SUMITOMO CHEMICAL
AgroSolutions Division - International

Chemical Defoliation of Apple Nursery Trees

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Nursery tree defoliation

- Defoliation is essential for the successful management of deciduous nursery plant production.
- Chemical and/or manual defoliation of apple trees is a common commercial practice in the apple nurseries before digging.

Why to defoliate?

- To allow early digging of the tree/stock.

Natural defoliation often occurs later than is desired for an efficient harvest
(low temperatures, snow, high precipitation)

Nursery tree defoliation

What if we do not defoliate?

- Digging trees that are still in leaf is impractical because leaf transpiration might result in water stress;
- leaves restrict air circulation in storage and promote fungus decay;
- create cleaning problems in the grading facilities.
- leaves add considerable weight to be handled during digging and grading.

Nursery tree defoliation

What if we defoliate too early?

- Severe winter injury - Immature plants dug too early can suffer branch dieback and death during storage overwinter;
- reduced carbohydrates/nutrient reserves;
- poor performance the subsequent year;
- promotes regrowth.

Nursery tree defoliation

- Many nurseries still rely on defoliation treatment strategies centered on the application of copper with or without the addition of urea.
- Copper not always effectively defoliate fruit trees.
- It hardly promotes leaf senescence, resulting in an inefficient N recovery from leaves – bud damage.
- Many trials have been conducted in the search for effective and non-phytotoxic chemical products to encourage defoliation (Larsen and Higgins, 1998; Elfing, 2010,; Guak et al., 2015).

Nursery tree defoliation

What is the ideal defoliant?

- 80% to 99% defoliation over a requiring period.
- However, compounds that would avoid wood tissue injury, improve handling and storage processes, enhance leaf senescence and facilitate autumnal mobilization of leaf N into woody tissues are other criteria when selecting a chemical defoliant.
- U.S. nurserymen are in need of more options for chemical defoliation of apples trees that would meet all the requirements cited above and be suitable across different climate regions in the U.S.

Goal

Find different options of treatments that can be applied under different weather conditions and will successful reach the defoliation target in a timely manner.

Trials

On-farm Nursery located in Western NY
Around 15,000 trees/acre
2016, 2017 and 2018

Products tested:

- Copper – CuEDTA 7.5% and Copper Sulfate Pentahydrate – 2 and 3%;
- Urea (45% N) – 1 and 3%;
- a commercial formulation of abscisic acid – ABA (Protone®, Valent BioSciences, Libertyville, IL) – 350 ppm to 1500 ppm;
- organosilicone surfactant (Silwet® L-77; Helena Chemical Co.) - 0.125 and 0.26%;

Trials

Galaxy Gala, Minneiska and XX on B.9

Rootstocks were budded in August 2015, 2016 and 2017.
Proposed digging date - Nov 11th 2016 and Nov 1st 2017.

Treatments were applied 4 or 3 or 2 weeks before "digging".
There were no re-applications.

Application method: backpack sprayer

Trees were hand-sprayed from the ground to the top until a full coverage was achieved;
Around 150 gallons of solution was delivered per acre (35ml/tree) – 1500 trees/acre.

Assessments

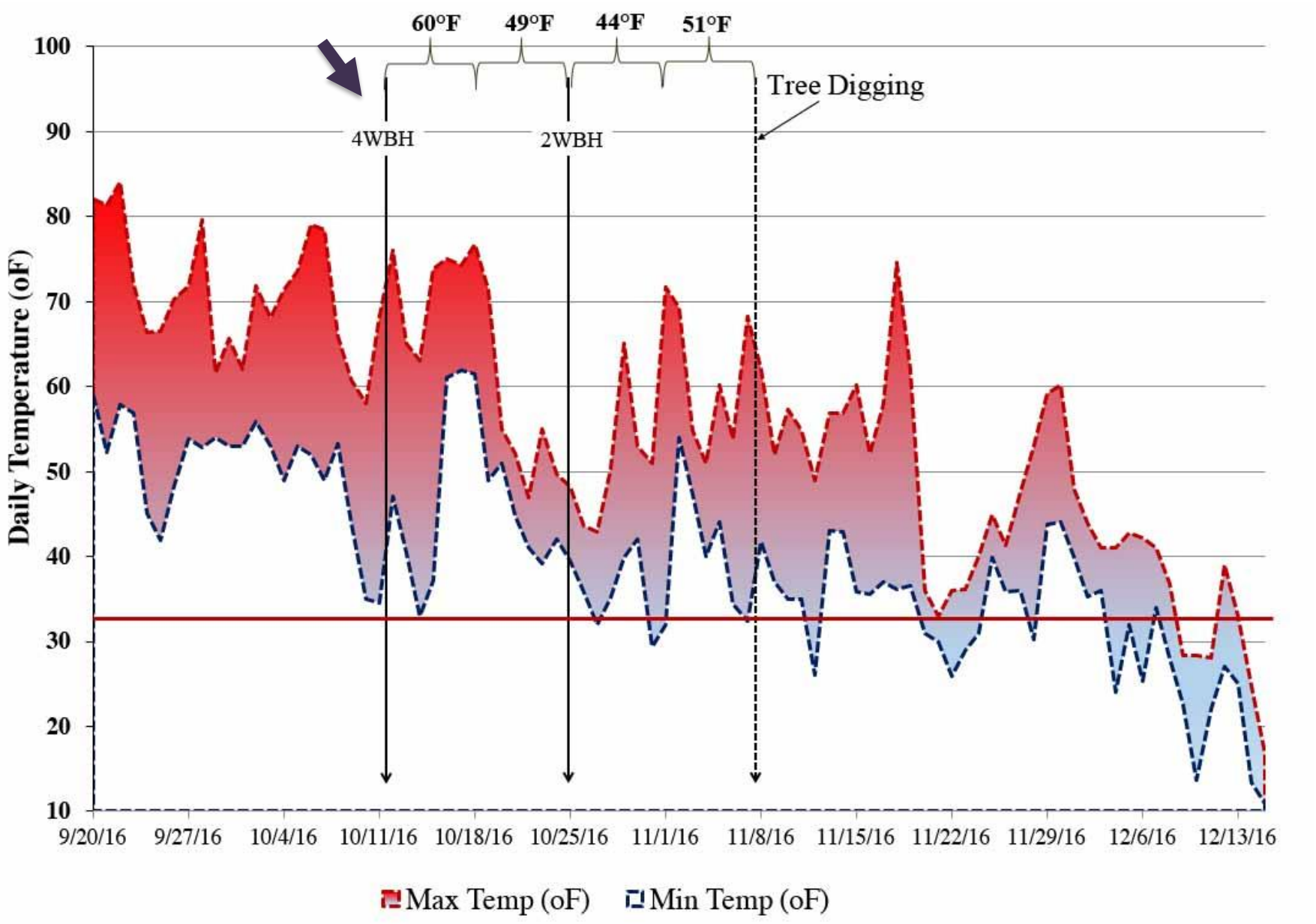
- % defoliation;
- % survival of the terminal bud;
- % bud break.

2016

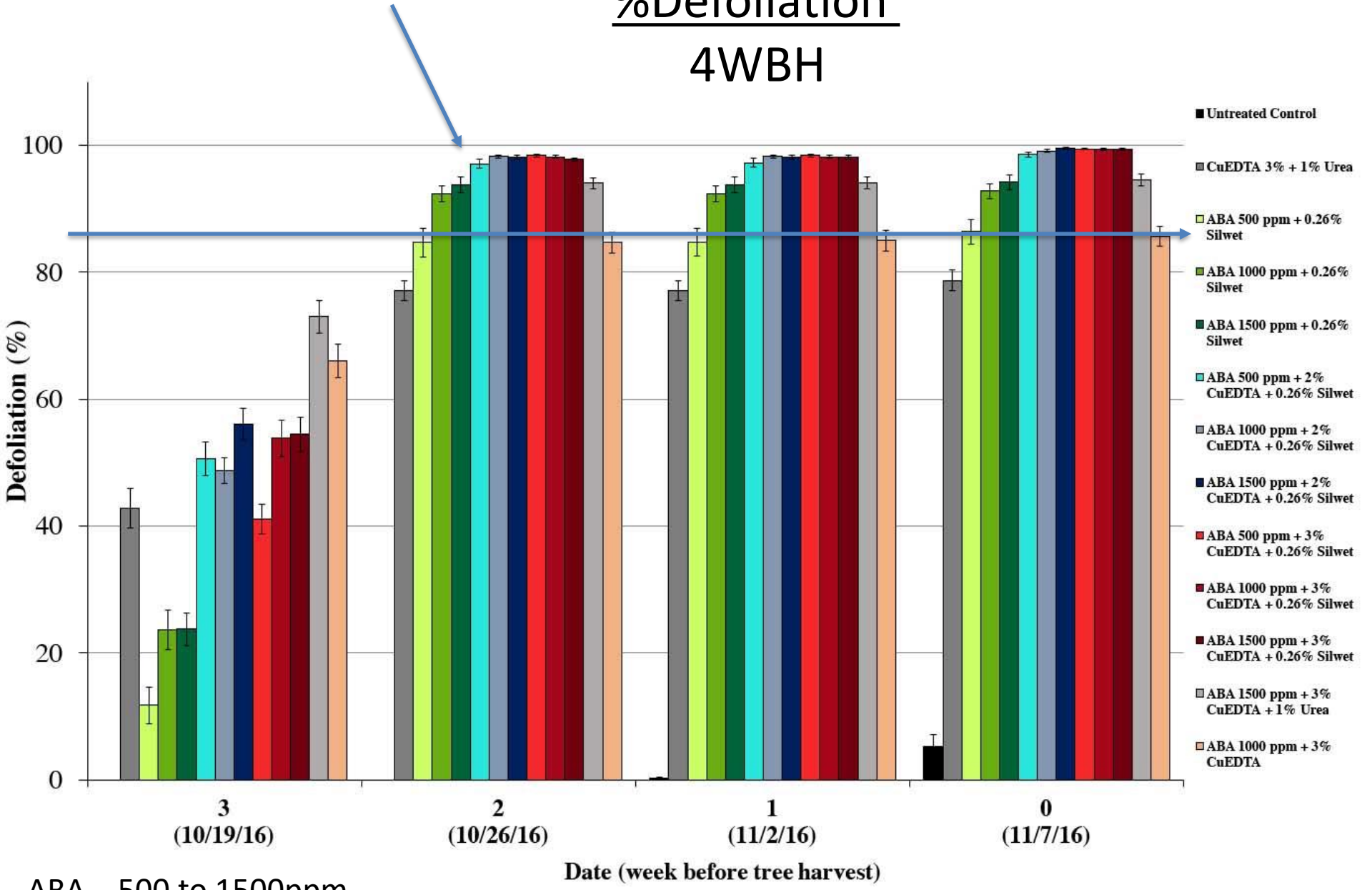
Gala/B9

CuEDTA: TRACO™ 7.5% Copper EDTA Chelate Solution – 2% and 3%
ABA (Protone) = 500, 1000 and 1500 ppm
Urea: 1%
Silwet (nonionic organosilicone surfactant) = 0.26%

Temperatures during treatment applications in 2016



%Defoliation
4WBH



ABA – 500 to 1500ppm

CuEDTA – 2 to 3%

ABA + CuEDTA + Silwet

ABA + Silwet

CuEDTA + Urea

CuEDTA + Silwet

ABA 500ppm + Silwet

ABA 1500ppm + Silwet

10/26/16 – 2 weeks after spray (no more defoliation)

Protone (ABA) + Silwet requires high temperatures (mid 70s) to cause defoliation.

ABA 1000ppm + Silwet

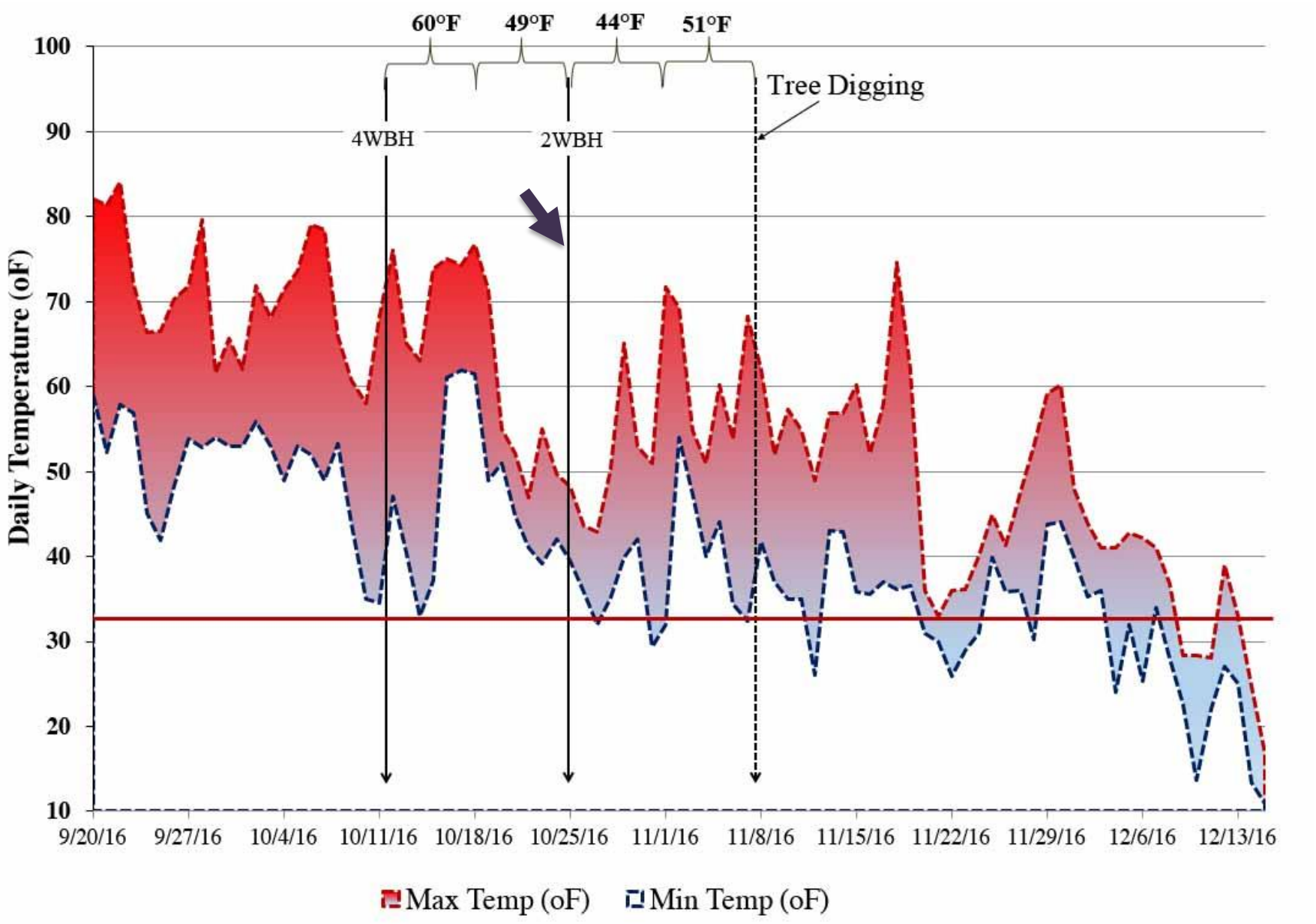
10/19/16 – 1 week after spray – Time 1

Standard – CuEDTA 3% + Urea 1 %

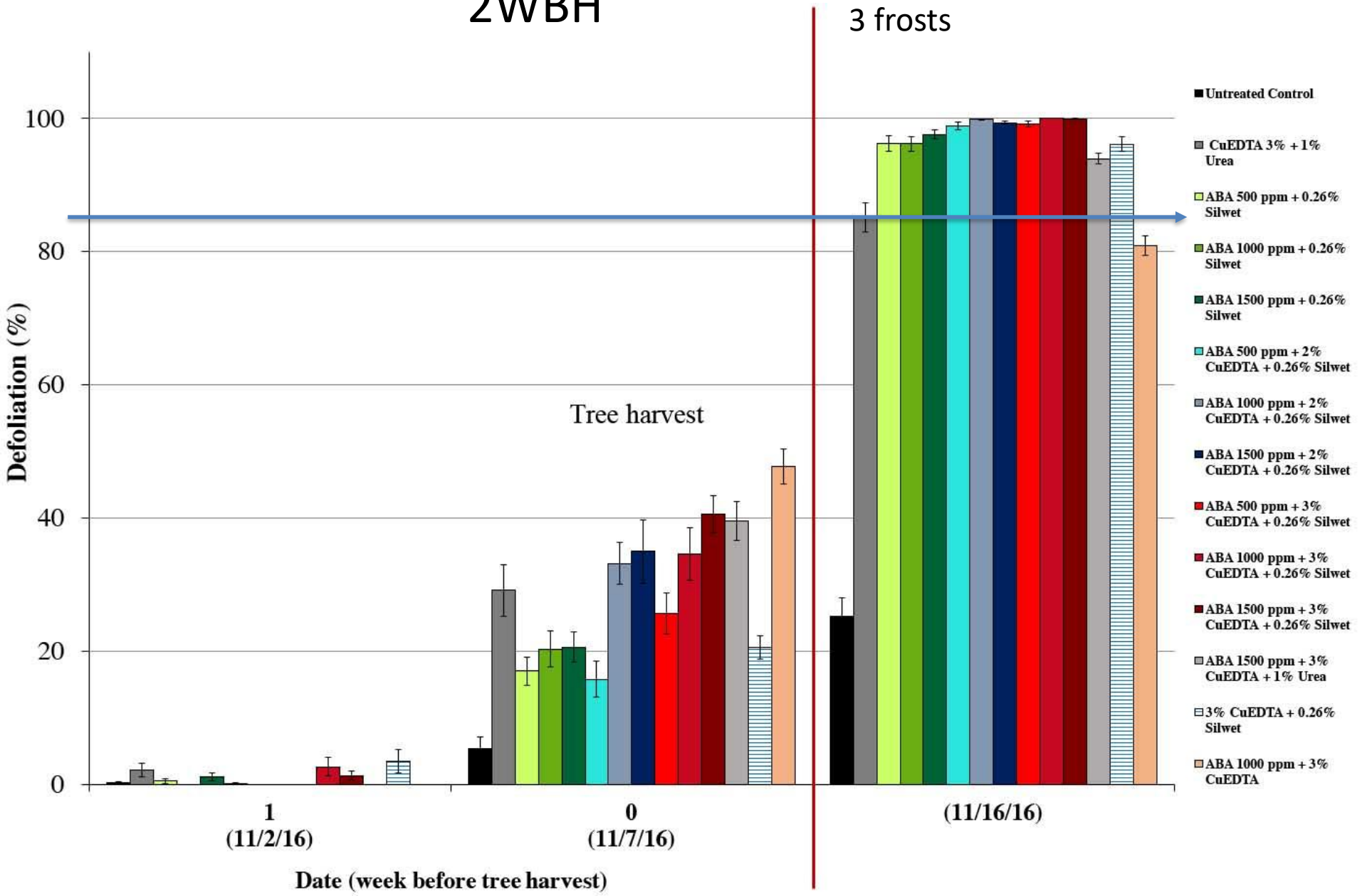
ABA 500 ppm + CuEDTA 3% + Silwet 0.26%

ABA 500 ppm + CuEDTA 3% + Silwet 0.26%
10/26/16 – 2 weeks after spray – Time 1

Temperatures during treatment applications in 2016



% Defoliation
2WBH



11/16/16 – 5 weeks after treatments

High rates of ABA + CuEDTA + Silwet

50% terminal bud injury on the 4 WBD applications
5% terminal bud injury on the 2 WBD applications

3% CuEDTA + 1% Urea
(untreated control)

ABA 1500 ppm + 2% CuEDTA
+ 0.26% Silwet.

Conclusions from 2016

- Cold vs warm weather – ABA rates responses.
- No difference between 500ppm and 1500ppm of ABA (plus Cu and Silwet) when temps are high (around 55-60F). If cold then a higher rate of ABA would be recommended.
- 1500ppm ABA + 3% CuEDTA + 0.26% Silwet damaged the terminal bud – but no concerns from the grower.
- CuEDTA 2% vs 3% - no difference.
- Silwet has a great effect when added to the tank.

2017

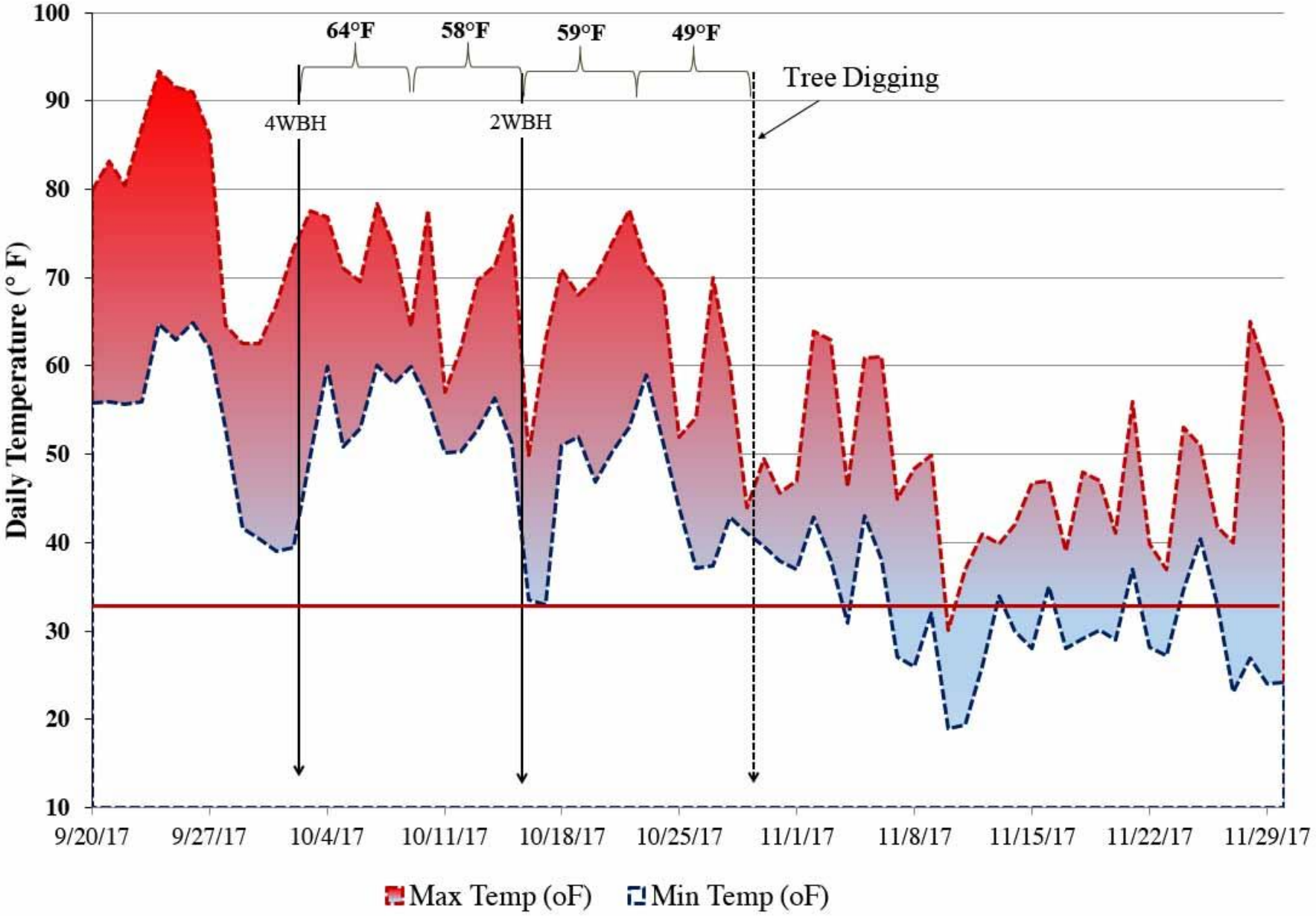
Minneiska/BA

Cu: Magna-Bon CS2005® - 19.8% Copper Sulfate Pentahydrate. As Magna-Bon is equivalent a 5% chelated copper we used 3%.

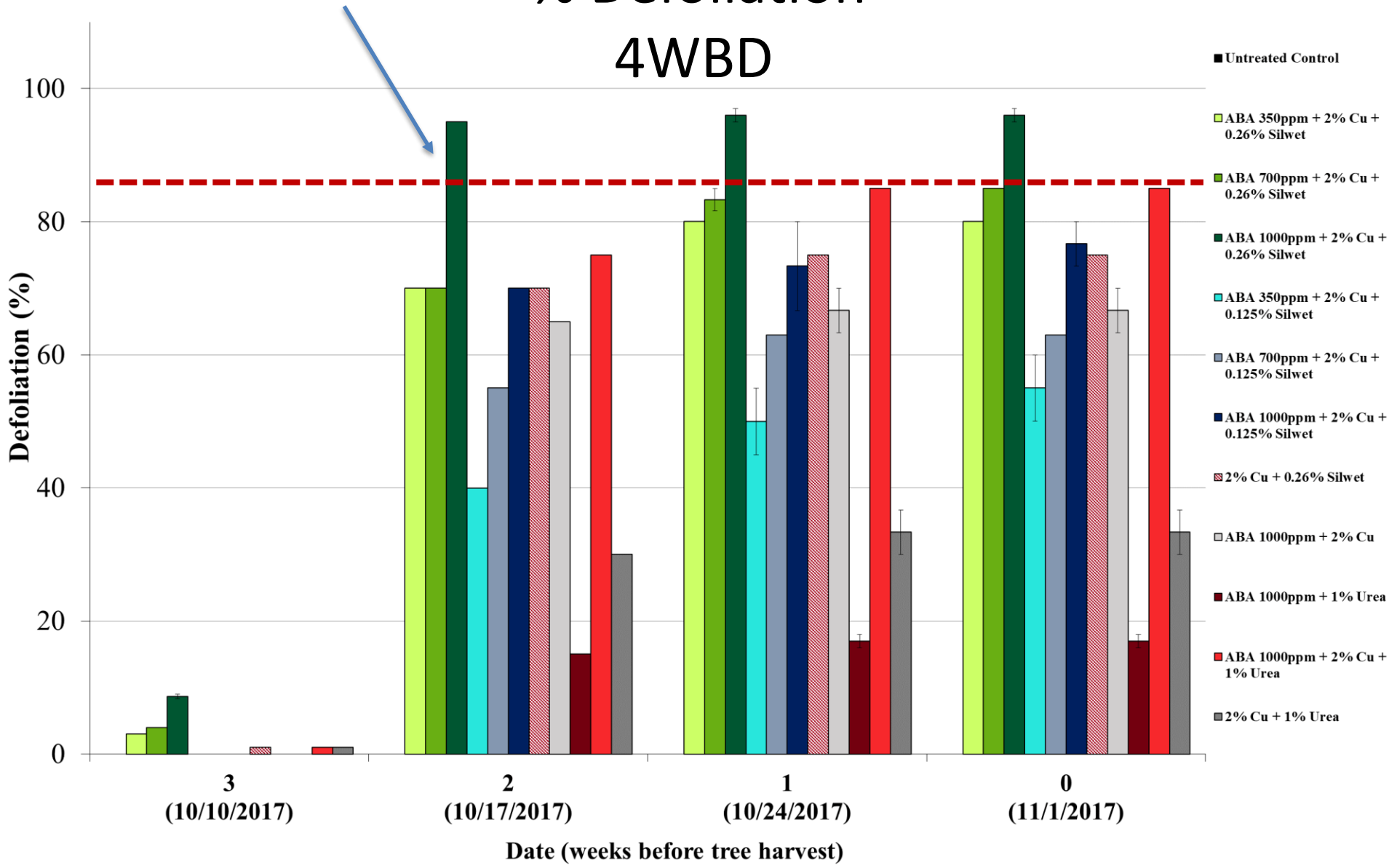
ABA (Protone) – 350ppm, 700ppm and 1000ppm

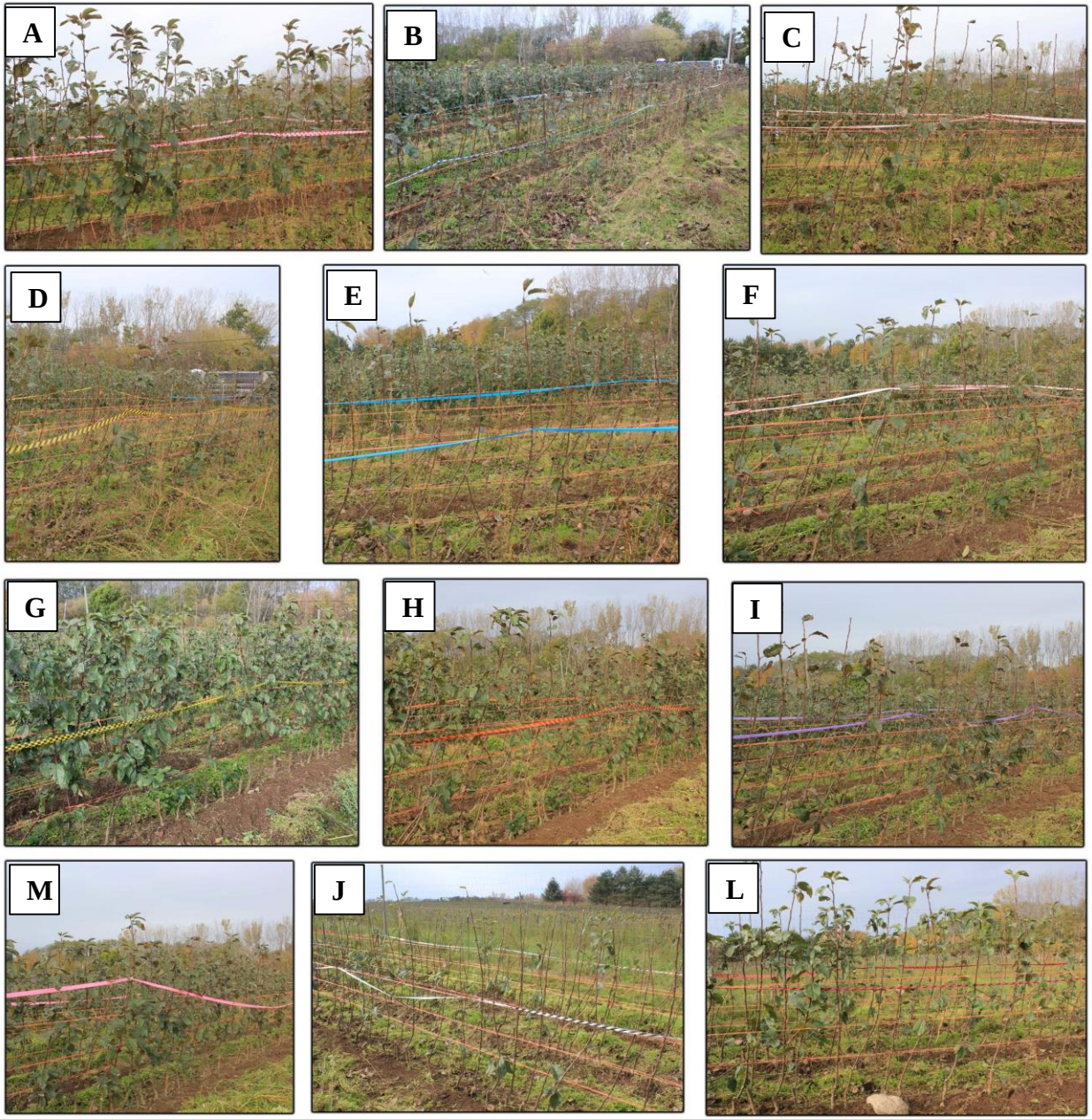
Silwet : 0.26 to 0.125%

Temperatures during treatment applications in 2017



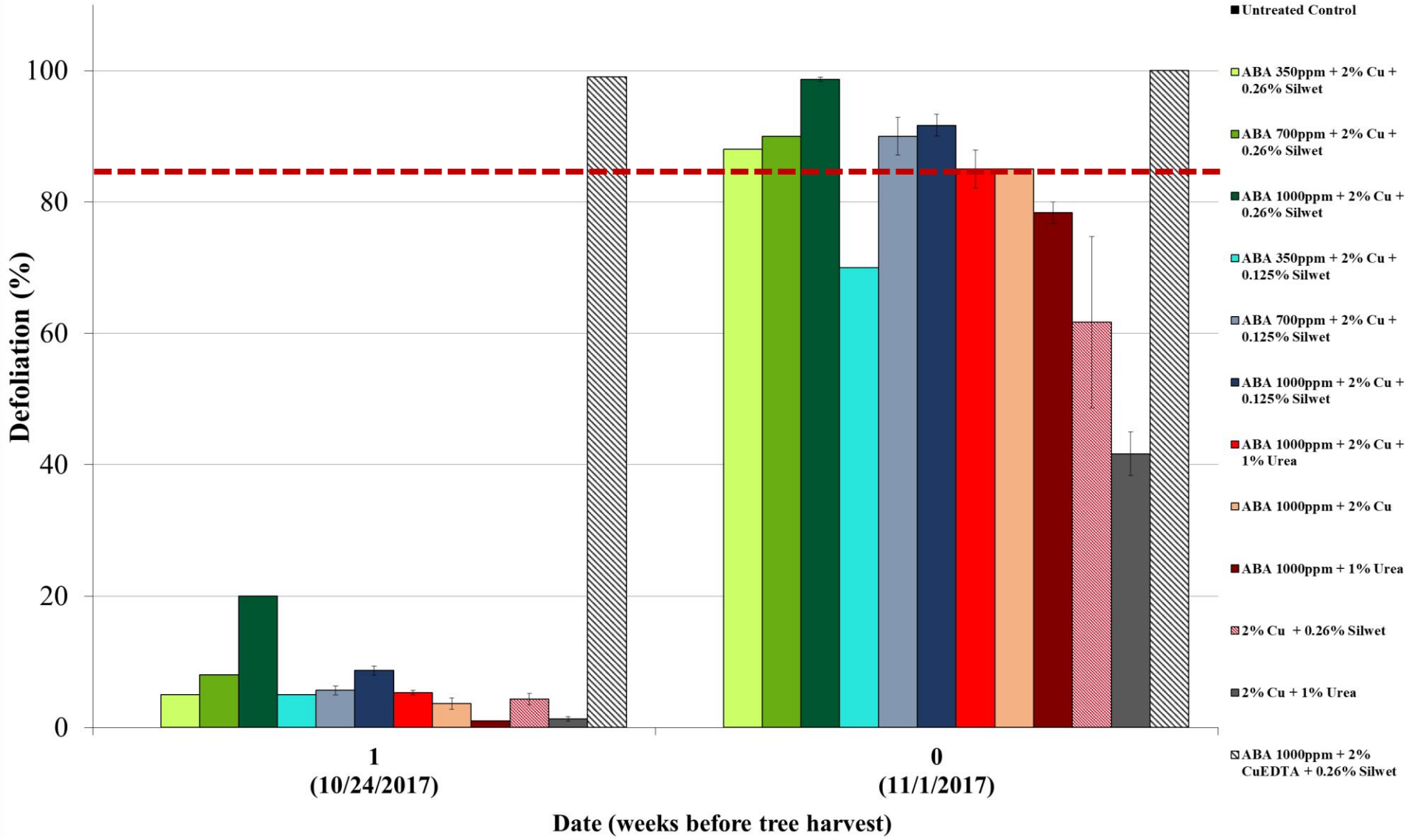
% Defoliation 4WBD





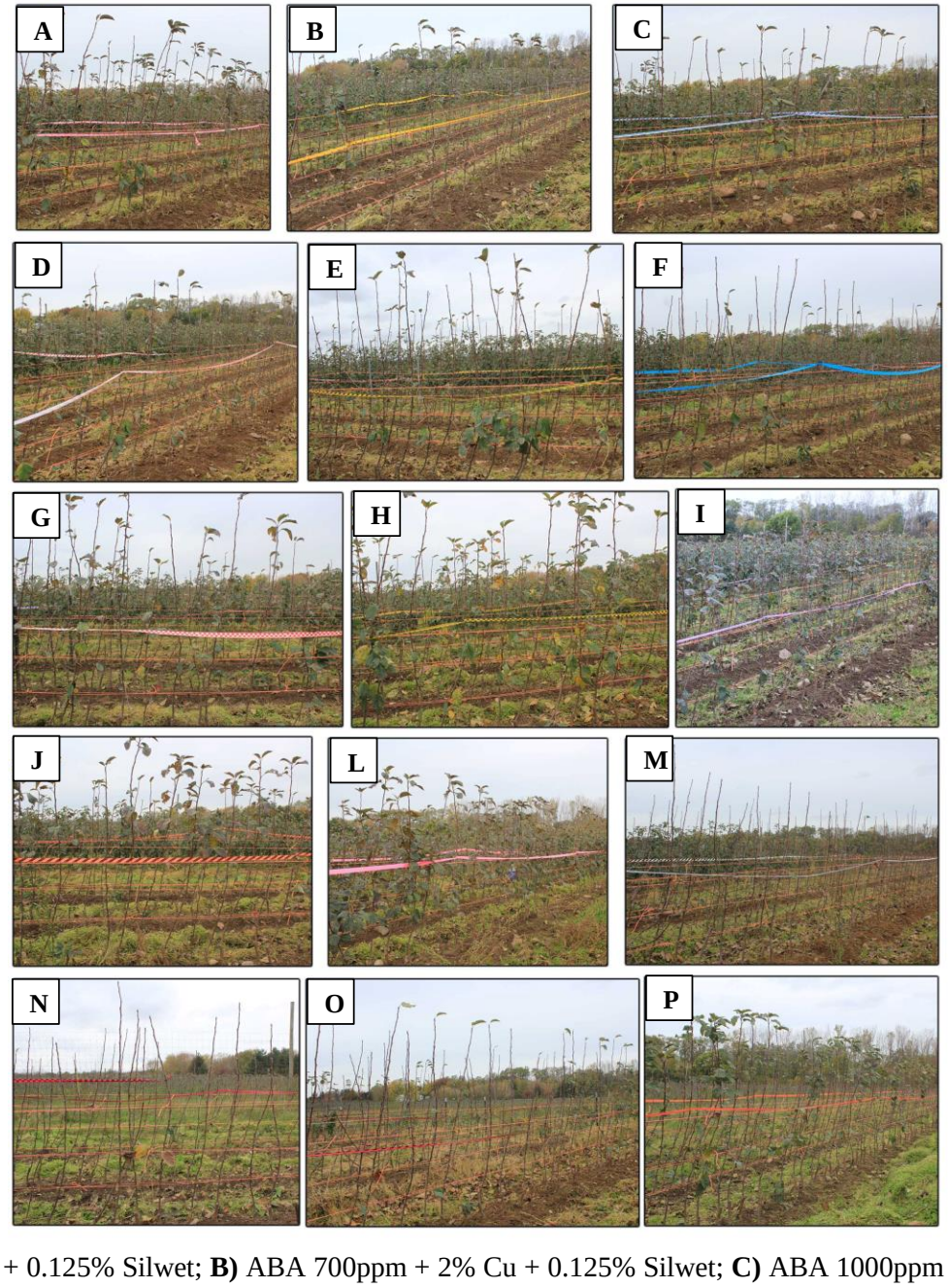
4 weeks before Harvest date (Oct. 2, 2017)

(Spray application**A)** ABA 350ppm + 2% Cu + 0.125% Silwet; **B)** ABA 1000ppm + 2% Cu + 0.125% Silwet; **C)** ABA 350ppm + 2% Cu + 0.26% Silwet; **D)** ABA 700ppm + 2% Cu + 0.26% Silwet; **E)** ABA 1000ppm + 2% Cu + 0.26% Silwet; **F)** ABA 1000ppm + 2% Cu + 1% Urea; **G)** ABA 1000ppm + 1% Urea; **H)** ABA 1000ppm + 2% Cu; **I)** 2% Cu + 0.26% Silwet; **J)** ABA 500ppm + Ethephon 500ppm + 0.125% Silwet; **L)** ABA 1000ppm + Ethephon 1000ppm; **M)** 2% Cu + 1% Urea.


Defoliation (%)
100
80
60
40
20
0
1
(10/24/2017)
0
(11/1/2017)
Date (weeks before tree harvest)
Untreated Control
ABA 350ppm + 2% Cu + 0.26% Silwet
ABA 700ppm + 2% Cu + 0.26% Silwet
ABA 1000ppm + 2% Cu + 0.26% Silwet
ABA 350ppm + 2% Cu + 0.125% Silwet
ABA 700ppm + 2% Cu + 0.125% Silwet
ABA 1000ppm + 2% Cu + 0.125% Silwet
ABA 1000ppm + 2% Cu + 1% Urea
ABA 1000ppm + 2% Cu
ABA 1000ppm + 1% Urea
2% Cu + 0.26% Silwet
2% Cu + 1% Urea
ABA 1000ppm + 2% CuEDTA + 0.26% Silwet

ABA 1000ppm + 2% CuEDTA + 0.26% Silwet

Defoliation occurred in one week



2 weeks before Harvest date (Oct. 17, 2017)

A) ABA 350ppm + 2% Cu + 0.125% Silwet; **B)** ABA 700ppm + 2% Cu + 0.125% Silwet; **C)** ABA 1000ppm + 2% Cu + 0.125% Silwet; **D)** ABA 350ppm + 2% Cu + 0.26% Silwet; **E)** ABA 700ppm + 2% Cu + 0.26% Silwet; **F)** ABA 1000ppm + 2% Cu + 0.26% Silwet; **G)** ABA 1000ppm + 2% Cu + 1% Urea; **H)** ABA 1000ppm + 1% Urea; **I)** 2% Cu + 0.26% Silwet; **J)** ABA 1000ppm + 2% Cu; **L)** 2% Cu + 1% Urea; **M)** ABA 500ppm + Ethephon 500ppm + 0.125% Silwet; **N)** ABA 1000ppm + Ethephon 1000ppm; **O)** ABA 500ppm + Ethephon 500 ppm + 3% Urea; **P)** Ethephon 500ppm + 0.125% Silwet.

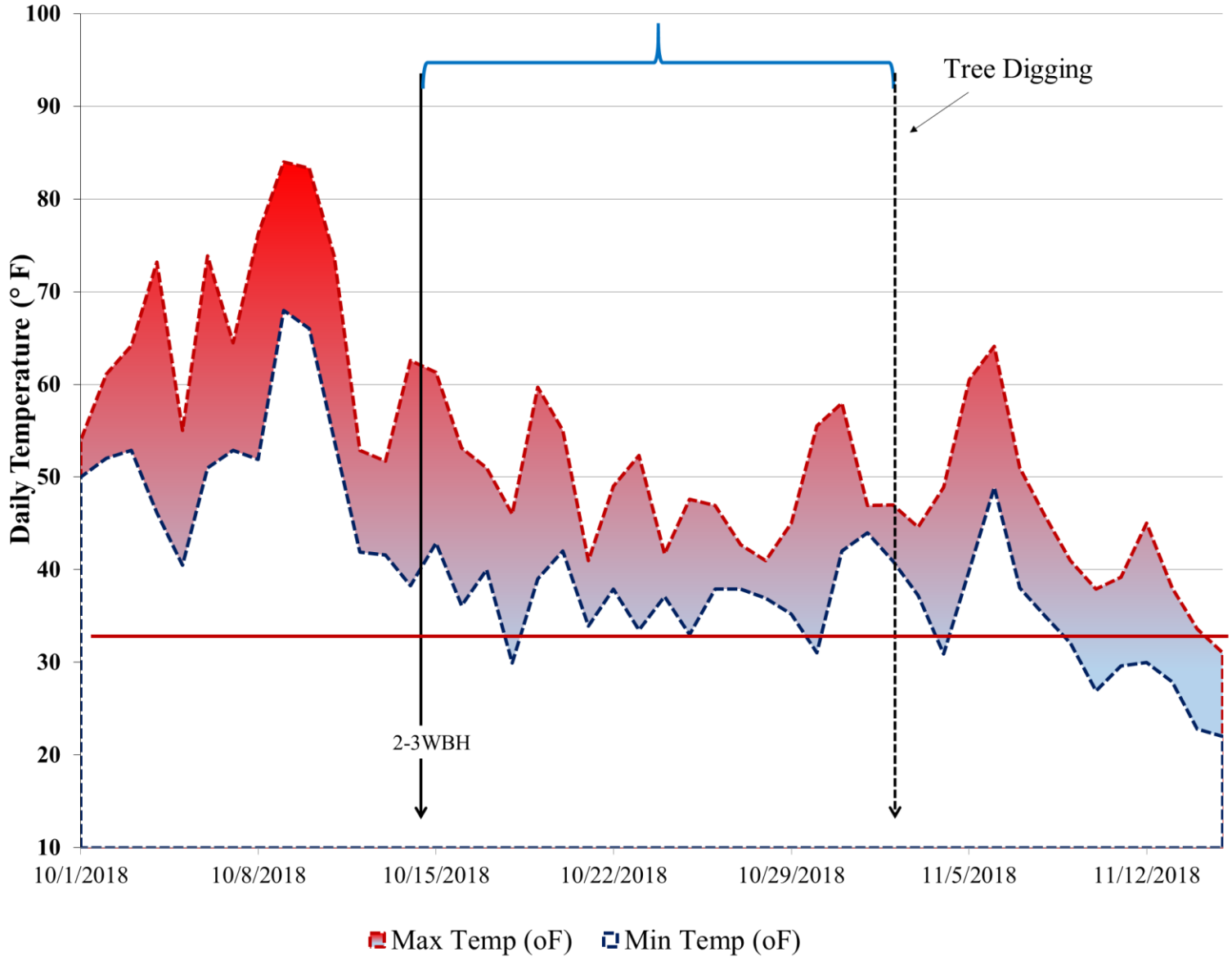
Untreated control trees – harvest date

2018

XX Variety/B.9

CuEDTA: TRACO™ 7.5% Copper EDTA Chelate Solution – 2%
ABA (Protone) = 500 and 1000 ppm
Urea: 1 and 3%
Silwet (nonionic organosilicone surfactant) = 0.125 and 0.26%

Temperatures during treatment applications in 2017



CuEDTA 2% + Urea 3% + Silwet 0.06%

CuEDTA 2% + Urea 1% + Silwet 0.125%

CuEDTA 2% + Urea 1% + Silwet 0.26%

CuEDTA 2% + Urea 1%

ABA 1000ppm + CuEDTA 2% + Silwet 0.26%

ABA 500ppm + CuEDTA 2% + Silwet 0.26%

ABA 1000ppm + CuEDTA 2% + Silwet 0.125%

ABA 500ppm + CuEDTA 2% + Silwet 0.125%

ABA 500ppm + CuEDTA 2% + Urea 3%

Untreated control

Conclusions

- The addition of chelated copper, Silwet or urea in the ABA tank provided substantial increase of defoliation.
- Temperature was one of the major driving factors that influenced the efficacy of the defoliants. Warm temperatures (above 55ºF) during and after spray application (at least 3 to 4 days) are required for better defoliation. On the other side, a good frost is also good.
- In all years and for most of the chemicals tested, the maximum defoliation was observed in two or three weeks after application.
- For better results, chelated copper (CuEDTA) is preferable to sulfate copper petahydrate. If Metallic Cu is used then ABA at higher rate (1000 ppm) works best;
- No difference between 2% and 3% of CuEDTA when combined with ABA+Silwet.
- Silwet at 0.125% worked as good as 0.26% in the ABA+CuEDTA combo;

Conclusions

- The threshold for ABA rate in this experiment was 1000 ppm. If temperatures were above 55-60^{o}F, 500 ppm ABA was as good as 1000 ppm in the combinations tested. However, when colder temperatures (no frost) are expected during spray application, a higher rate of ABA (1000 ppm) seemed to be needed.
- The addition of CuEDTA 3% in the ABA+Silwet (if rates of ABA is >1000 ppm) can cause damage to the terminal bud of the main leader when sprayed earlier. If no CuEDTA was added to the tank, no damage was observed. No injury to the terminal bud was observed when metallic copper was used.
- Urea may be an option to substitute Silwet acting either as a surfactant and enhanced the uptake of the defoliants, or might have promoted leaf abscission itself. A higher rate of Urea (>3%) in combination with ABA+CuEDTA need to be investigated.
- Backpack sprayer vs airblast sprayer – Good coverage (150 gallons/acre - 15000 trees)

Conclusions

- Based on the two-year experiment, we have already several alternatives that look promising for further consideration. Some choices will depend on how much defoliation is desired (50 to 100% defoliation) and the additional benefits the combination may provide.
- Cost-benefit will be probably favorable.
- Due to the unpredictability of the weather and inconsistency of the treatments in causing acceptable defoliation, the best option that has shown the most consistent results over the two years is, so far, the combination of ABA + CuEDTA + Silwet.
- Nutrient analysis of the buds is necessary to verify the real benefits of the treatments on mobilization of leaf nutrients, mainly N, intro tree storage.

Conclusions

Our best option:

150 GPA - 15000 trees/acre
Digging trees in early Nov.

If max temps are around 50s-60s, spray 3 weeks before harvesting the trees for better response.

- 40 – 48 oz Protone
- 2% CuEDTA 7.5 = 3 gallons
- 0.125% SilWet = 1.5 pint

If temperatures are in the mid 70s, defoliation can happen within a week. In this case, lower rates should be further investigated.

Chemical Defoliation of Apple Trees

Need:

WAS: old trees - early pruning
young trees – reduce cold damage

WAS and NY: top-grafting trees – intensive growth (rainy periods) – reduce cold damage

Brazil: mainly to induce dormancy;

Thank you!