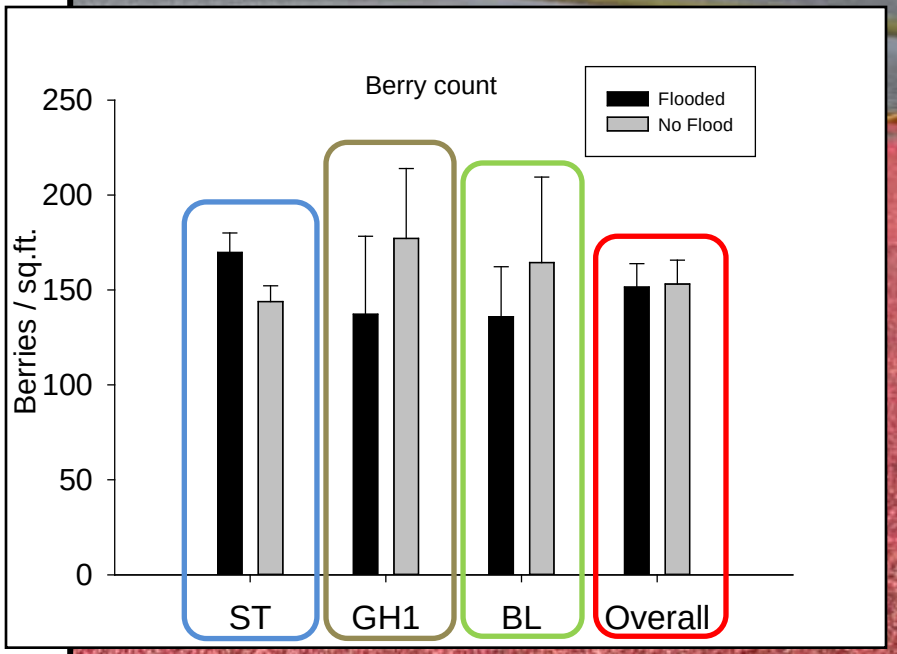
	Flooded	Non-flooded	*P*
Total weight (g/ft^2):	204.3	203.0	0.934
Berry count (per ft^2):	151.5	153.1	0.900
Per-berry weight	1.34	1.32	0.541

Harvest breakdown

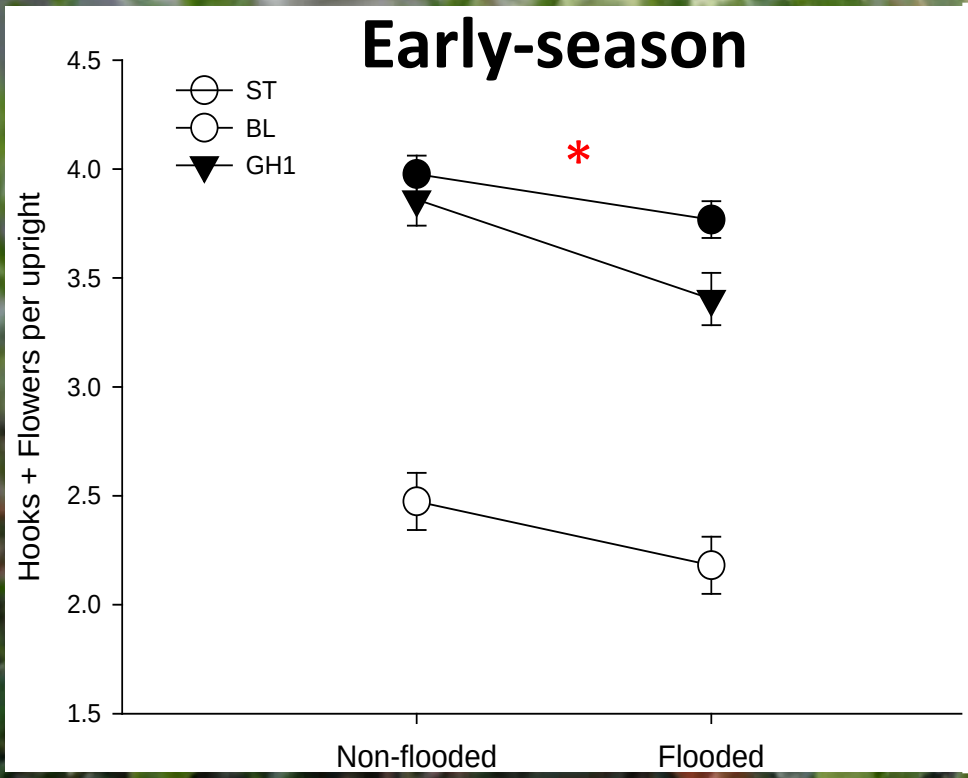


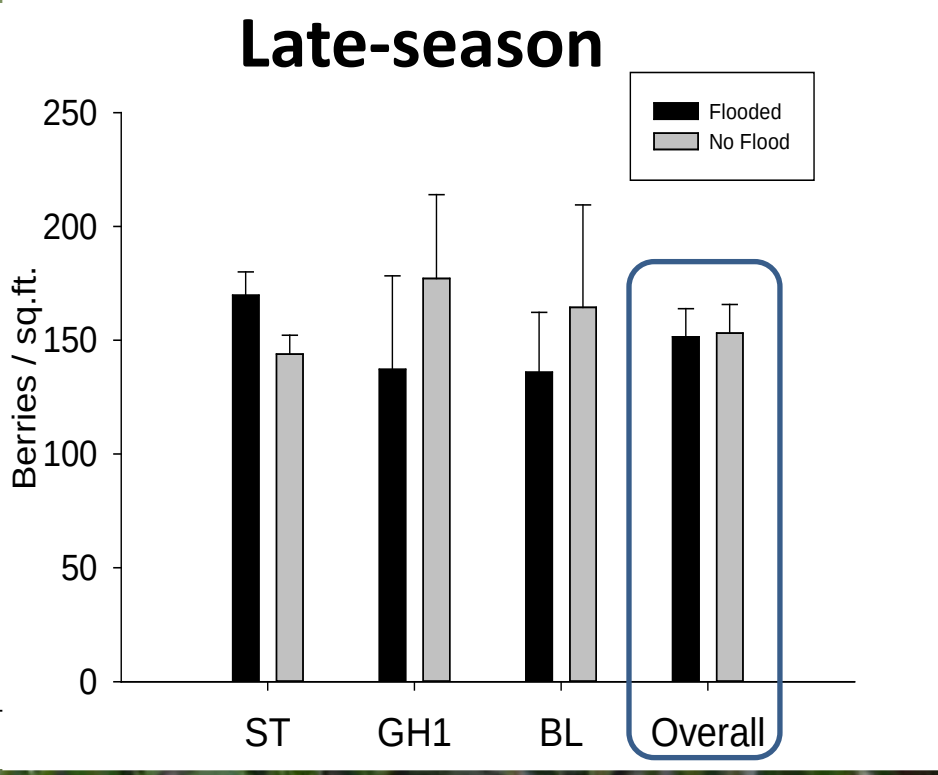
Harvest breakdown



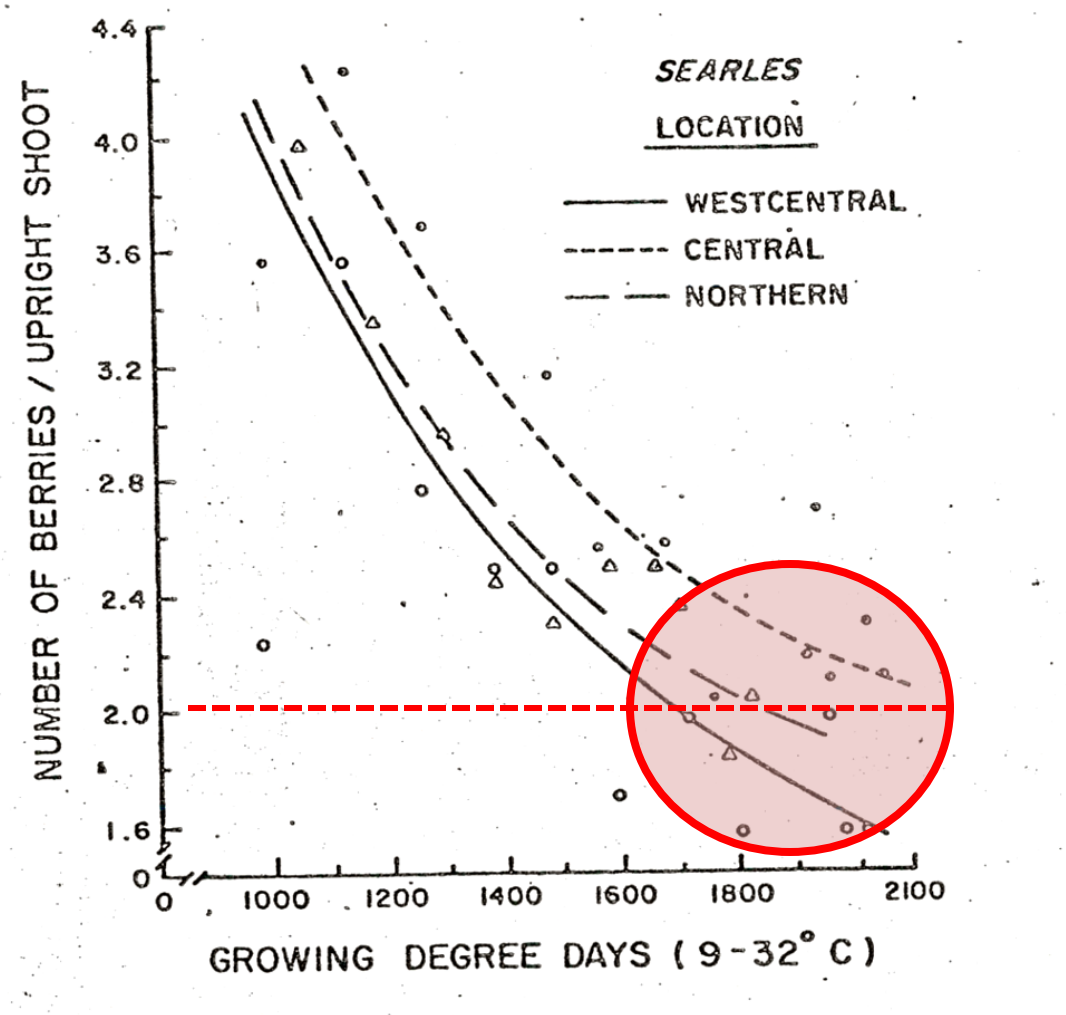


Does the plant compensate for early-season stresses?



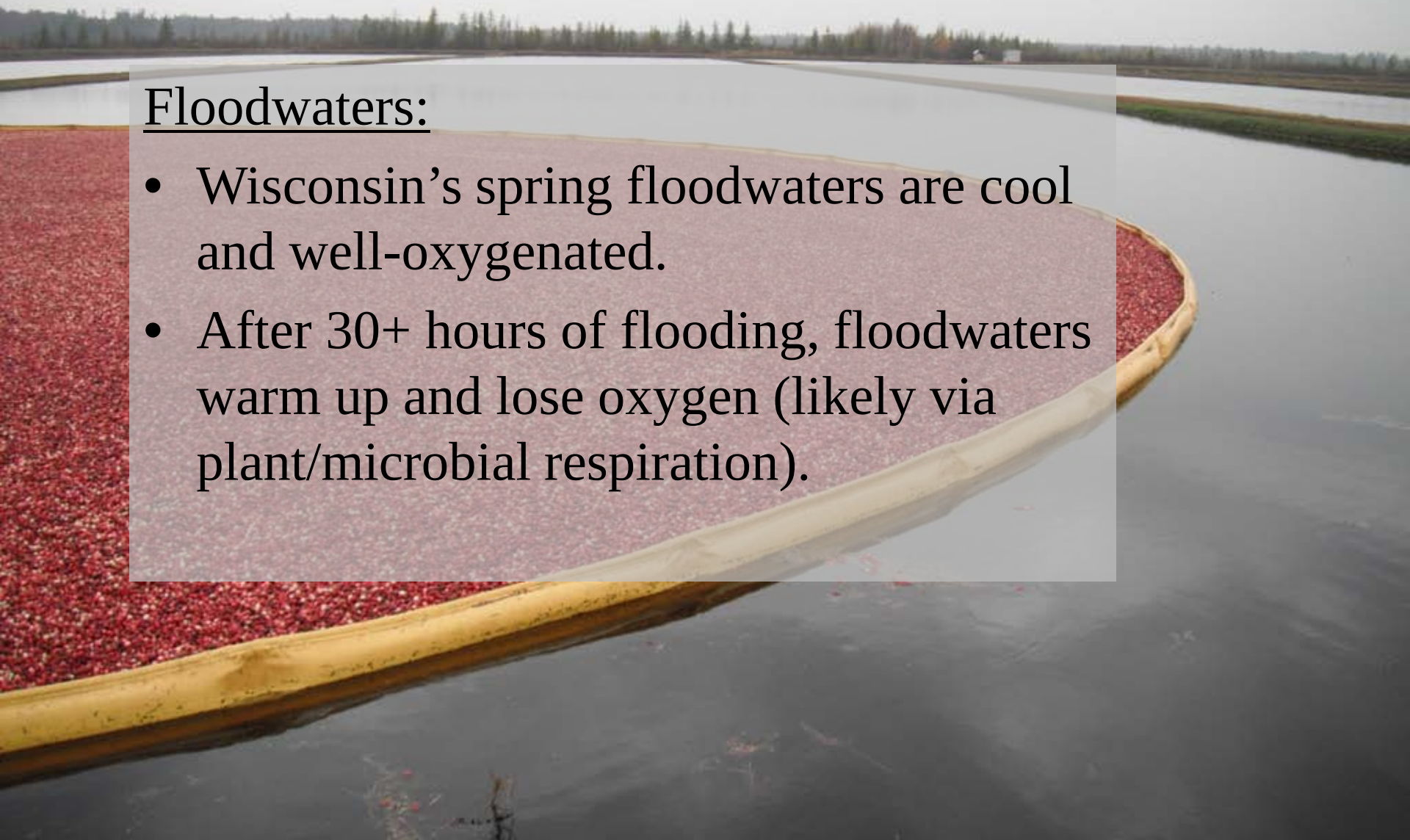


Does the plant compensate for early-season stresses?



Hawker & Stang (1985)

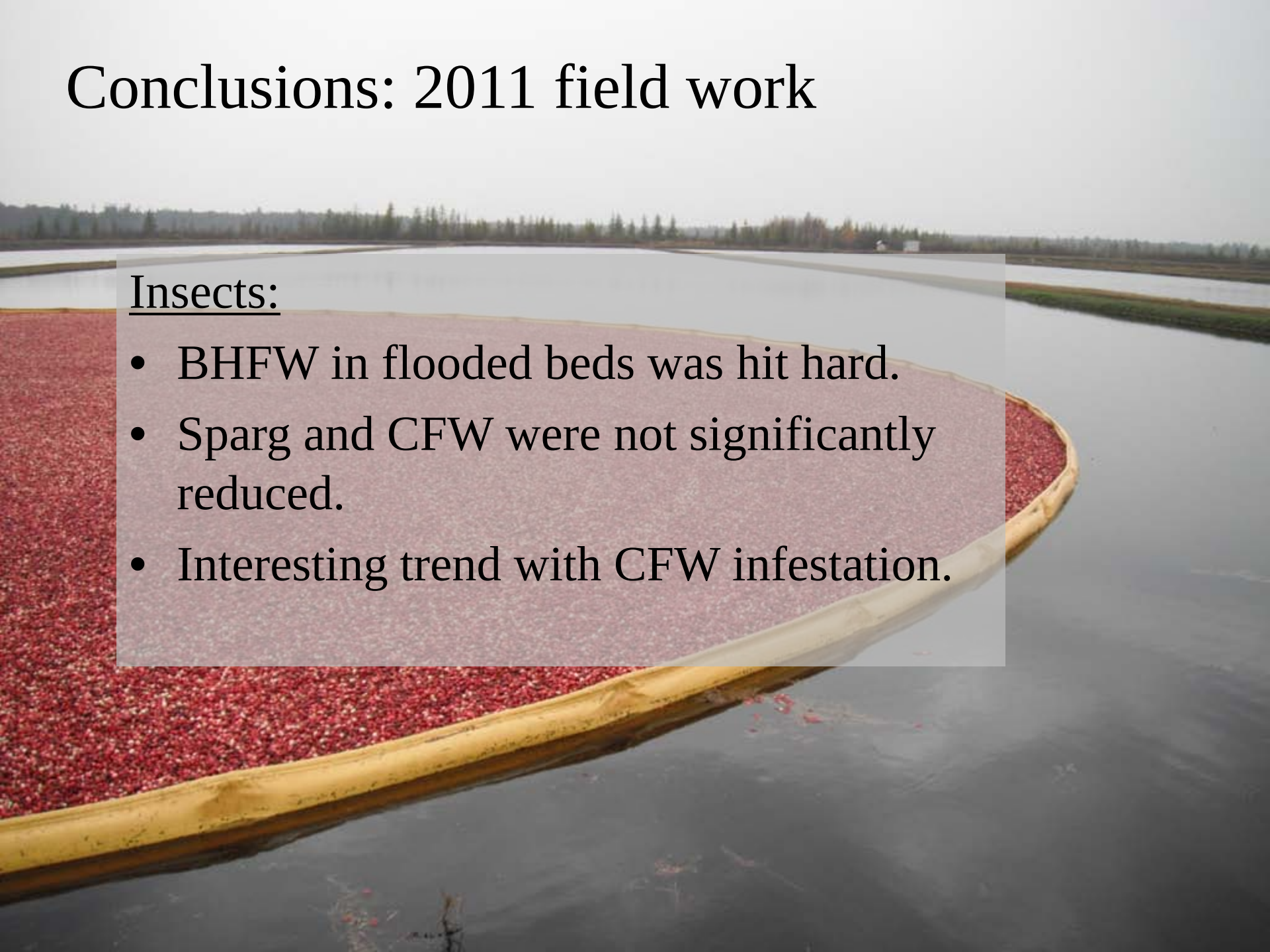
Conclusions: 2011 field work



Floodwaters:

- Wisconsin's spring floodwaters are cool and well-oxygenated.
- After 30+ hours of flooding, floodwaters warm up and lose oxygen (likely via plant/microbial respiration).

Conclusions: 2011 field work



Insects:

- BHFW in flooded beds was hit hard.
- Sparg and CFW were not significantly reduced.
- Interesting trend with CFW infestation.

Conclusions: 2011 field work

Plants:

- Flooded beds endured stress.
  - reduced chlorophyll (immediate effect)
  - slower growth (early-season upright length)
  - reduced flowers/upright (4 weeks post-flood)
- Harvest data suggest flooding stress was minimal by Sept/Oct.
  - Overall, no significant effect of flooding on crop

Economics:

- Can a prolonged (30+ hrs) spring flood replace 1-2 pre-bloom sprays?

Wisconsin cranberry entomology

- WI cranberry grower-cooperators
- Cranberry consultants

Harvest weight (grams/ft.^{2})

	Flooded (g)	Non-flooded (g)	*P*
Overall:	**204.3**	**203.0**	**0.934**
Ben Lear	165.6	183.6	0.742
Stevens	237.8	209.7	0.180
GH1	179.7	222.6	0.101

Individual berry weight (grams/berry)

	Flooded	Non-flooded	*P*
Overall:	**1.34**	**1.32**	**0.541**
Ben Lear	1.20	1.07	0.182
Stevens	1.41	1.46	0.059
GH1	1.32	1.25	0.558

Berry count (berries/ft.^{2})

	Flooded	Non-flooded	*P*
Overall:	**151.5**	**153.1**	**0.900**
Ben Lear	135.9	164.4	0.486
Stevens	169.7	143.8	0.106
GH1	137.2	177.2	0.067