Optimizing flowering in low-chill peaches in Florida

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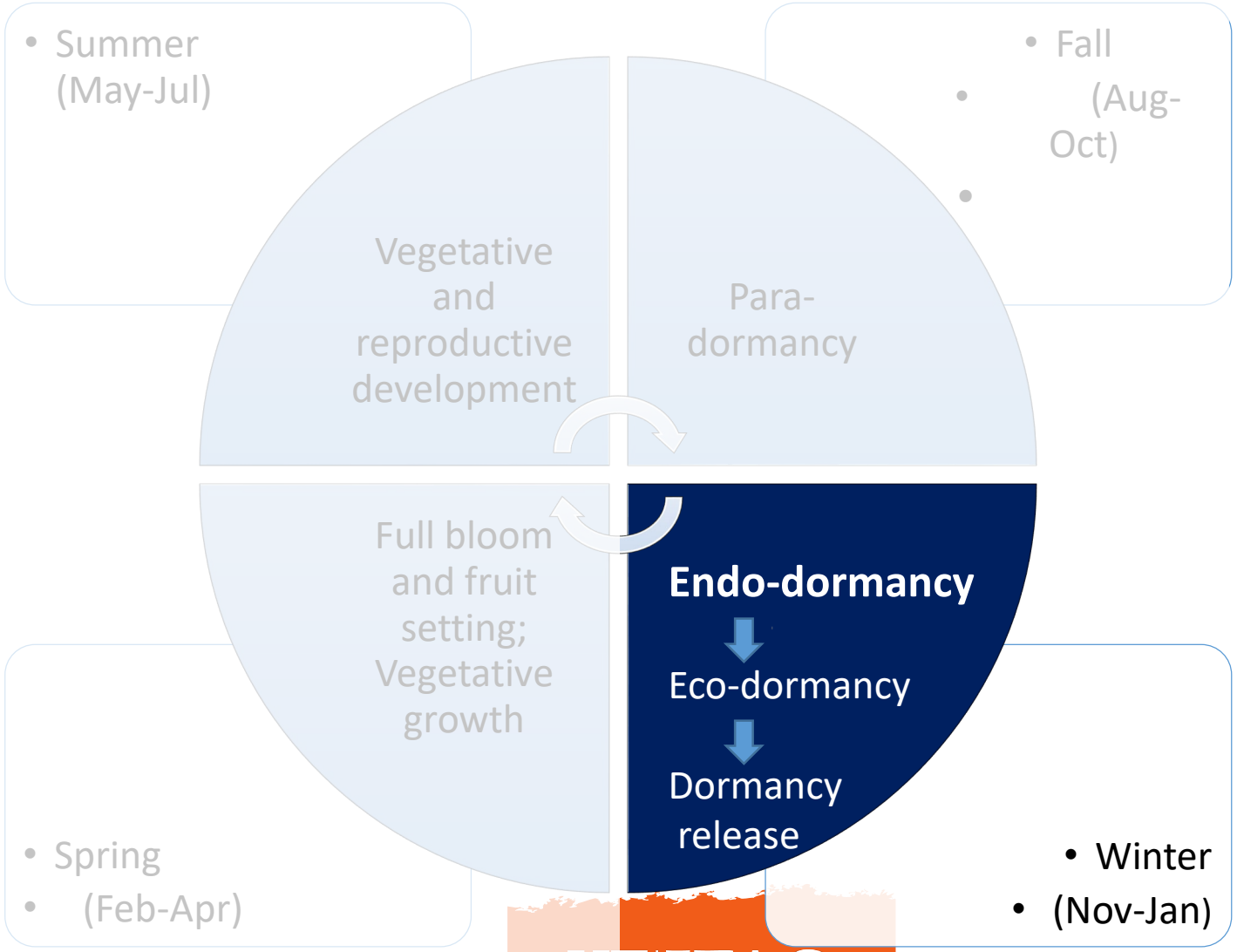
LOW-CHILL PEACH

- **Peach is a deciduous, stone fruit crop commonly grown in temperate regions**
  - Drops leaves in Fall
  - Dormancy
  - Requires cold weather for ‘chill hour accumulation’
  - New growth in spring
- **Low-chill peach cultivars developed by plant breeding program, University of Florida**
  - Chilling unit (CU) requirement: 100-500 with fruit development period of 60-110 days
  - Compared to 1000+ CU for South Carolina varieties

Fig:1 UFBest peach

Phenology of peach in Florida condition



Dormancy

- No visible growth; meristem activity absent
- Cool temperature and shorter day is required
- Helps plant to protect against cold winter and any other biotic and abiotic stress
- Chill hour accumulation is a plant strategy to identify right time to come out of dormancy

What is chill hour?

- 1 chill hour : low temperature < 45 ^{o}F accumulated in an hour
- Cultivar specific
- Defoliation is required for chill hour accumulation
- Once chill hour is fulfilled, endodormancy is released

http://agroclimate.org/tools/Chill-Hours-Calculator/

Cooler weather and shorter days

↓

Leaf fall begins

↓

Tree undergoes dormancy

↓

Endo-dormancy-starts accumulation chill hour

↓

Endo-dormancy releases upon sufficient chill hour accumulation

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Tree enters eco-dormancy

↓

Warm temperature induces signals for cell division

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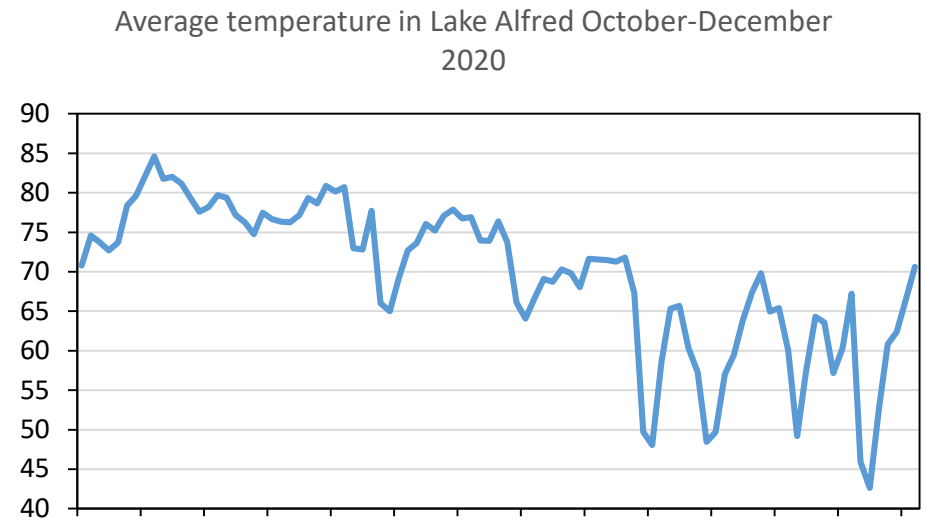
Dormancy releases

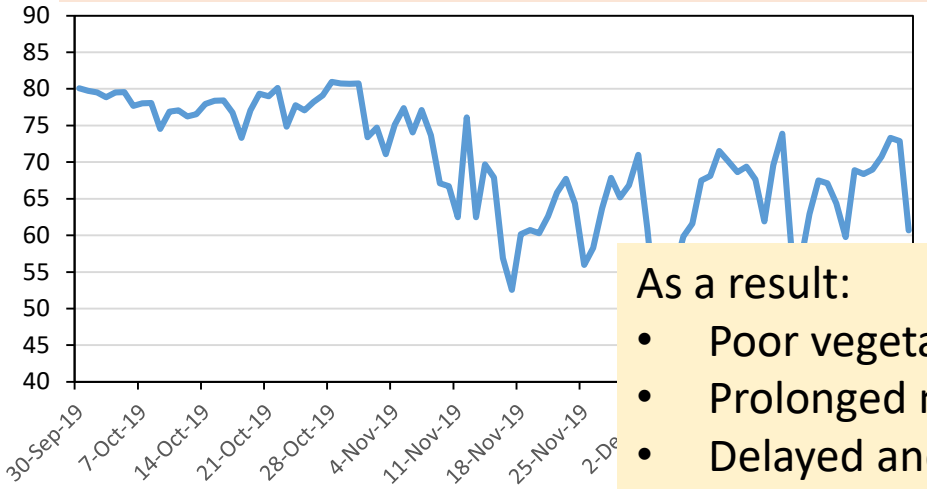
↓

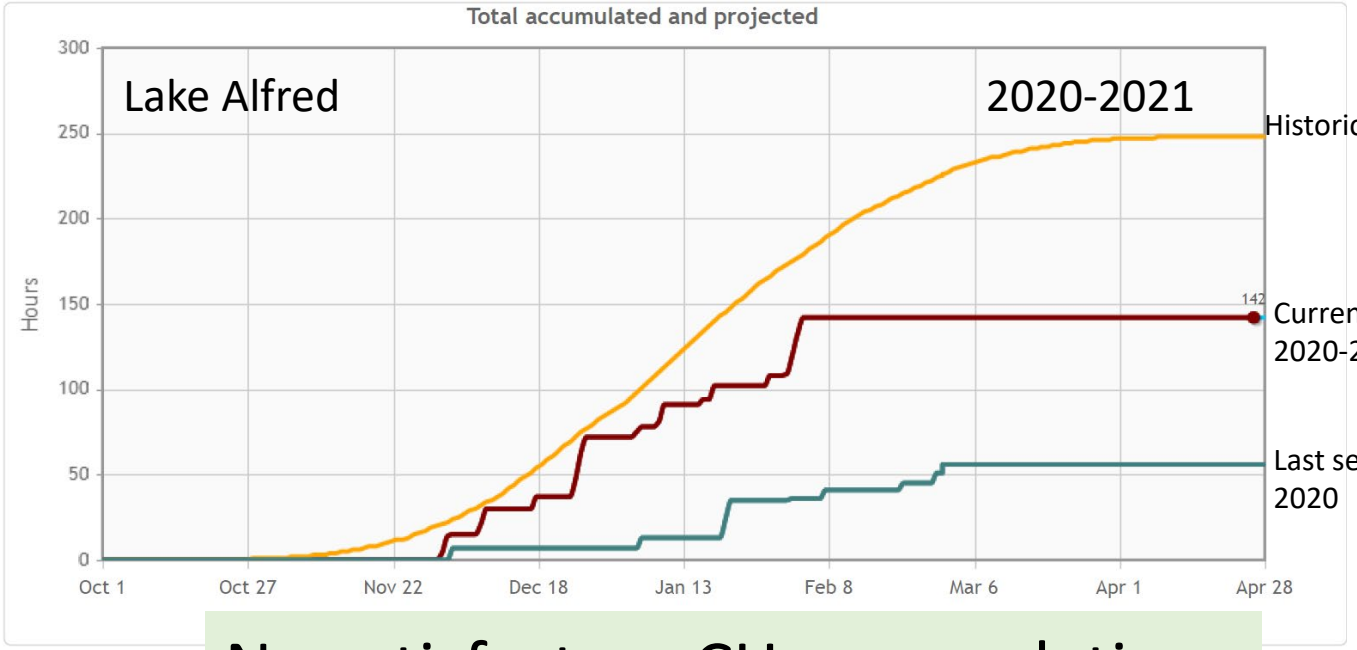
Flowers and leaf growth resumes

Weather conditions in Florida

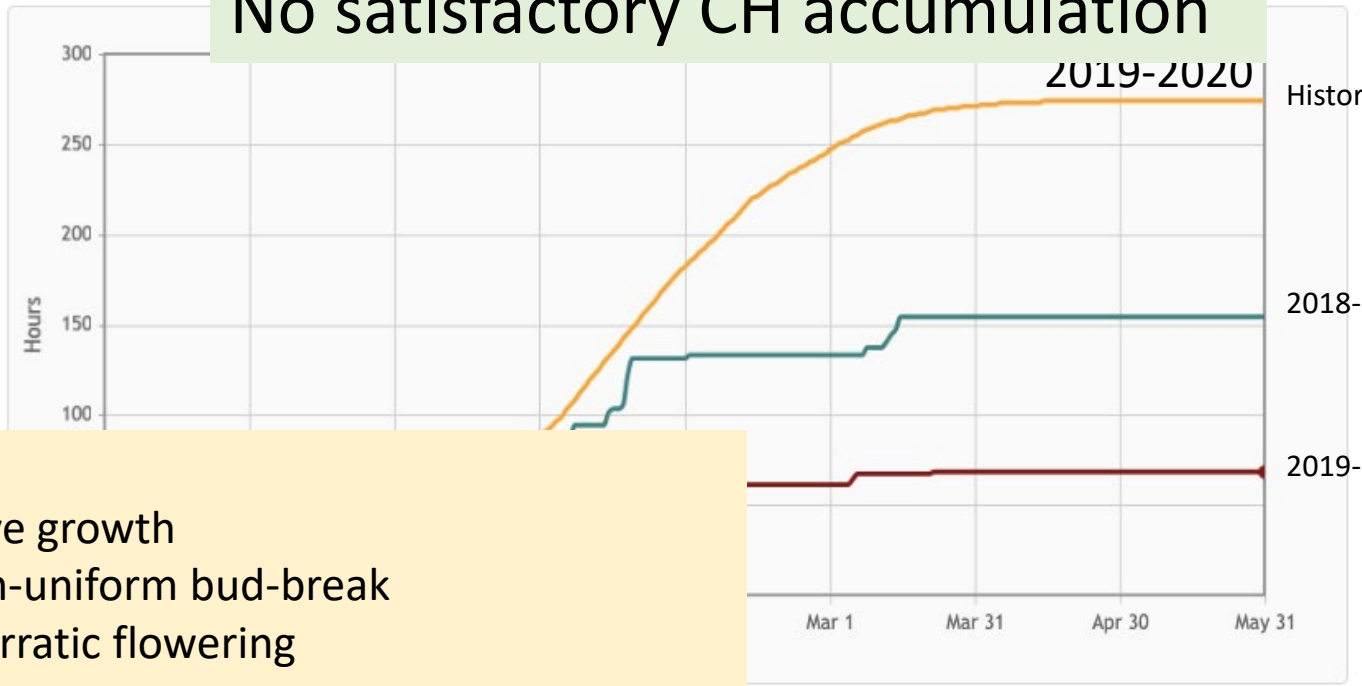


Failure in experiencing the endo-dormancy





No satisfactory CH accumulation



As a result:

- Poor vegetative growth
- Prolonged non-uniform bud-break
- Delayed and erratic flowering

HYDROGEN CYANAMIDE (HC) ?

- Used as a dormancy breaking agent in deciduous fruit crops
- Used in grapes, kiwi, cherry grown in sub-tropical climate
- Result in oxidative stress and transient respiratory disturbance in buds
- Resulting bud-break is dependent on crop and cultivar
- Should be applied when certain chill hours have already been accumulated
- Right time of application is very critical
  - Too early can cause bud-break early, making it prone to frost injury
  - Too late can cause phytotoxicty
- HC is toxic to humans, proper PPE is required. Restrictions related to alcohol consumption

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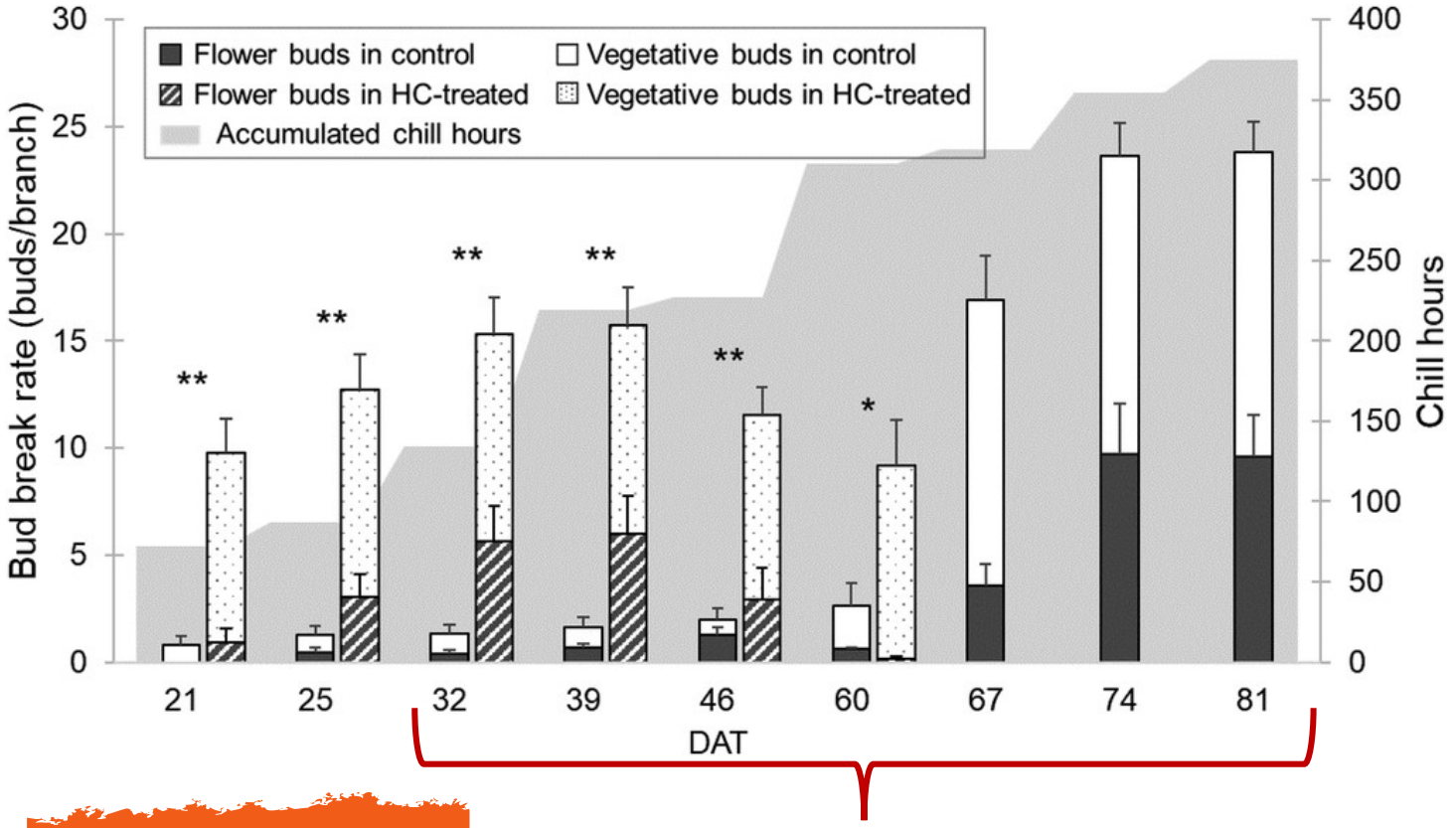
What is the efficacy of HC in low-chill peaches??

USE OF HC IN FLORIDA PEACHES

Bud-break in HC treated trees 21 days after the treatment
Location : Citra

USE OF HC IN FLORIDA PEACHES

- Tropic Beauty
- HC applied at 1.2%
- On 23rd December (60 CH)
- Pollen grain color was still translucent
- Location: Citra



Bud break advanced by 6 weeks

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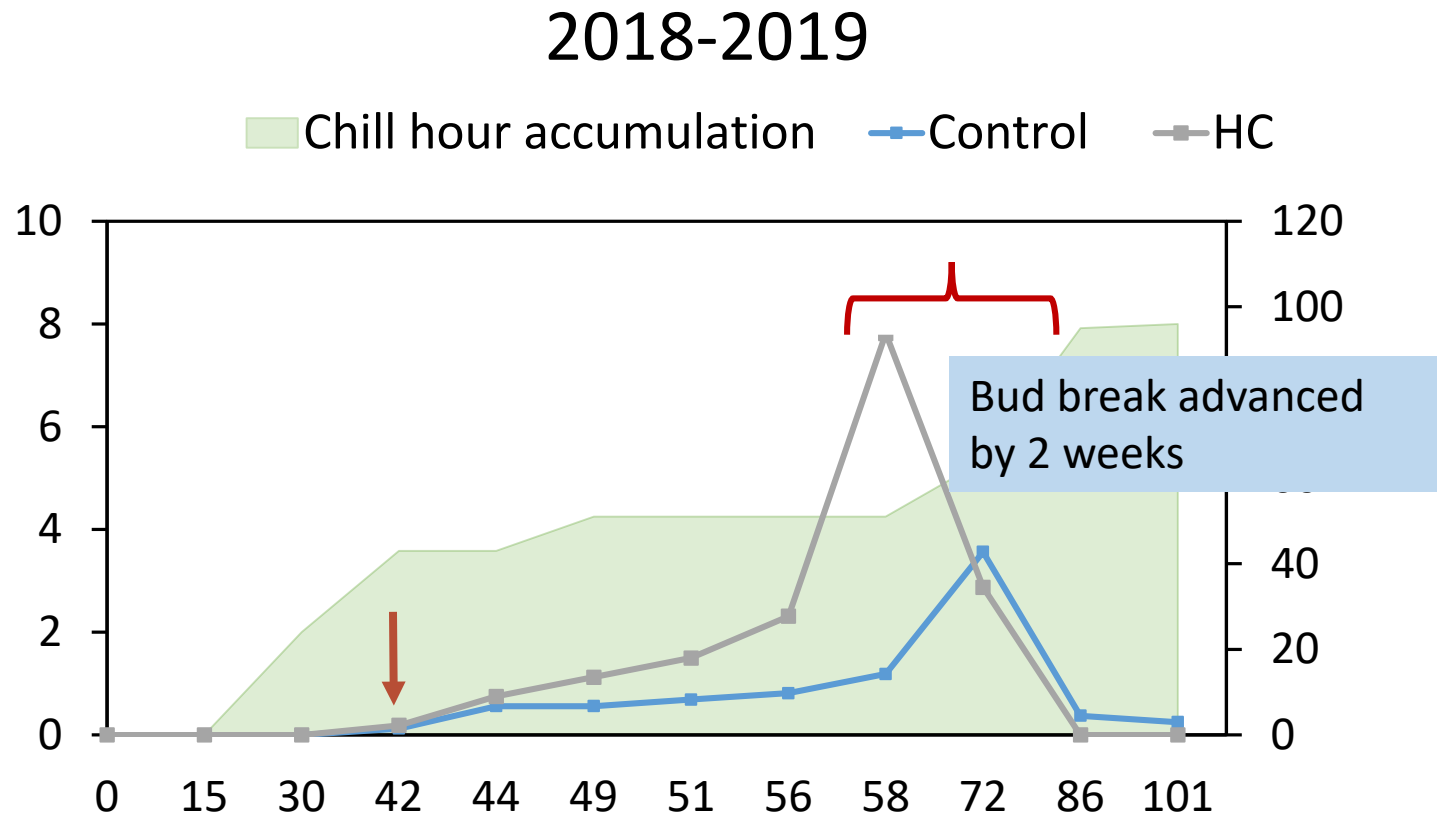
USE OF HC IN FLORIDA PEACHES

- UFBest and UFSun (100 CH)
- HC applied at 1.2%
- On 18th December (43 CH)
- Pollen grain color was still translucent
- Location: Lake Alfred



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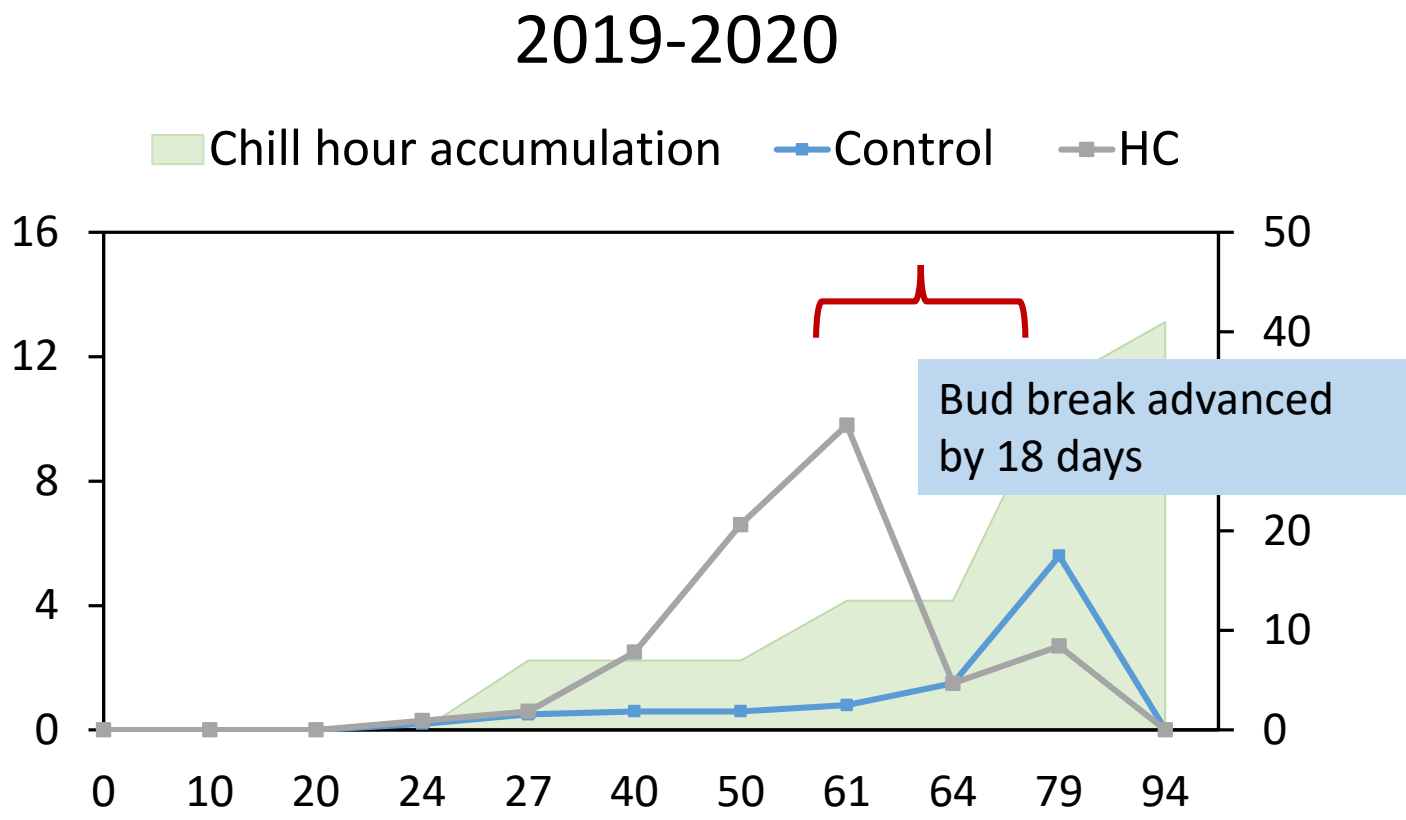
USE OF HC IN FLORIDA PEACHES

- UFBest and UFSun (100 CH)
- HC applied at 1.2%
- On 16 th December (10 CH)
- Pollen grain color was still translucent
- Location: Lake Alfred



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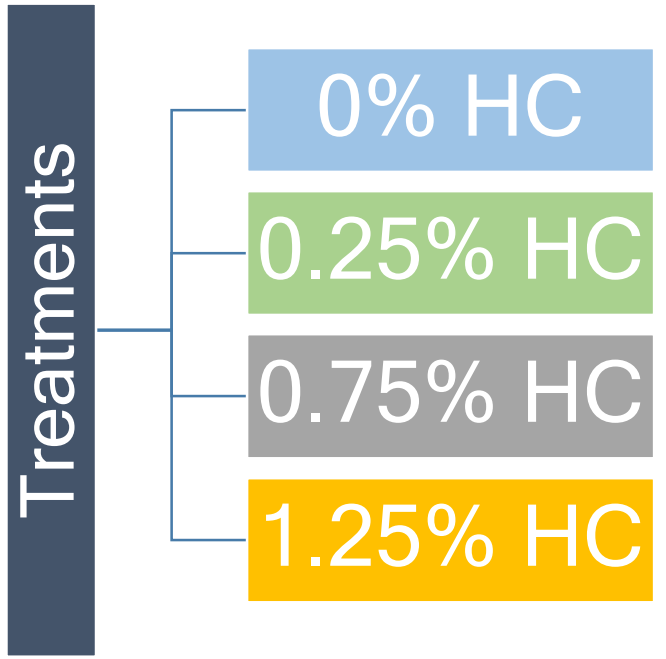
USE OF HC IN FLORIDA

- 1.2% HC is effective in inducing bud-break in peaches when insufficient chill hours have accumulated
- HC-treatment results in bud break advancement but it depends on location
  - 6 weeks in Northern Florida
  - 2-3 weeks in Central Florida
- HC-treatment did result in significant bud advancement even when chill hour accumulation was as low as 15 in 2019-2020
- More prolonged bloom is obvious with warmer weather in December-January
- UF Sun (100 CH) requirement showed no response to HC treatment
- HC application should be done before buds are swollen and pollen grain are still translucent as late application can cause phytotoxicity (HC causes oxidative stress)

To identify minimum required rate of HC for bud-break in low-chill peach cultivar under Florida condition

- Low rate may reduce phytotoxic response
- Application window can be prolonged
- Cost-effective



- ‘UFBest’ (6 years old)
- 100 chilling units required
- Location: Lake Alfred, Florida

- HC was sprayed when 51 chilling hours accumulated (2018-2019)
- 7 CH was accumulated during HC application in 2019-2020
- Pollen grain color shifts from light green to yellow green

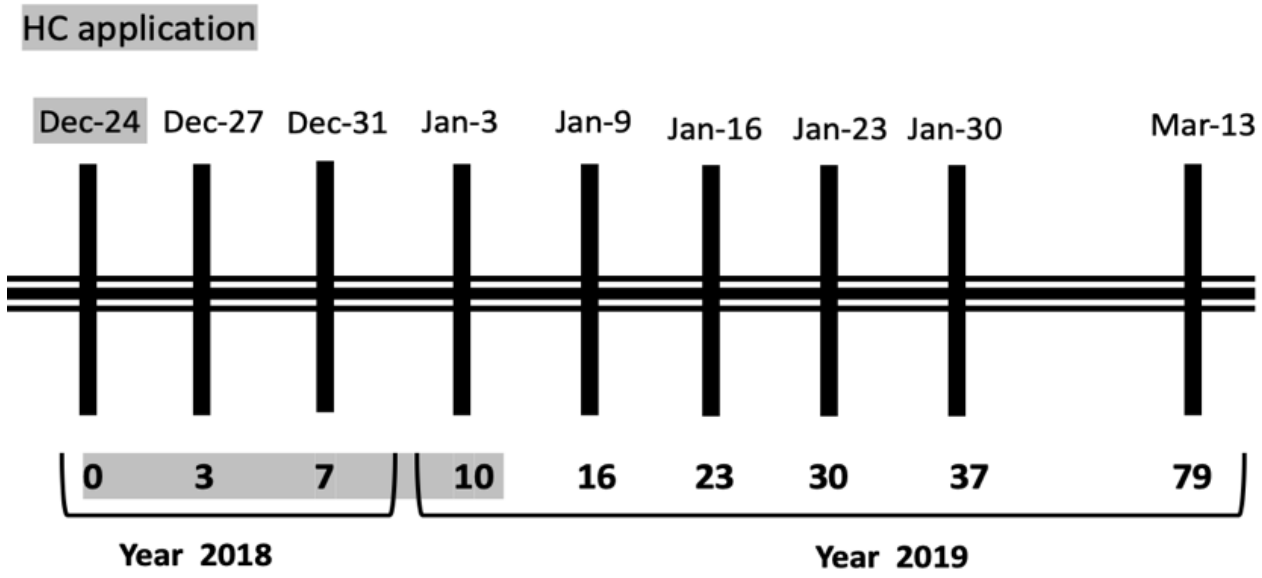
Assessment and Analysis

<u>Phenotypic assessment (2018-2019 and 2019-2020):</u>

- Bud-break, and flower count

<u>Gene expression and biochemical analysis:</u>

Bud samples collected at day 0, 3, 7, & 10 were used

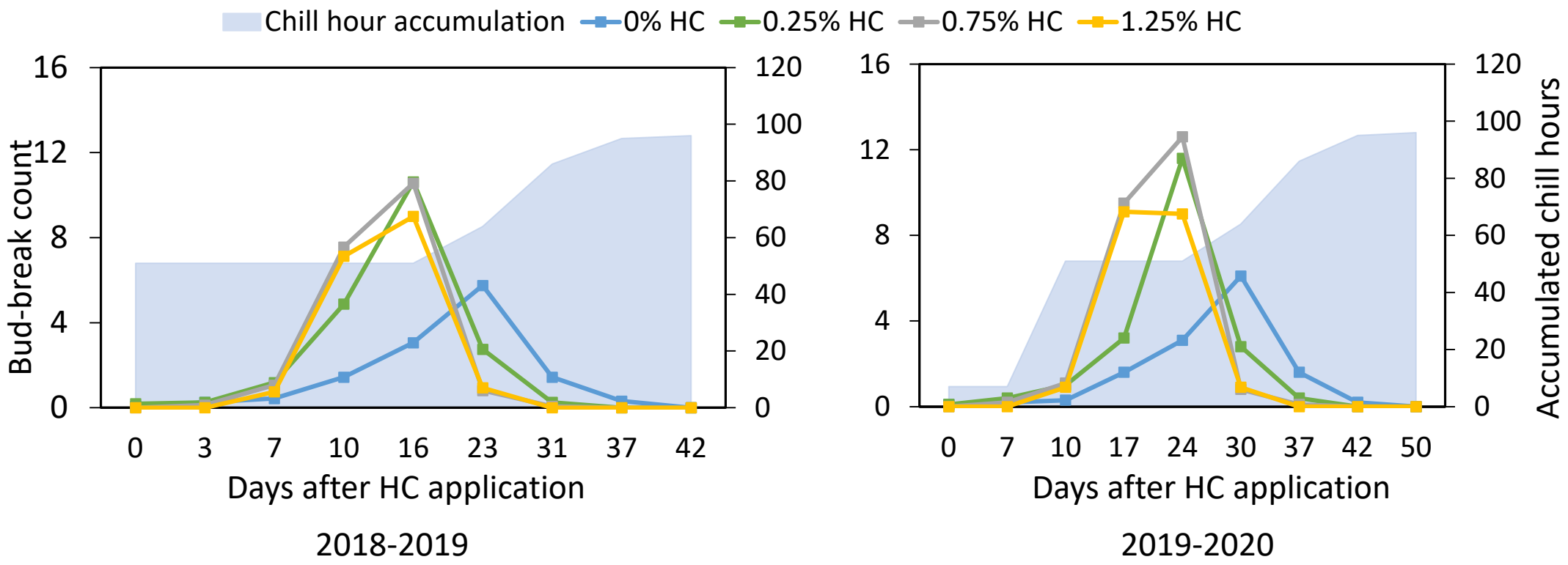


Antioxidant enzyme assessment:

- Catalase activity
- Hydrogen peroxide content
- Lipid peroxidation assessment:
- Malondialdehyde assay(MDA)

Relative expression analysis of specific genes using qRT-PCR

Bud-break advanced by 2 weeks on 0.25%, 0.75%, and 1.25% HC treated buds

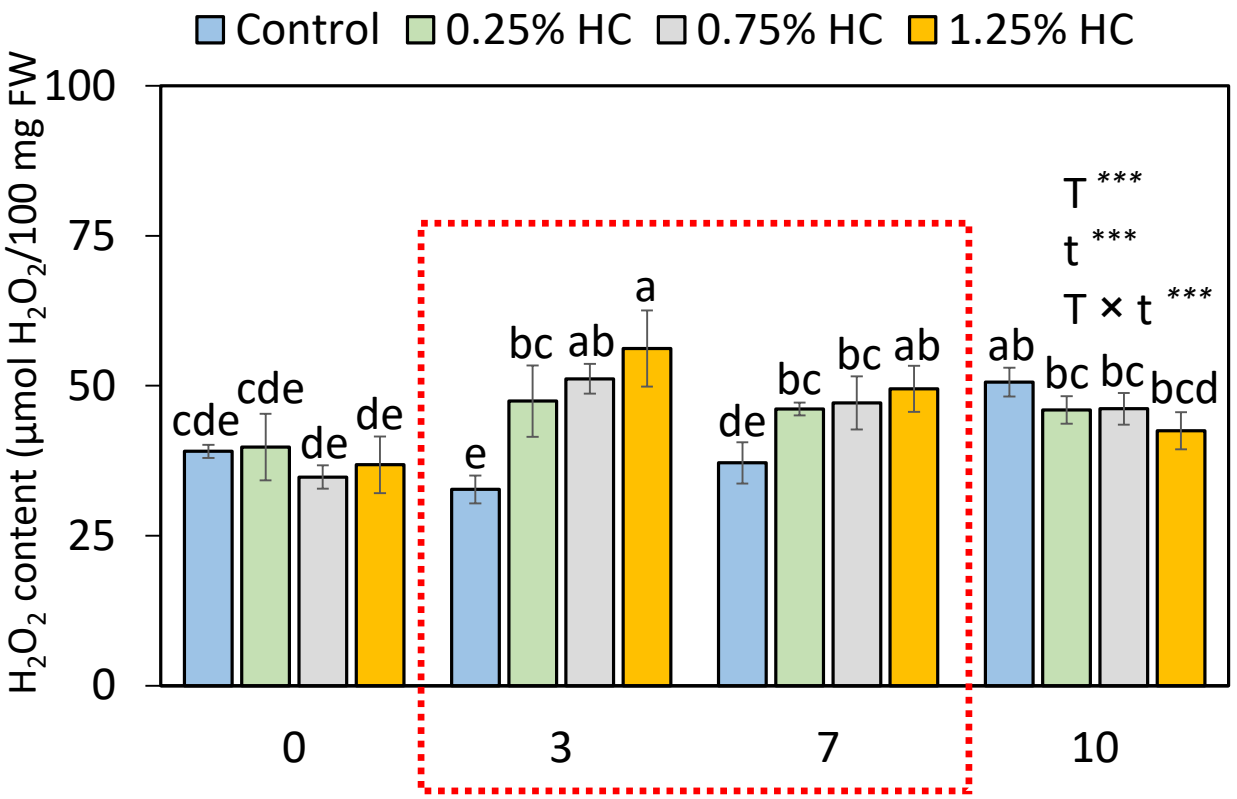


Flowering advanced by 12-15 days on 0.25%, 0.75% and 1.25% HC treatment

Bud-break and flowering delayed by 1 week in 2nd year

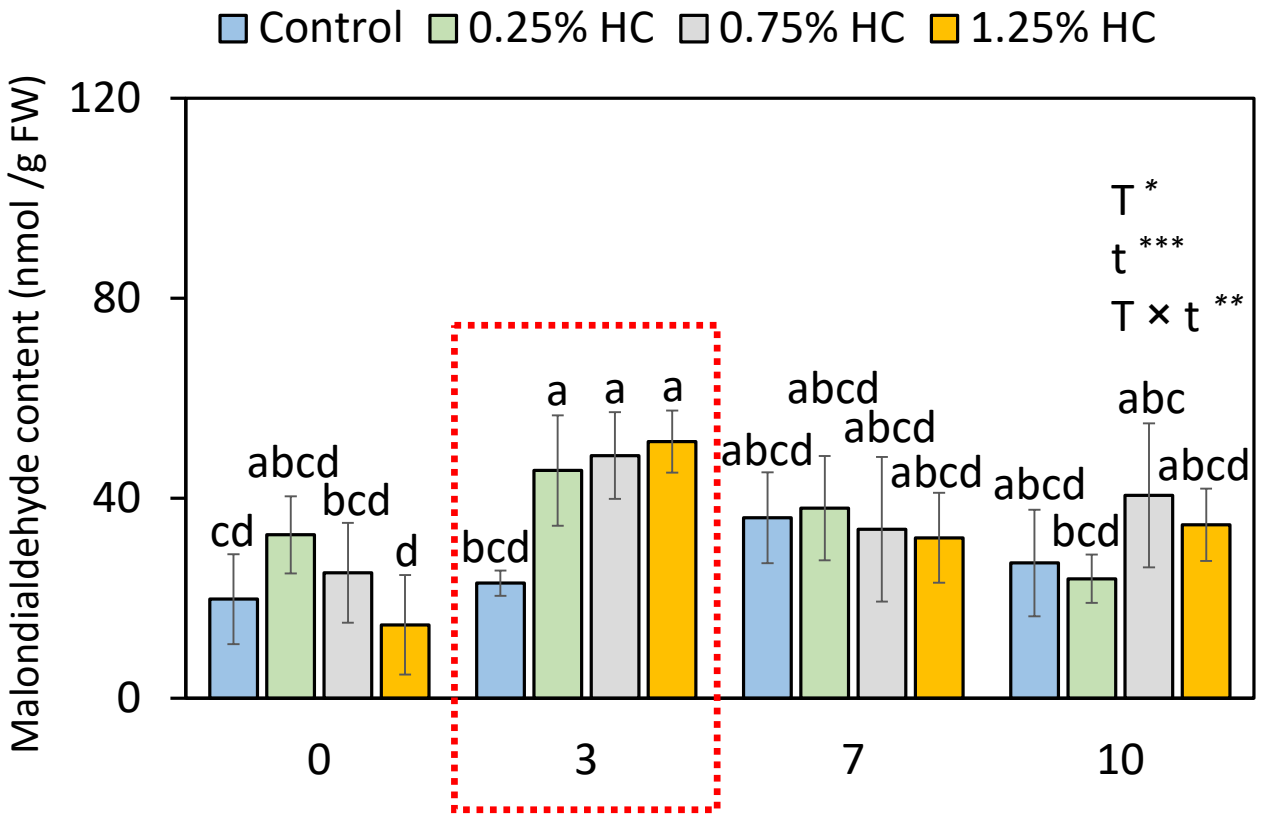
Flowering period prolonged on 1.25% HC in 2019-2020

H_2O_2 content increased with increase in rate of HC



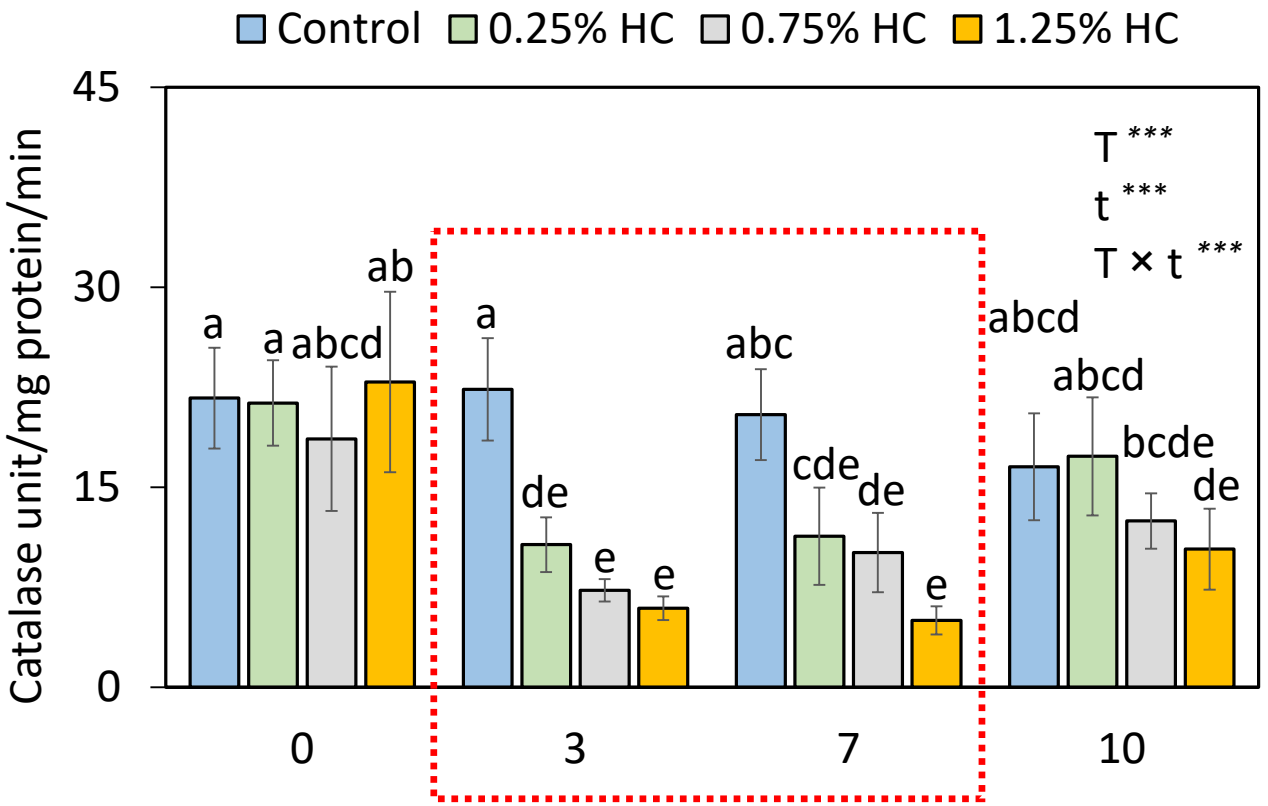
Plant responded to all three HC treatments by evoking reactive oxygen species, H_2O_2

Lipid peroxidation increased significantly in all HC treatments



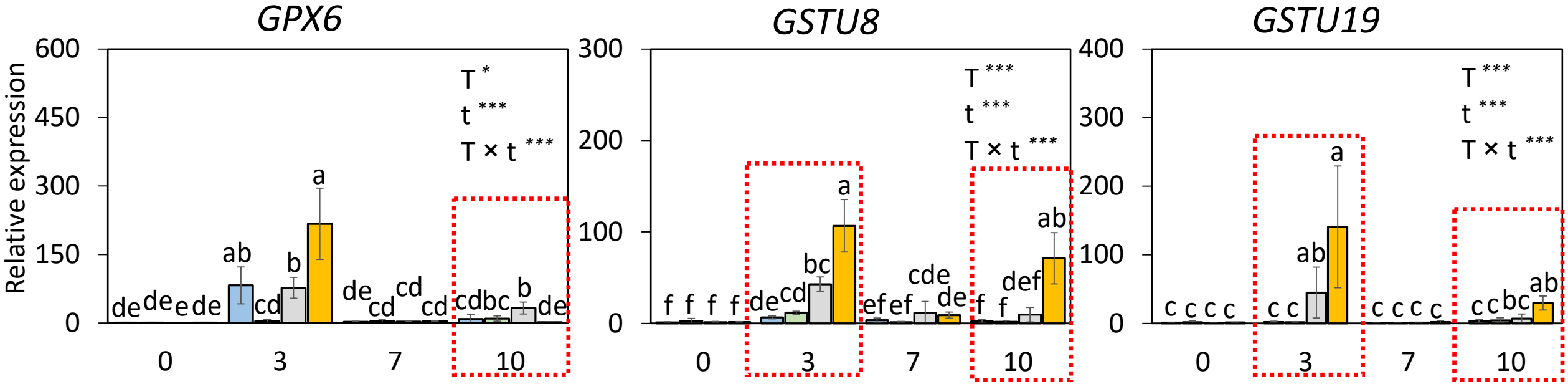
At day 3, all three HC treatments indicated higher MDA level due to oxidative stress causing lipid peroxidation activity in bud

Higher the rate of HC= low Catalase activity



All three HC treatments resulted in lower activity of catalase at day 3; at day 7, 0.25% was not significantly lower.

Oxidative stress related genes- Glutathione gene family



Increased *GSTU8* and *GSTU19* expression level at day 3 and 10 suggested the response to increased oxidative stress due to 0.75% or 1.25% HC treatments

Conclusions

- Higher the rate of HC = higher oxidative stress
- Higher rate (1.25%) applied below 10 chilling hours accumulation can cause bud-abscission, therefore reducing yield potential
- Lower rate (0.25% and 0.75%) of HC can be used safely without compromising bud-break activity
- HC has a potential to advance bud-break and flowering by 12-15 days in Southern Florida under mild winter condition which is different from North Florida; weather specific

Abscisic Acid (ABA) ?

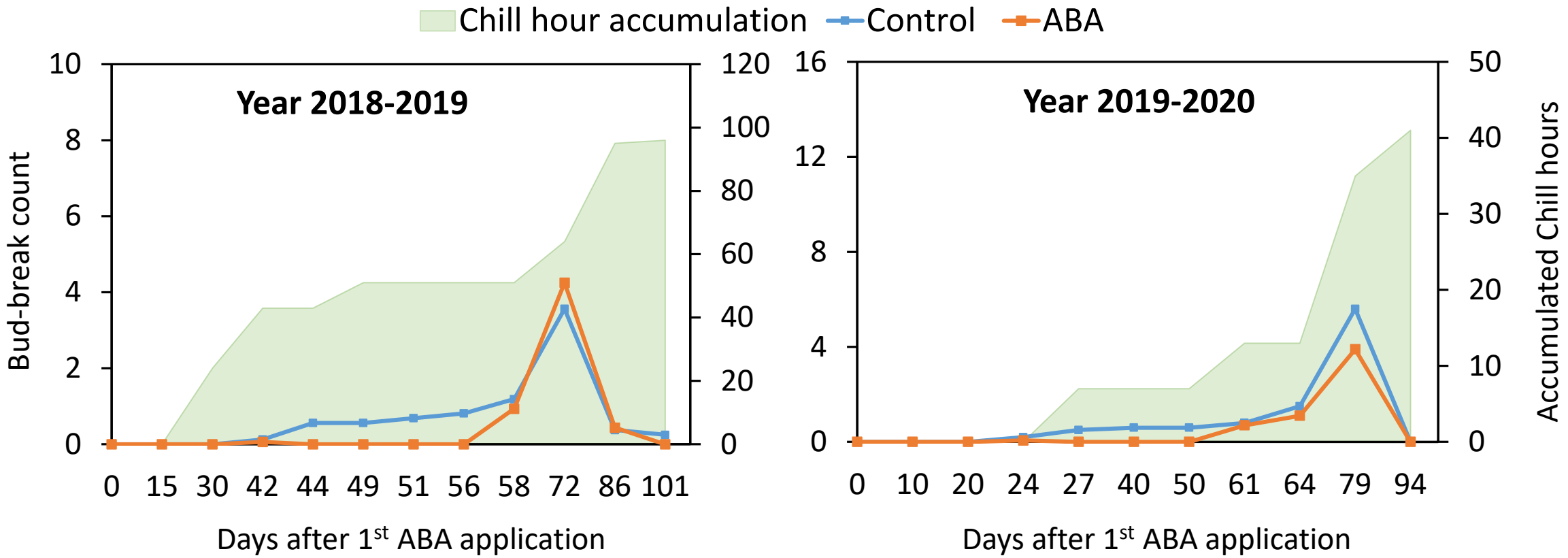
- Stress related hormone; act as plant defense response against abiotic stress
- The accumulation of endogenous ABA started with onset of winter and increase with increased depth of dormancy
- Exogenous application cause leaf abscission and enhances bud-growth inhibition in grapevines Reduce off-season as well as prolonged bud-break and flowering

Before ABA application

After ABA application

Can we use ABA to induce dormancy and HC to release dormancy?

ABA application showed complete inhibition of bud-growth activity on UFBest



- More synchronized bud-break in ABA (2-3 weeks) compared to control (4-7 weeks)
- No ABA treatment effect observed in flowering pattern on both years
- No effect of ABA on **UFSun**

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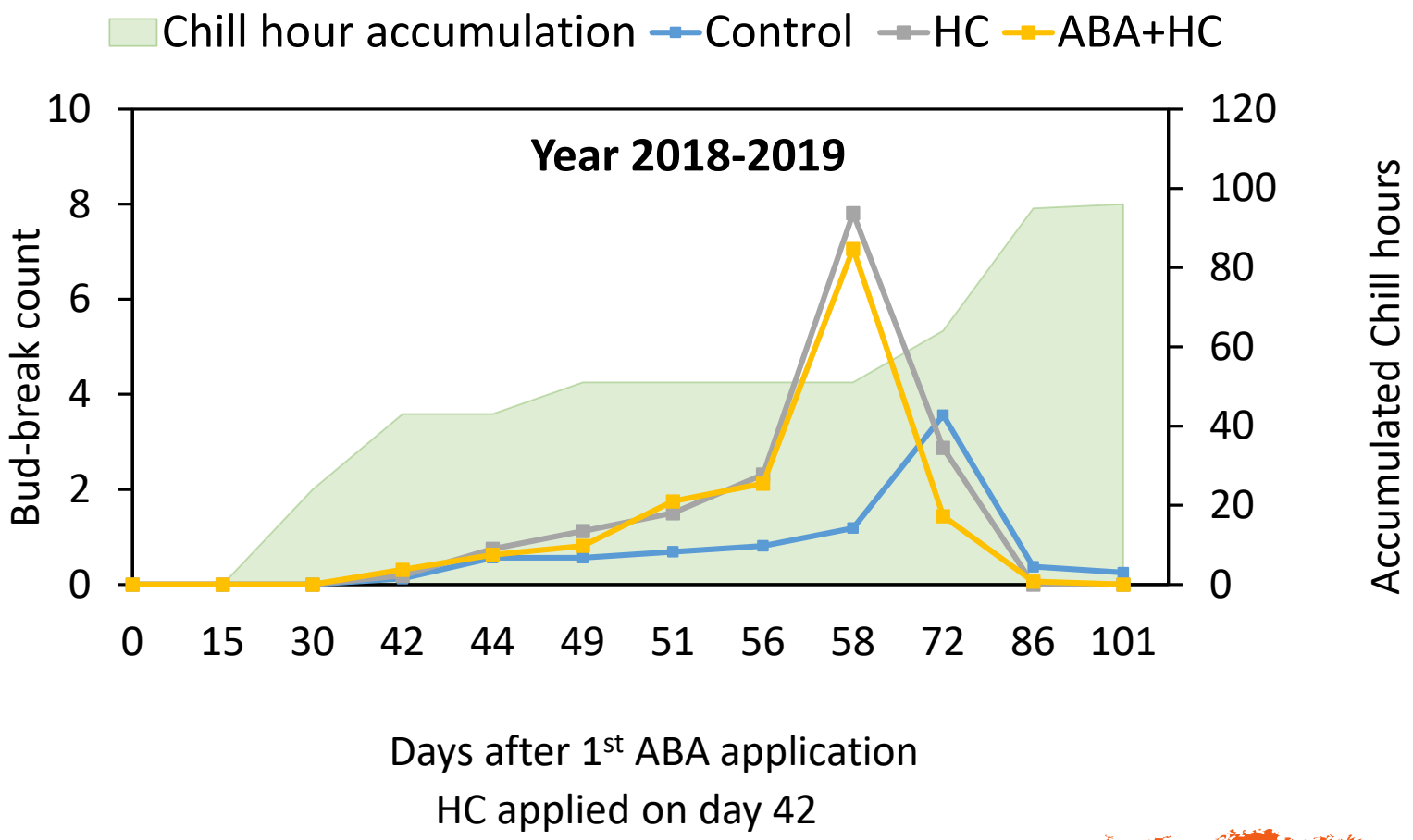
ABA application did not show significant inhibition of bud-break when applied with HC;



HC advanced bud-break and flowering by 14 days; overcame the inhibiting effect of ABA

		58	72
Bud-break	HC	7.8±3.7 a^{A}	2.9±2.1 ab^{AB}
	ABA+HC	7.1±2.1 a^{A}	1.4±1.5 b^{BCD}
		72	86
Flowering	HC	6.5±2.7a^{A}	3±2.1 a^{AB}
	ABA+HC	6.9±1.1a^{A}	0.4±0.8 b^{BC}

More synchronized bud-break and flowering activity in ABA+HC2

No effect of ABA as well as HC application in UFSun

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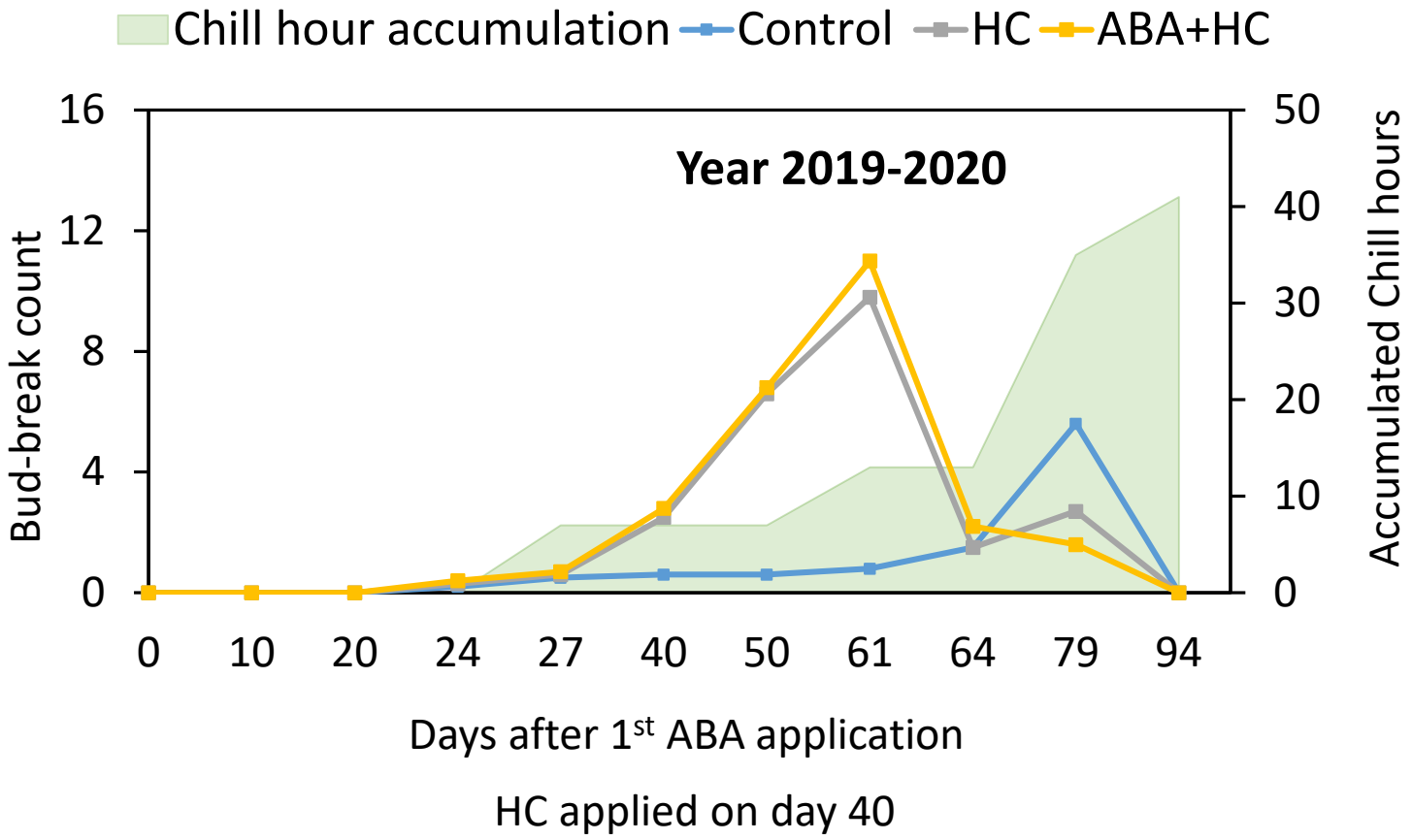
ABA application did not show significant inhibition of bud-break when applied with HC; HC advanced bud-break by 18 days in UFBest



Similar pattern of flowering observed; advancement by 14 days

Better synchronization in ABA+HC

No effect of treatment on UFSun

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ABA USE?

- ABA is not labelled for used in Florida as dormancy inducing agent
- ABA is labeled to be used grape for color development
- More research is underway!!