Pruning to death: effect of topping on plant growth and physiology and on microclimate conditions

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TREE FUND
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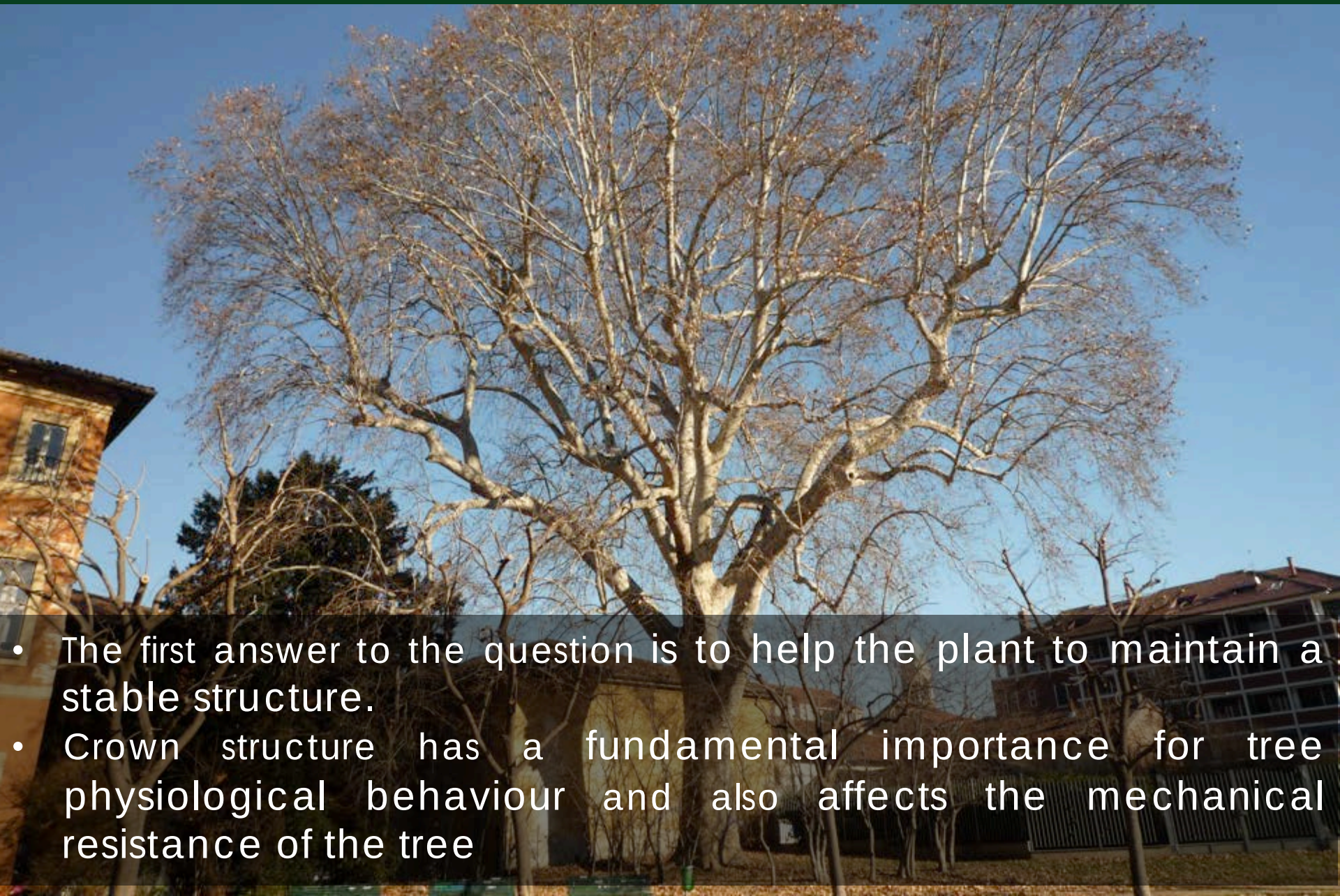
Pruning can be one of the best things an arborist can do for a tree and one of the worst things an arborist (??) can do to a tree (Shigo, 1989).

Pruning…why?



- The first answer to the question is to help the plant to maintain a stable structure.
- Crown structure has a fundamental importance for tree physiological behaviour and also affects the mechanical resistance of the tree

What do we really know about ornamental tree pruning?

- Pruning severity and timing *(Mierowska et al., 2002; Gilman and Grabosky, 2009, AUF; Fini et al., 2013; Purcell, 2015)*
- Tree response to wounding *(Solomon and Blum, 1977; Neely, 1979; Dujesiefken et al., 2005; O'hara, 2007; Schwarze,2008)*
- Compartmentalization of wood decay fungi *(Shigo and Marx, 1977; Schwarze, 2001; O'Hara, 2007; Schwarze et al., 2007)*
- Tree response in the wind *(Gilman et al., 2008a, 2008b; Pavliset al., 2008; James et al., 2006; James, 2010; James and Hallam, 2013)*

What don't we know?

Little information on pruning methods on the long-term structure and physiology of urban trees and that the effects of different pruning methods on tree physiology have received little attention and deserve further research (Clark and Matheny, 2010).

TREE FUND
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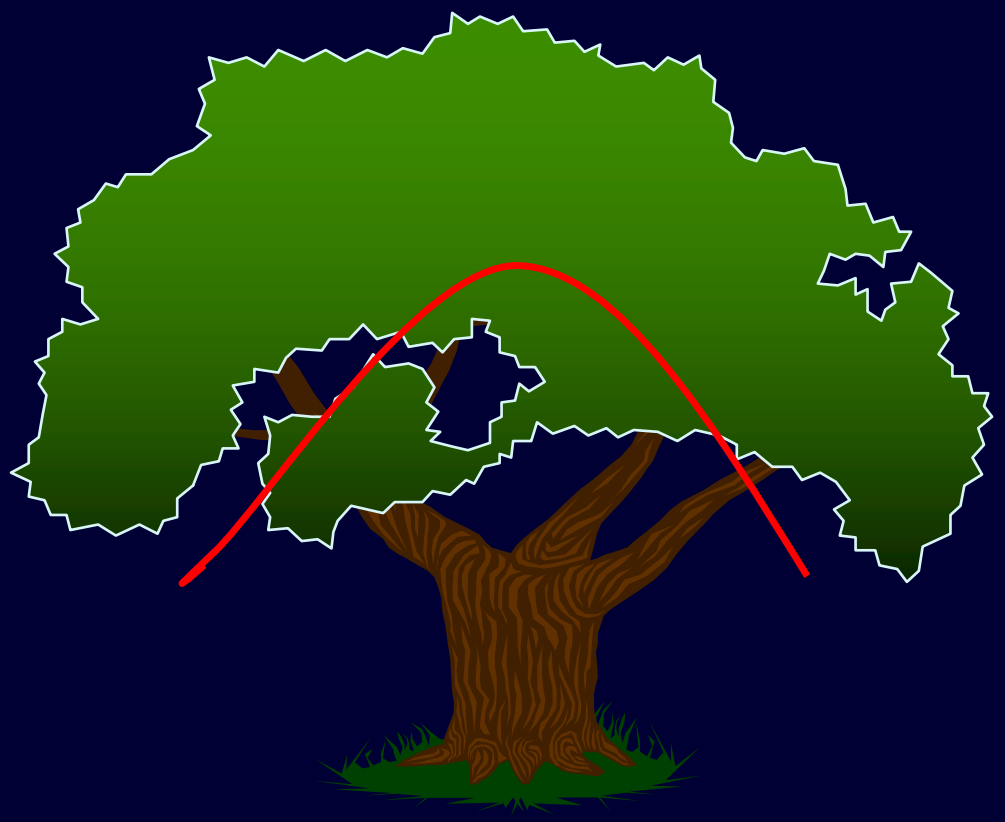
Future of Arboriculture
Topics

ENOUGH WITH
TOPPING RESEARCH!

LIONS TAIL NEEDS
TO STOP!

From Balder, 2008 readapted

Heavy pruning



Decrease of the photosynthesis rate

Reduction of assimilates

Lost of vitality

Attack of wood destroying fungi

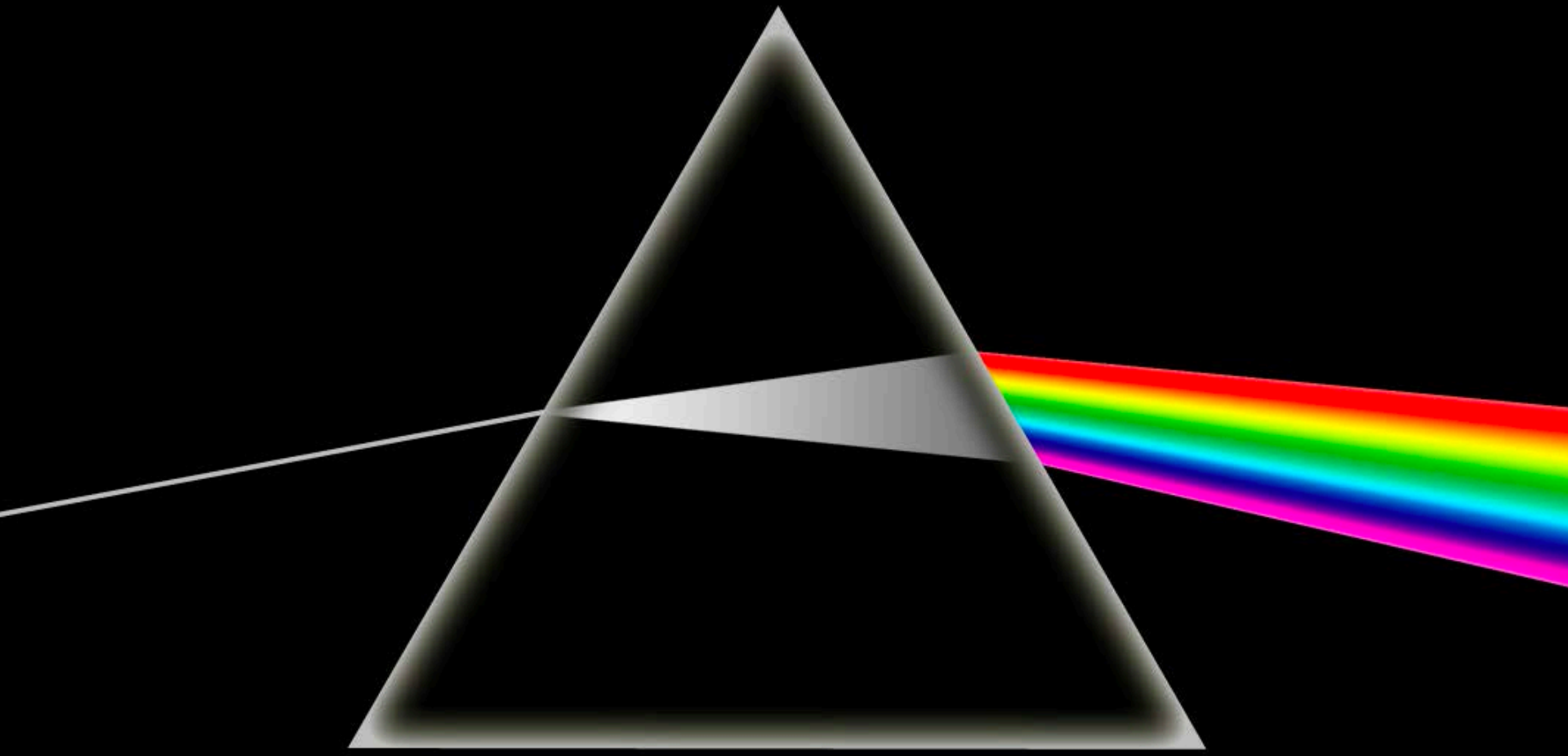
Uneven hormone situation

Sun damages on the stem

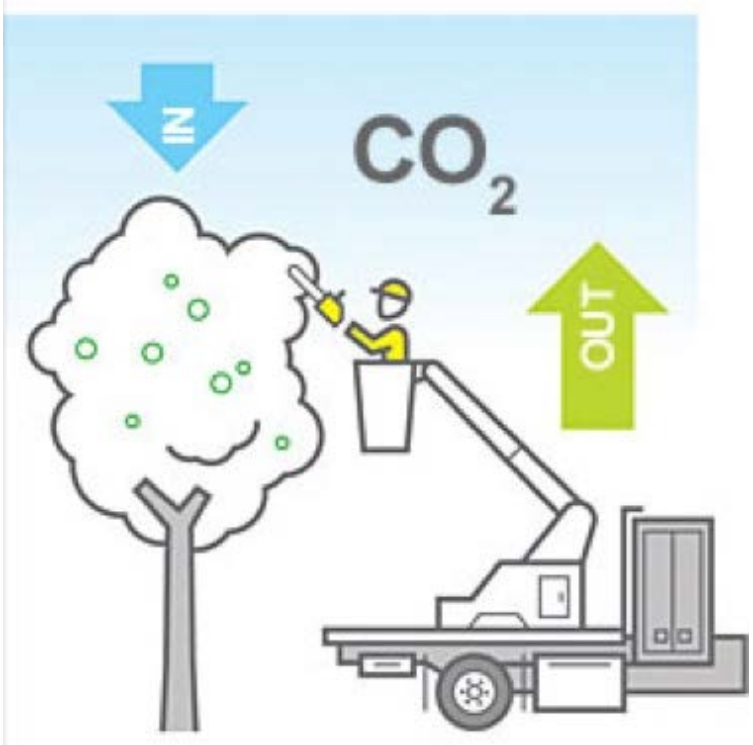
Lost of the crown architecture

Mobilisation of reserve substances

The dark side of tree topping

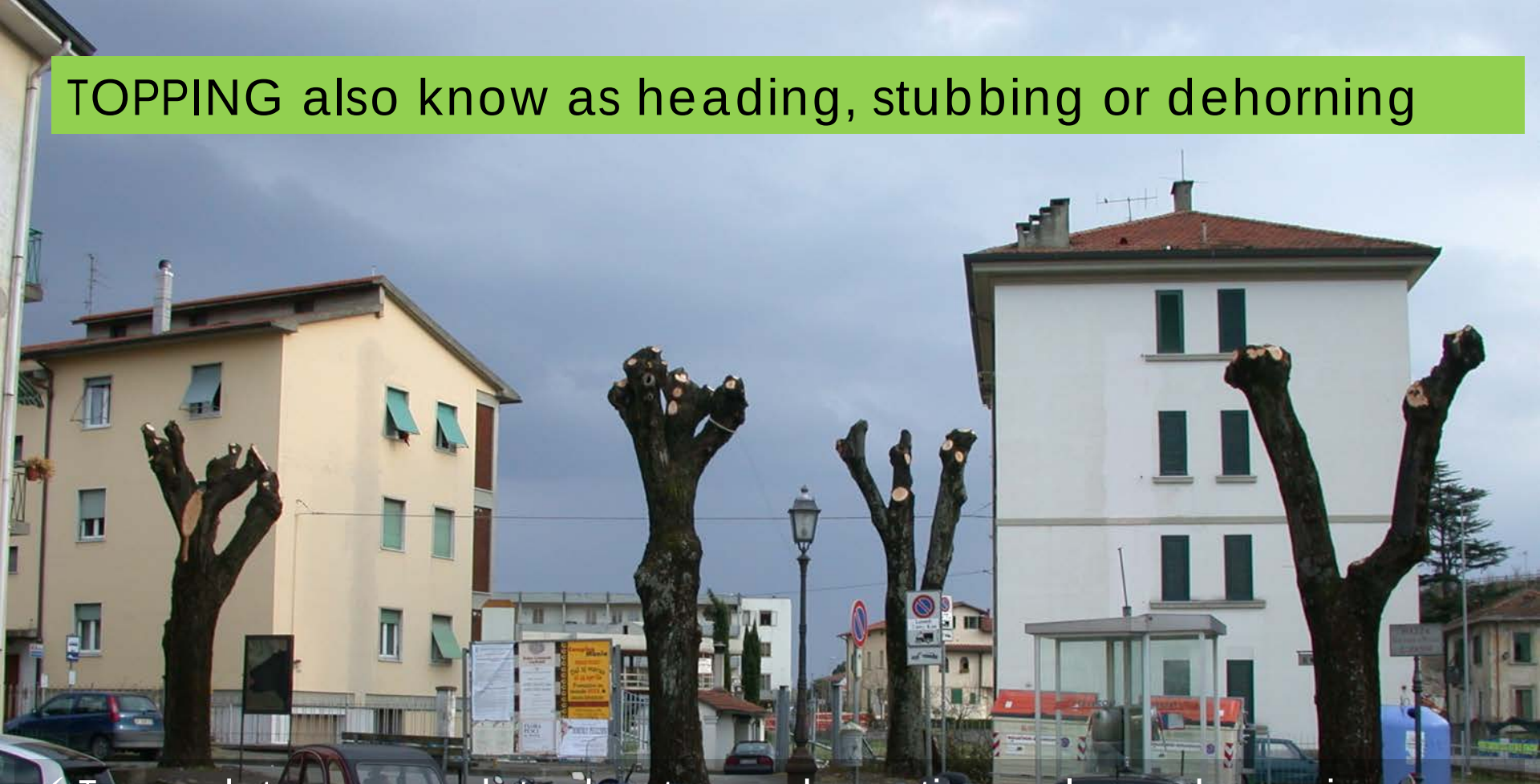


Anytime we prune a tree we produce a lot of CO_2



Anytime we prune a tree we reduce the CO_2 storage potential and the benefits provided will be reduced for several years

TOPPING also know as heading, stubbing or dehorning

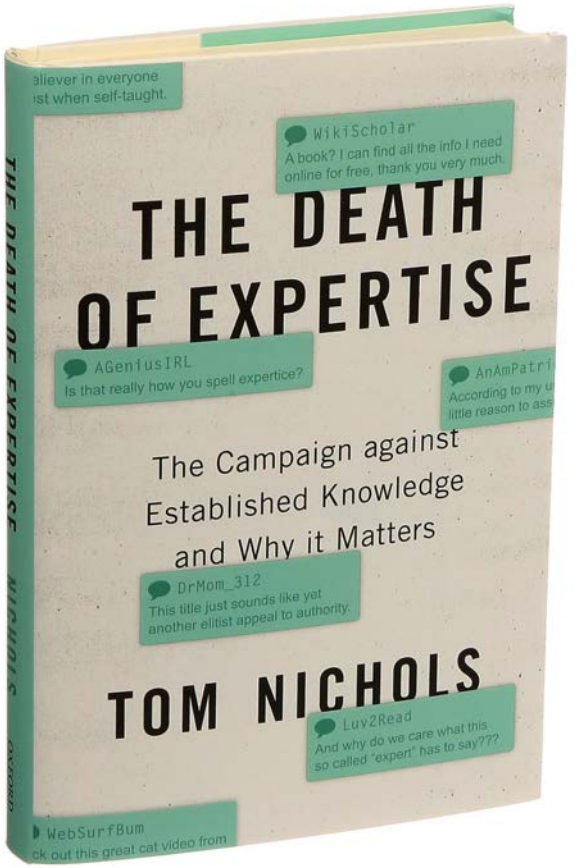


- ✓ Topped trees need to be topped continuously and require more attention in the future
- ✓ Topping will not invigorate trees: fewer leaves or the reduction of leaf surface may have negative effects on the root system. Removal of large portion of leaf bearing crown produces starving in trees
- ✓ Shoots of topped tree are weakly attached to the tree because they originate from buds near the surface

- ✓ A topped tree may more easily become a hazard because it causes wood decay
- ✓ Weakened trees are more vulnerable to insect and disease hazard
- ✓ Iper-topping can kill a tree
- ✓ Topped tree are more expensive in the long run and may cause property value to drop
- ✓ Topped tree are ugly, disfigured and their natural form is destroyed and can never be regained

Though severe pruning and crown restructure can be required for safety reason, such an intervention cannot be continued forever and is always deleterious for tree life

Why people top trees?



- Probably the expertise isn't dead but it's in real trouble.

- If you spend some time on social media for work you can see a disturbing trend taking place on the internet. A toxic brew of «I read it on Google» that is annihilating any professional work and provokes strong, and often angry, reactions when a true professional explains how a tree has to be pruned

CERTIFIED ARBORIST

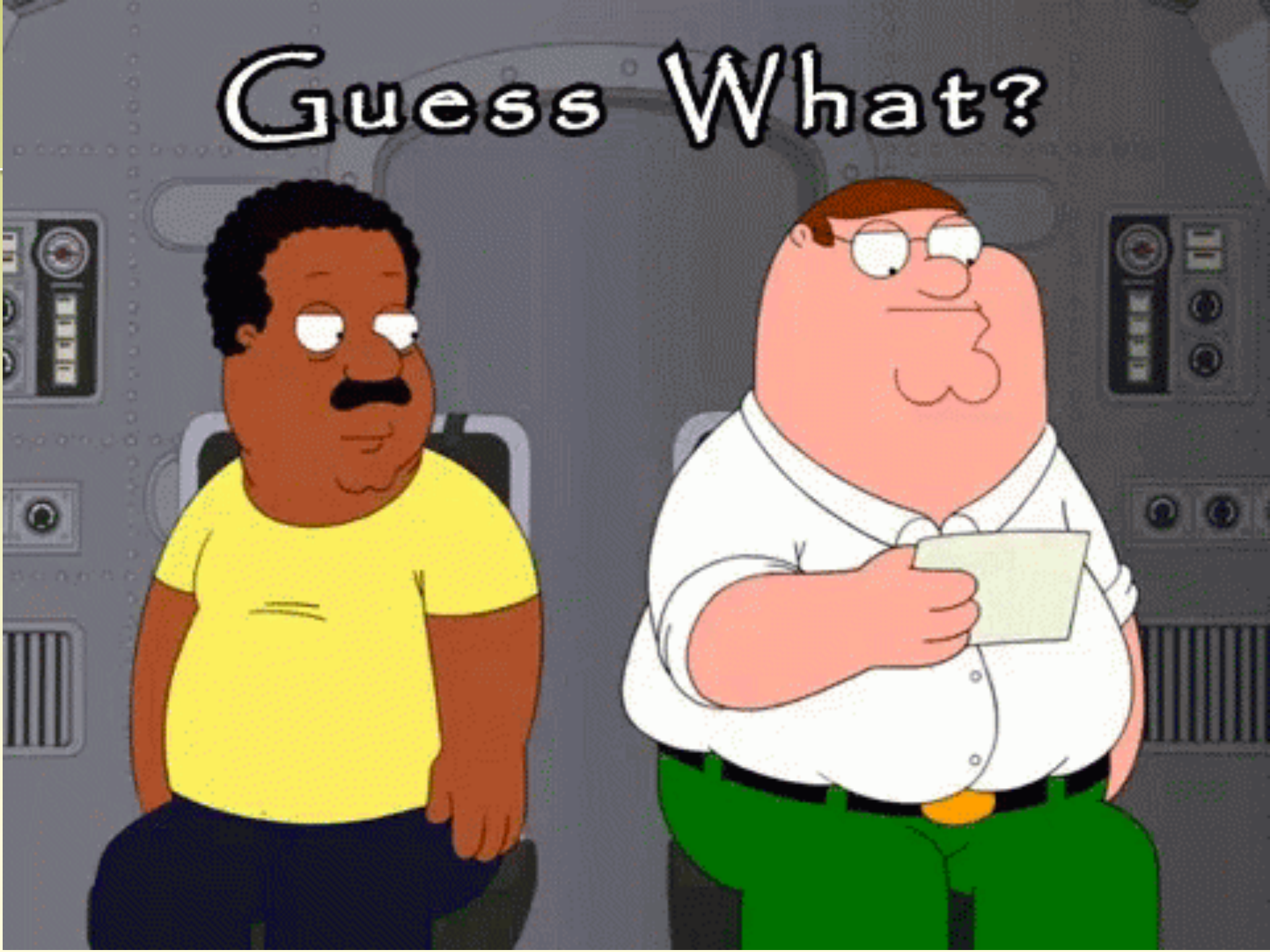
ISA

TM

Why people top trees?

- No national legislation ruling the best practices for pruning
- Privates top trees because of lack of information (every one is an arborist…)
- Fear of injury or to cause damage to their own or someone else property (that tree is too big. It must be dangerous…it's taller than my house. How dares it?
- Topping seems quicker and cheaper
- Despite the best pruning should be hardy noticeable, people want to see trees pruned…I want to see the pile of wood!!!!

Other reasons? Would love to know them!!


Guess What?

- **False information:** Many people think, that this is "the proper way to prune trees”.
- **Justification:** ”My customers always ask to take away a lot of wood”.
- **False myth:** "So the plants invigorate" (old popular belief) and then the next pruning will be done no less than five years from now!
- **Suspicious:** ”I know you arborists….., you want to make sure that you will come back again in two-three years, to steal me more money!”
- **Lack of trust:**” "But the gardeners I know tell me the opposite of what you say!”
- **Bad example:**” ”don’t bother me and look at what the City does”
- **Materialist:** ”But the summer shade of this tree is not pleasant?" ... "Yes it's true, but now we have the air conditioner"
- **(Da Bonora R., 2016. modified)**

Question: "But these coat racks for giants without branches, with few leaves, apart from the fact that their ecosystem services are close to zero, do you think they are nice to see?

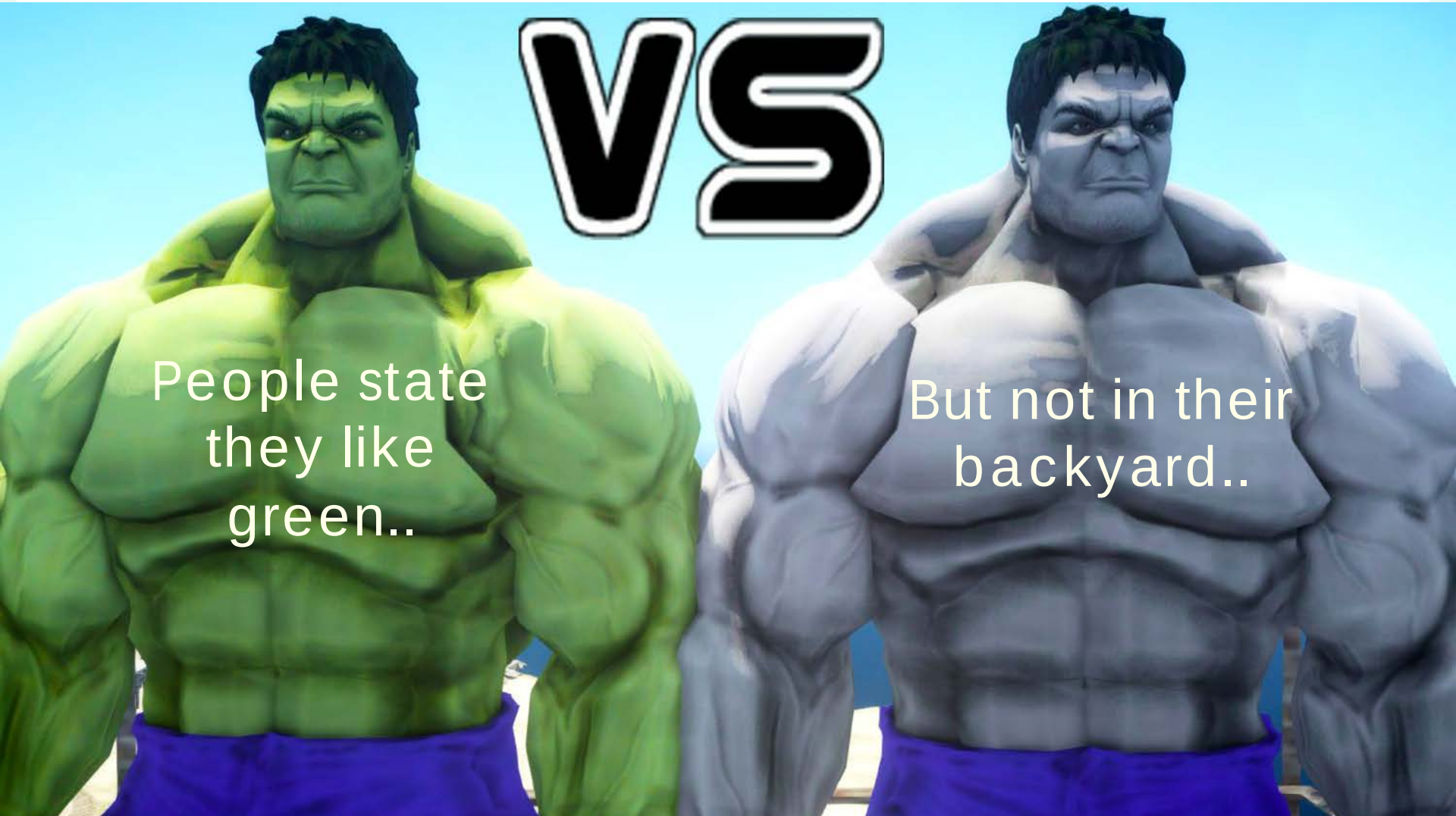
Answer: This is what you see around and in any case…. should my trees be the only defense against the pollution?

Preferences: "I'd rather spend my money on things that give me a lot more gratification (car, PC, smartphone, tablet, dining out, weekend excursions, trips…).

Grey vs Green: The lawn….. "next year we'll pave the area. Mowing is boring. "

(Da Bonora R., 2016. modified)

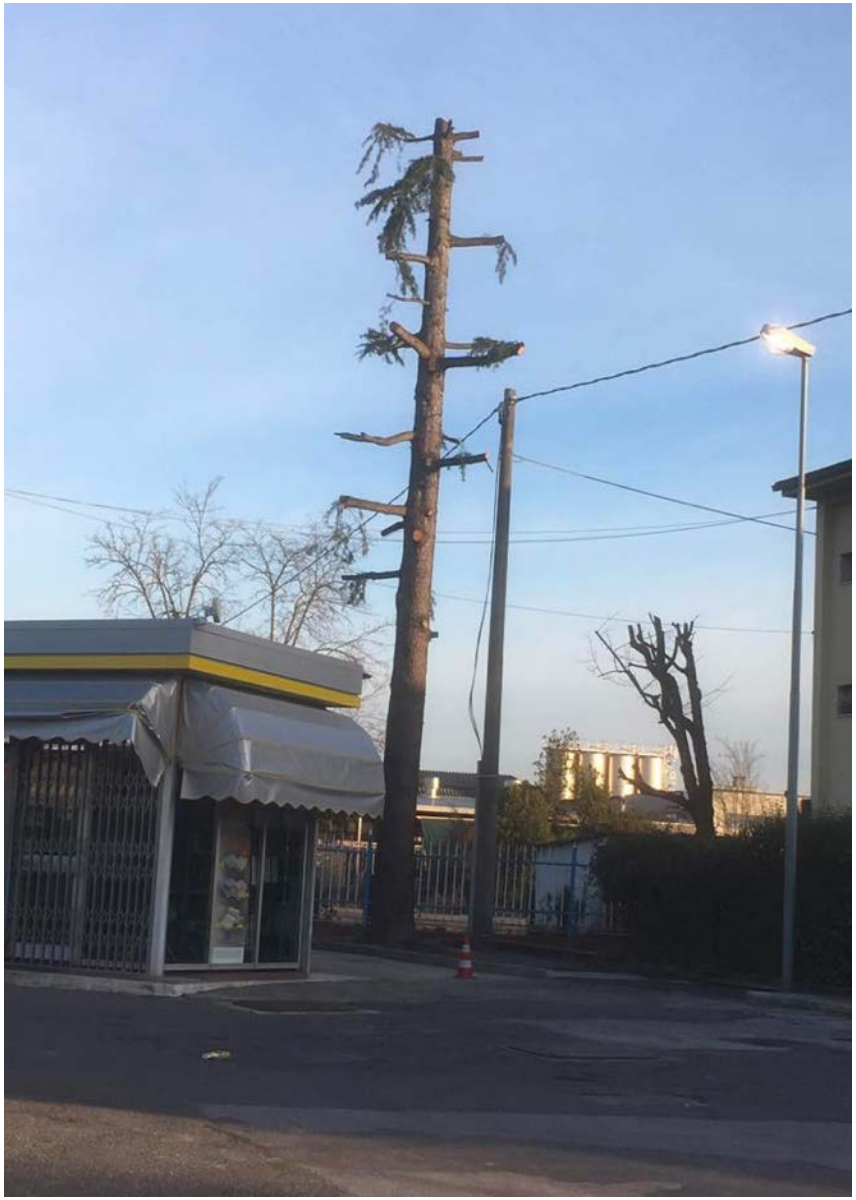
Green vs Grey



Why people hate trees?

1. They dirt (especially the leaves, but also fruit)
2. They are dangerous
3. They block the light (inducing mold, fungi, lawn and turf don't grow, etc.)
4. Ignorance and historical and cultural heritage (trees must be in the countryside and in the parks and not along the streets)
5. They host animals (squirrels, ibis, starlings, birds in general)
6. The roots damage the floors and buildings in general
7. They cost too much (i.e. to care for them)
8. There are too tall and large …(is higher than my house!!!)
9. They do not produce anything (tree that does not bear fruit, cut it all ....)
10. They provoke allergies
11. Cover and hamper visual landscapes
12. I want to pave my garden and trees stop me
13. They take off the air (??)
14. Political reasons (in one direction or another)
15. Are a refuge for thieves, junkies, make the roads less safe, etc.
16. They become ill
17. I hate my neighbor's tree (I actually hate my neighbor)

In Italy I've seen things... you people wouldn't believe. (readapted from Blade Runner, 1982)



An old saying maintains that Italians are a nation of poets, sailors and lovers…

Not a stereotype: we are the best toppers in the world!

We are proud to have such a long tradition of topping!!!!

Filare di platani nel parco delle Cascine. Le prime due piante ancora non potate; le altre con la chioma ridotta ai monconi dei rami principali.

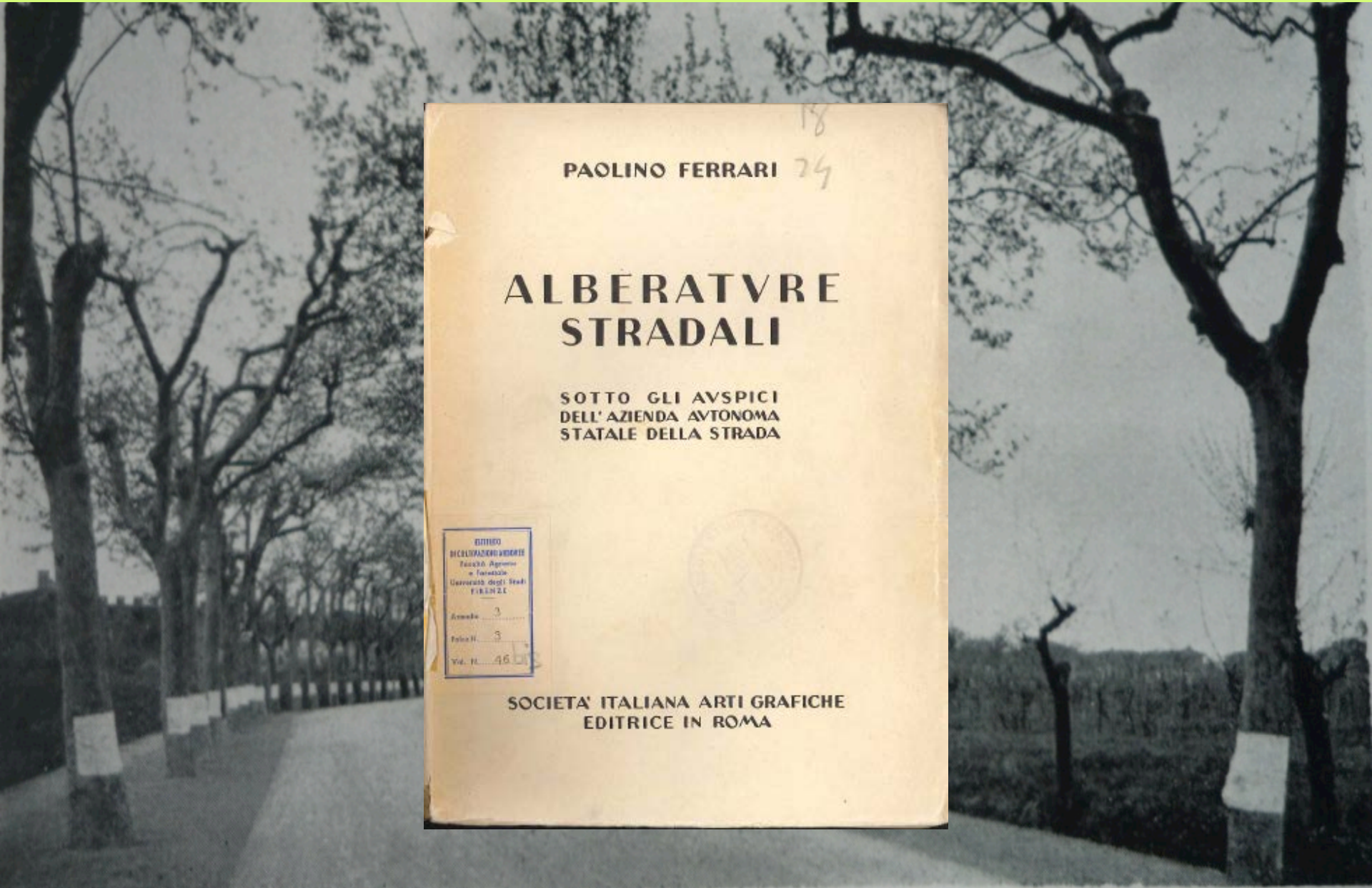
Row of plain trees in the Cascine Park in Florence. The first two plant still unpruned, the other with their crown mutilated

Il misero aspetto di un gruppo di alberi, una volta bellissimi, ora completamente mutilati dalla potatura. Per alcuni anni le piante non riformano una sufficiente chioma.

The ugly look of trees once very beautiful, now completely mutilated by topping. For several years these trees won't have a sufficient crown


This is how they pruned the same plane trees
the past winter

State road #12 “dell’Abetone e del Brennero” near Pisa, with a view of the Leaning Tower. Example of old street trees devastated by stupid topping (from Ferrari P., 1938)



Italians are artists…is it actually a stereotype?

Leonardo Da Vinci, *Annunciation*, 1475 – Uffici Gallery (Florence)

“New” pruning techniques recently developed in Italy

“Columnar” pruning

“Lunch break” pruning

“Umbrella” pruning

“New” pruning techniques recently developed in Italy

“Victory” pruning

“Ladder” pruning

“Go to hell” pruning

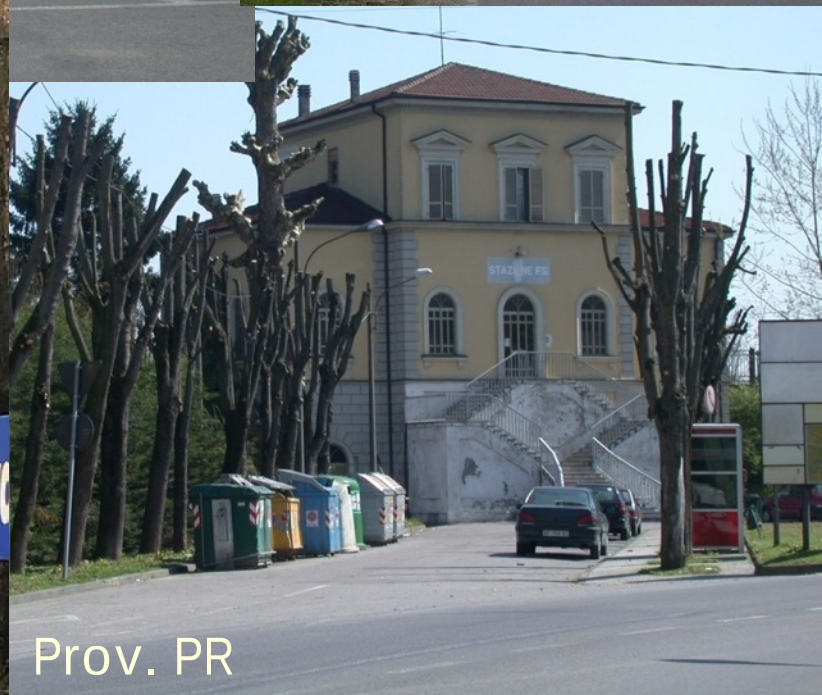
“New” pruning techniques recently developed in Italy

“Religious” pruning

“Toothbrush” pruning

“Criminal Massacre” pruning

GREATEST HITS I



GREATEST HITS II

Research on pruning ornamental trees at the University of Florence

Urban Forestry & Urban Greening 14 (2015) 664–674

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Effects of different pruning methods on an urban tree species: A four-year-experiment scaling down from the whole tree to the chloroplasts

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[c] Research Unit CLimate chAnge SyStem and Ecosystem (CLASSE), University of Florence, Florence, Italy
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Photo taken from: https://entretien-elagage-jardin-78.fr/taille-elagage-95/

Conclusions

We provide some evidence supporting old knowledge:

Myth: topping will make trees easier to maintain

FAKE: topped branches grew faster, more slender and codominance often occurred

Myth: topping invigorates trees

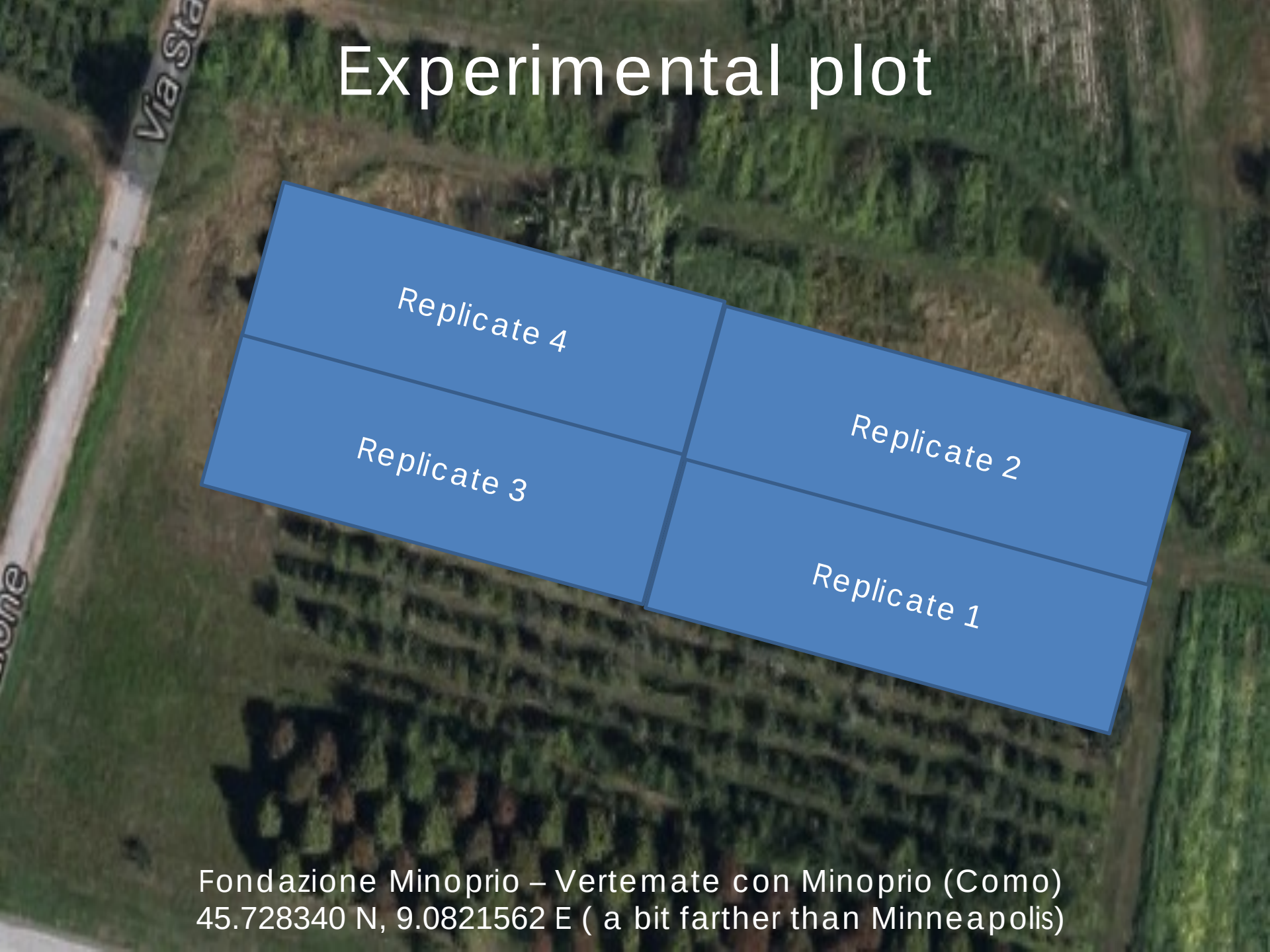
FAKE: topping altered tree physiology, providing a shift to a more pioneer behavior (each individual shoot grows as fast as possible), but at expenses of stress tolerance. Inefficiency increases within the tree.

- Pruning method, not only its severity, modulates the morpho-physiological response of trees.
- Removal cut provides minimal disturbance to tree physiology
- Reduction cut preserved normal branching pattern and had little effects on leaf structure and photosynthetic performance

Effect of topping on microclimate condition and on human comfort (ongoing first results)

supported by Tree FUND

Experimental plot



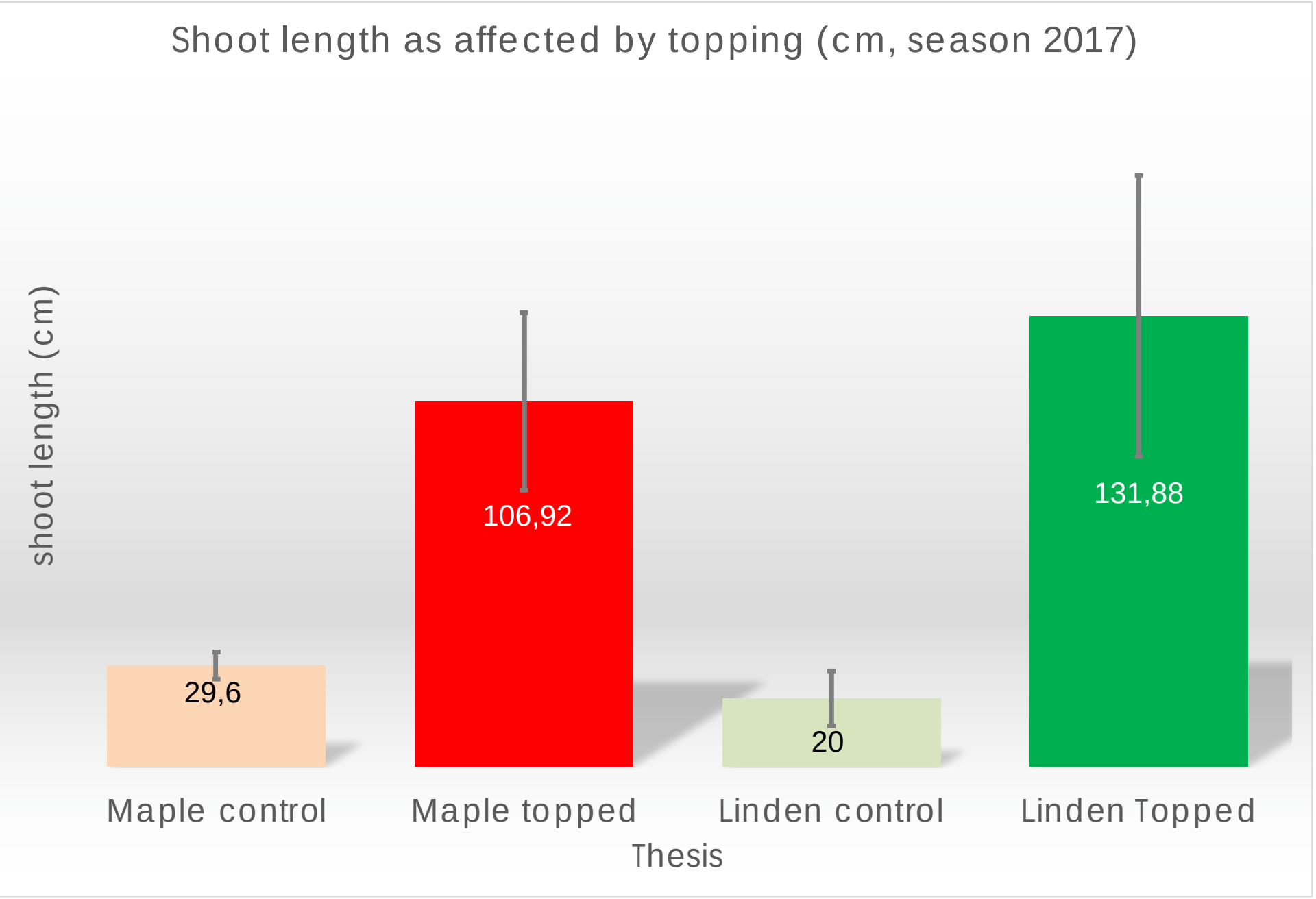
Fondazione Minoprio – Vertemate con Minoprio (Como)
45.728340 N, 9.0821562 E (a bit farther than Minneapolis)

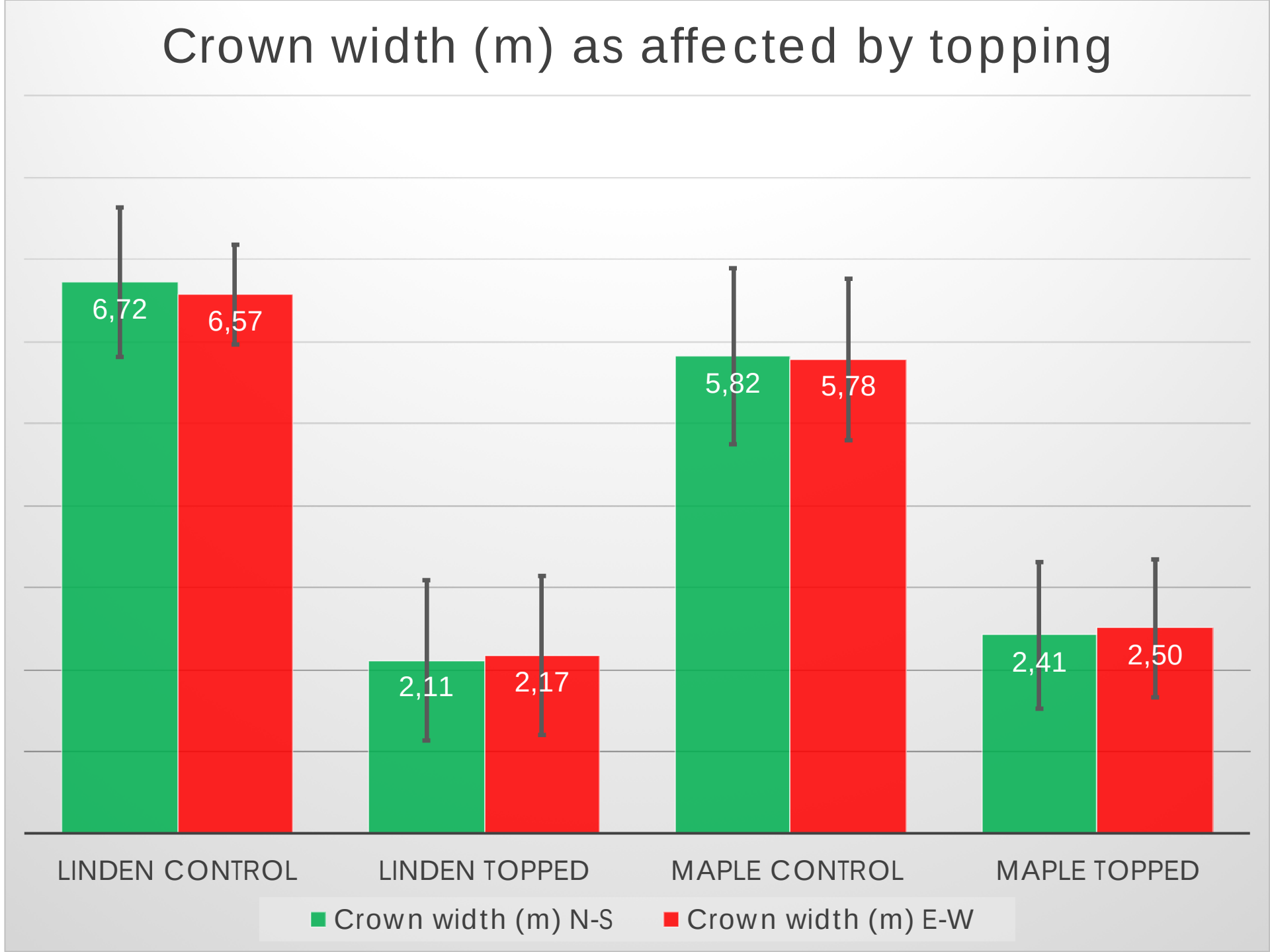
Parameters measured

- Phenological phases (budbreak date, leaf yellowing and leaf fall)
- Biometric data (shoot length, trunk diameter, crown width, leaf area)
- Ecophysiology (leaf gas exchange, A/Cc curves)
- SPAD value
- Thermal imager photos with drone + NDVI with drone
- Climate data (from 2016) every 15 minutes with 6 sensors HOBO Temperature/Relative Humidity Data Logger

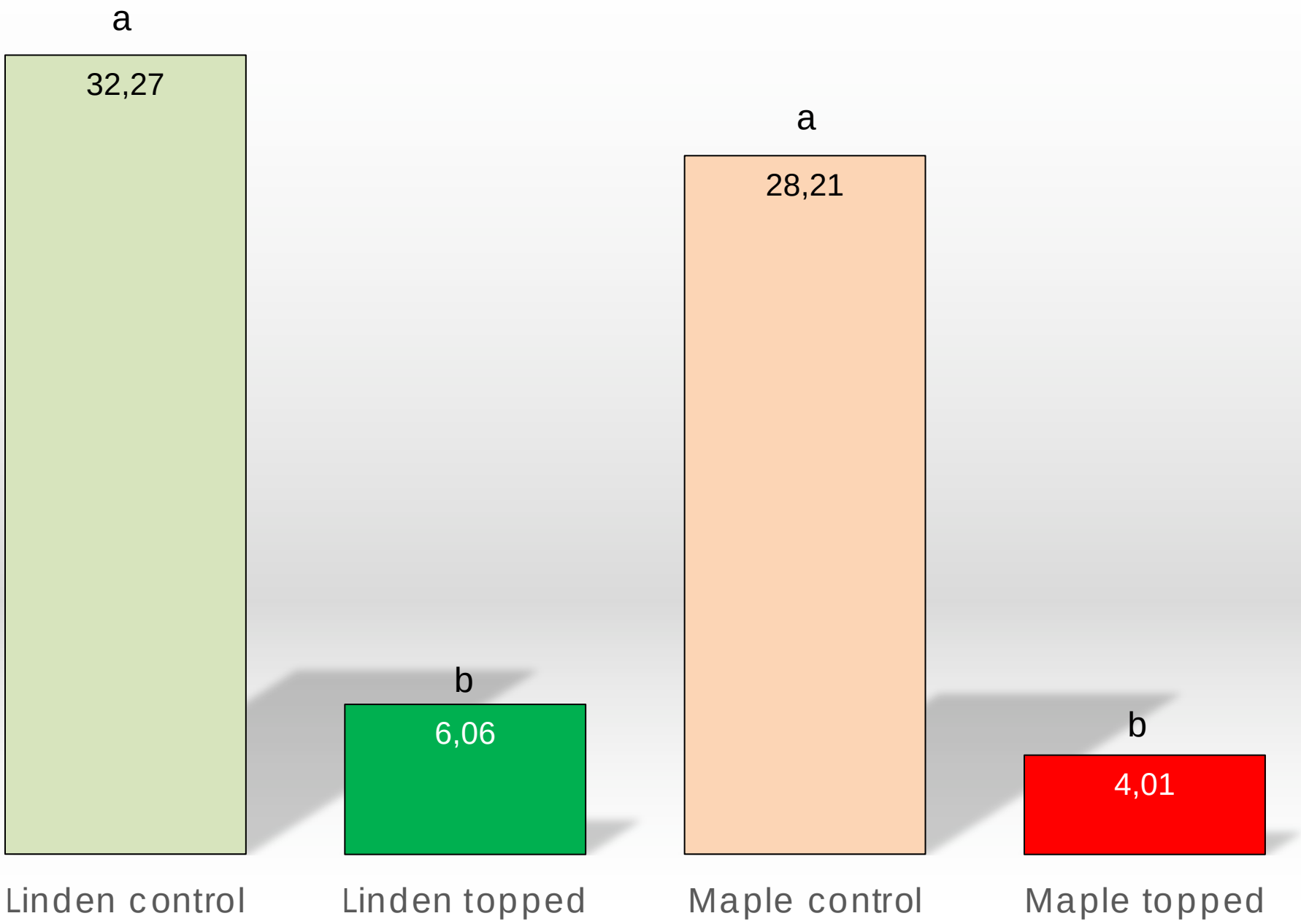
Results

Morphological and physiological data

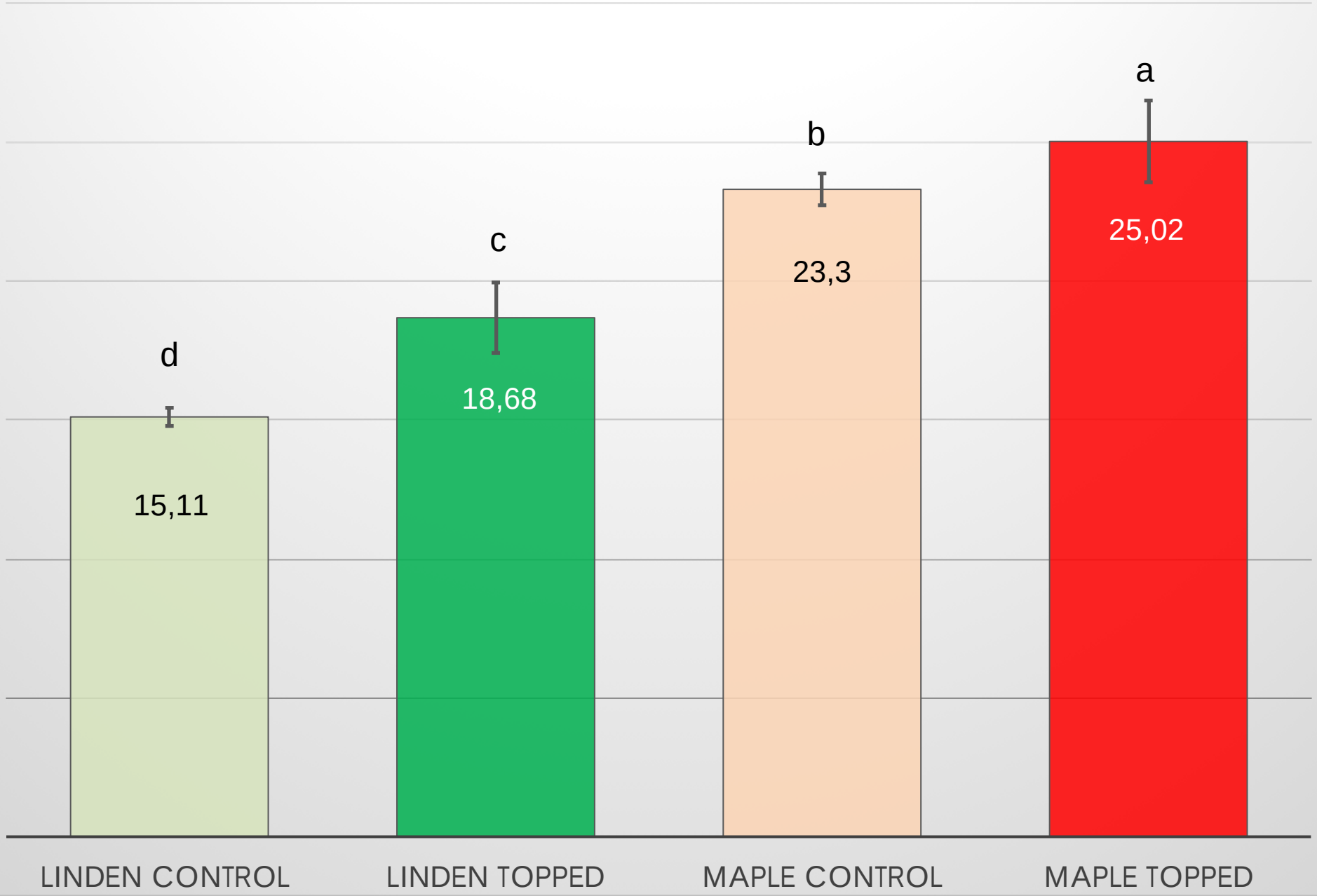

Shoot length as affected by topping (cm, season 2017)
shoot length (cm)
29,6
106,92
20
131,88
Maple control
Maple topped
Linden control
Linden Topped
Thesis

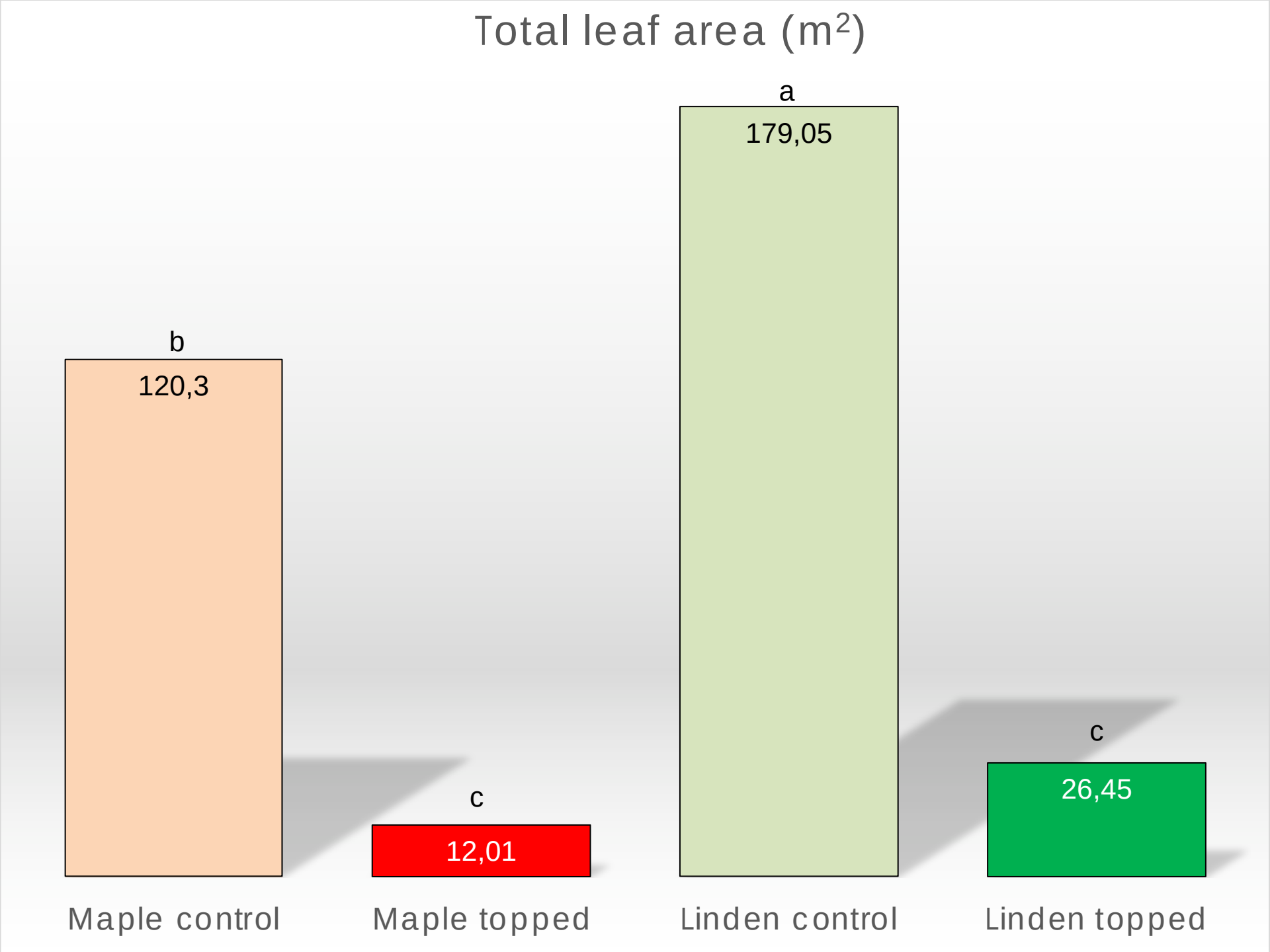

Crown width (m) as affected by topping
6,72
6,57
2,11
2,17
5,82
5,78
2,41
2,50
LINDEN CONTROL
LINDEN TOPPED
MAPLE CONTROL
MAPLE TOPPED
Crown width (m) N-S
Crown width (m) E-W

Dripline area 2017 (m^2)

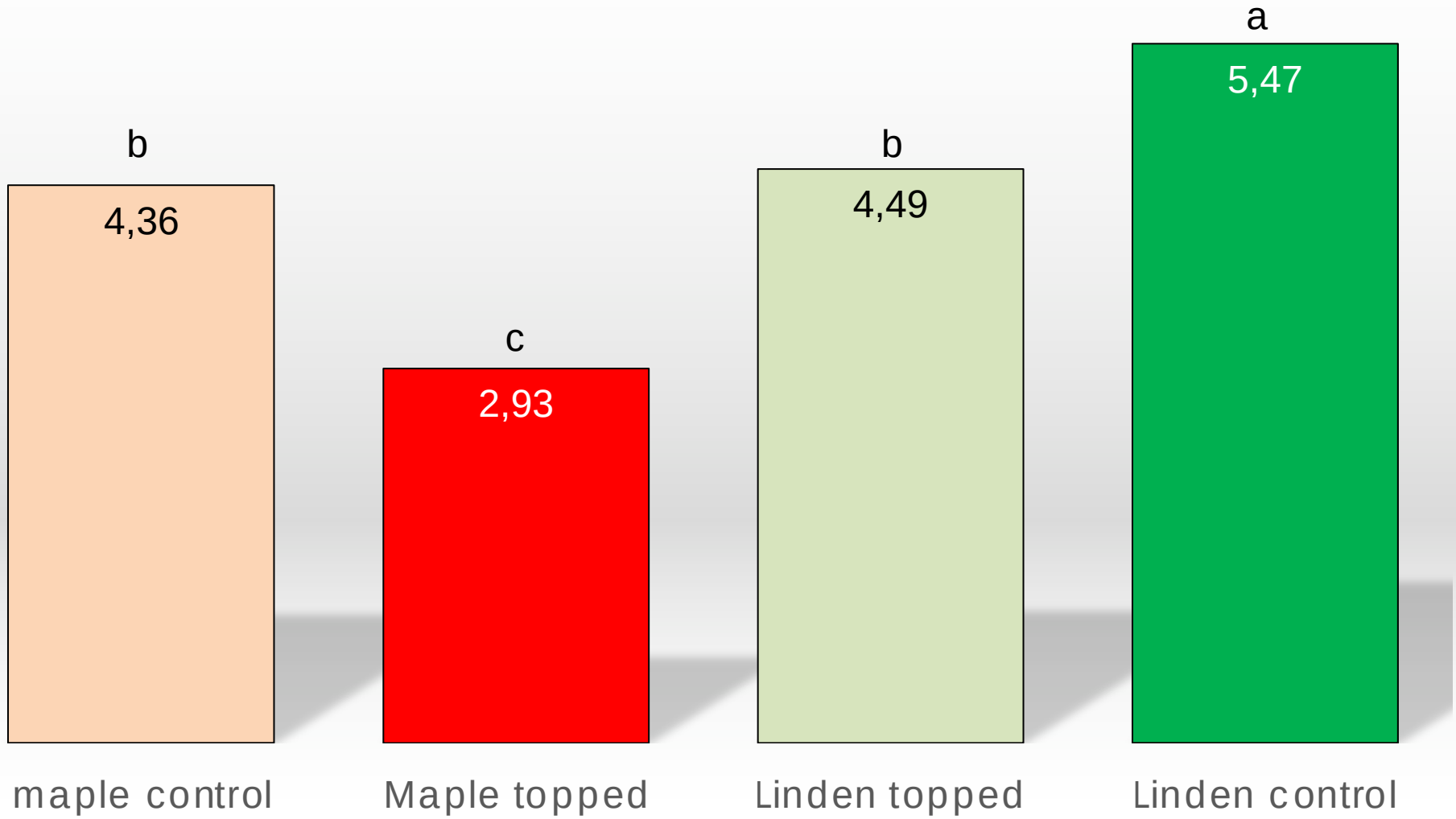


Leaf weight (g)



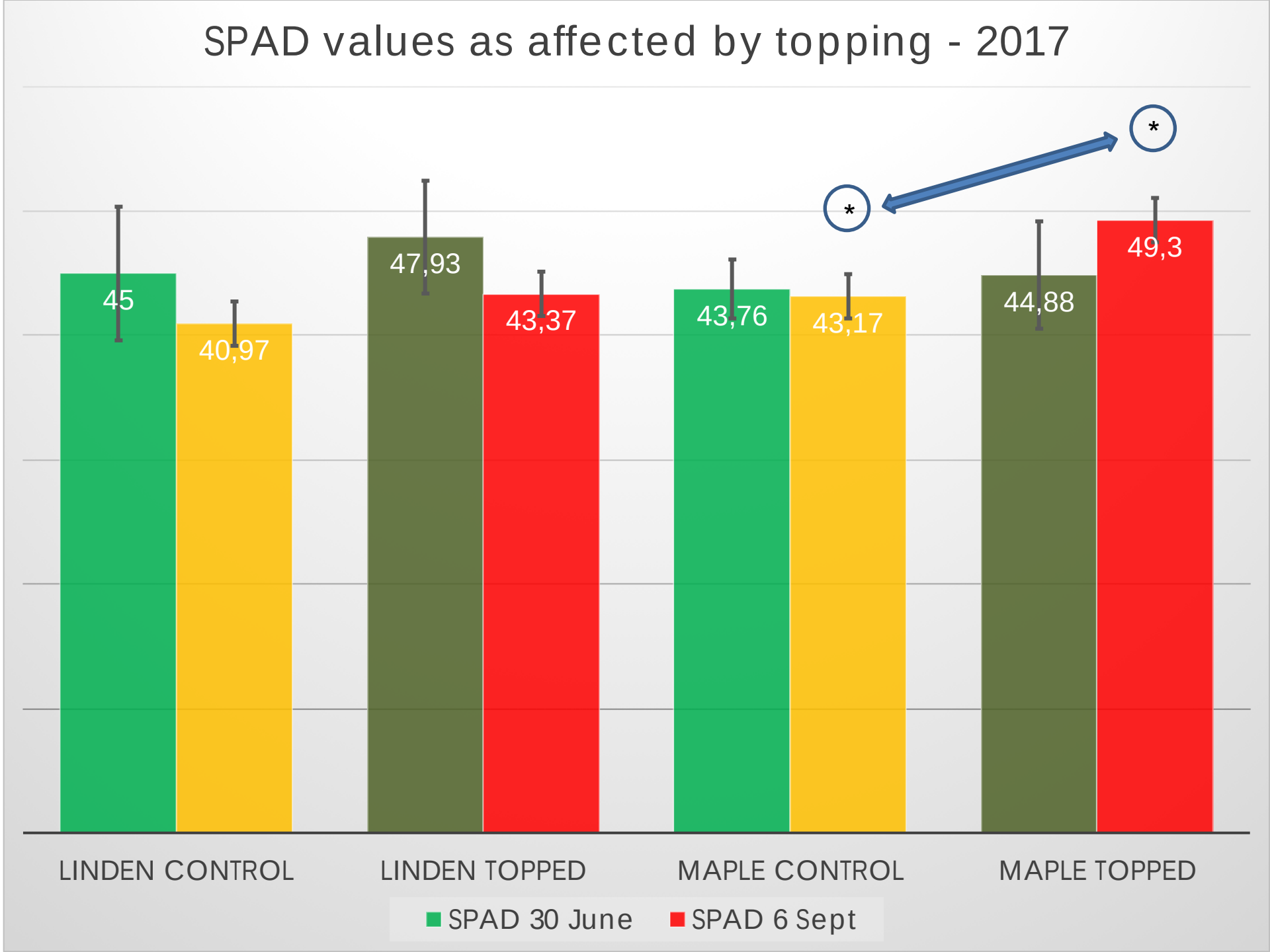

Total leaf area (m2)
b
120,3
c
12,01
a
179,05
c
26,45
Maple control
Maple topped
Linden control
Linden topped

Leaf area Index (LAI) 19th June, 2018

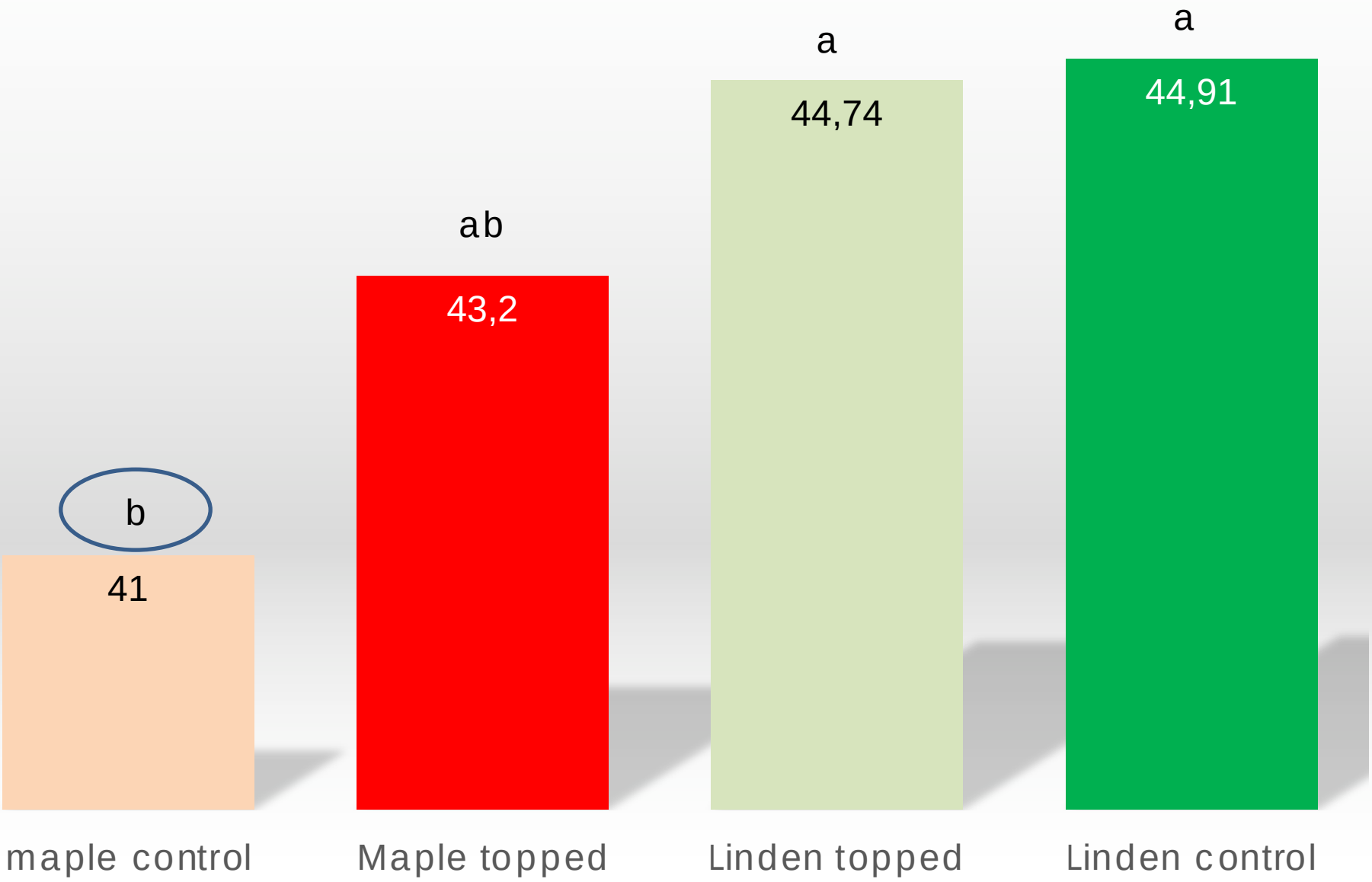


LAI is used to predict photosynthetic primary production, evapotranspiration and as a reference tool for crop growth. LAI can be determined directly by taking a statistically significant sample of foliage from a plant canopy, measuring the leaf area per sample plot and dividing it by the plot land surface area. Indirect methods measure canopy geometry or light extinction and relate it to LAI.

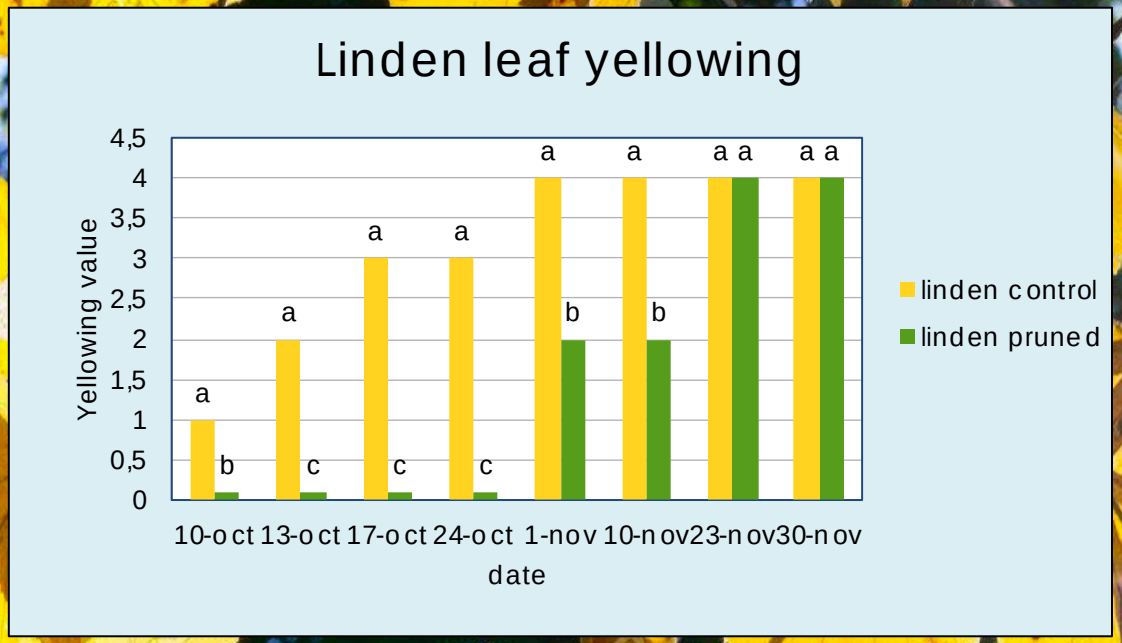
Breda, N (2003). "Ground-based measurements of leaf area index: A review of methods, instruments and current controversies". Journal of Experimental Botany. 54: 2403–2417. doi:10.1093/jxb/erg263

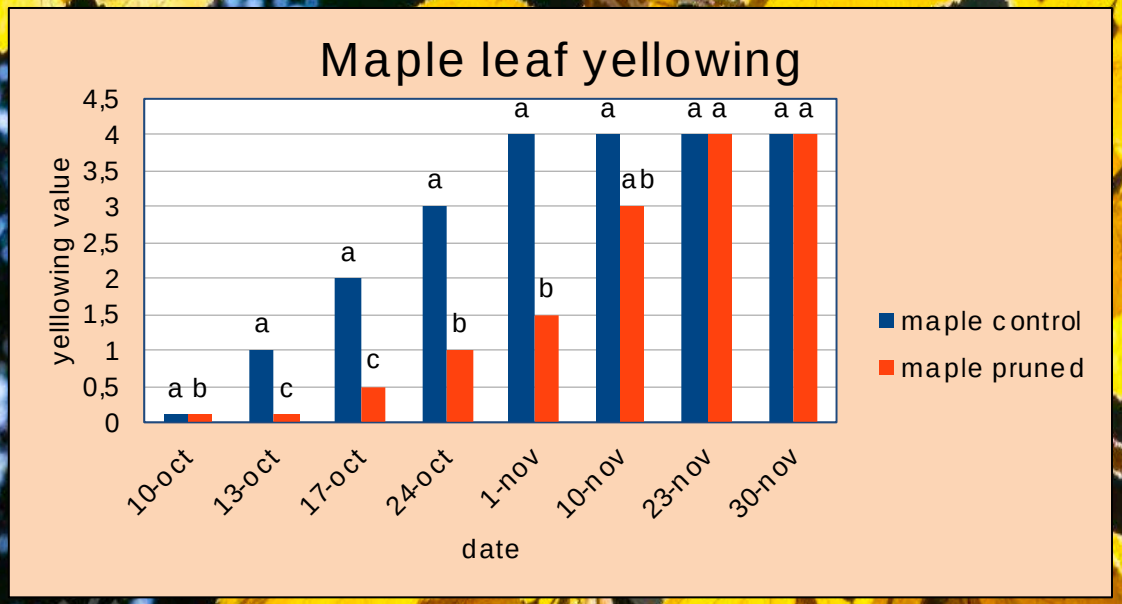

SPAD values as affected by topping - 2017
45
40,97
47,93
43,37
43,76
43,17
44,88
49,3
*
*
LINDEN CONTROL
LINDEN TOPPED
MAPLE CONTROL
MAPLE TOPPED
SPAD 30 June
SPAD 6 Sept

SPAD value 6th June 2018



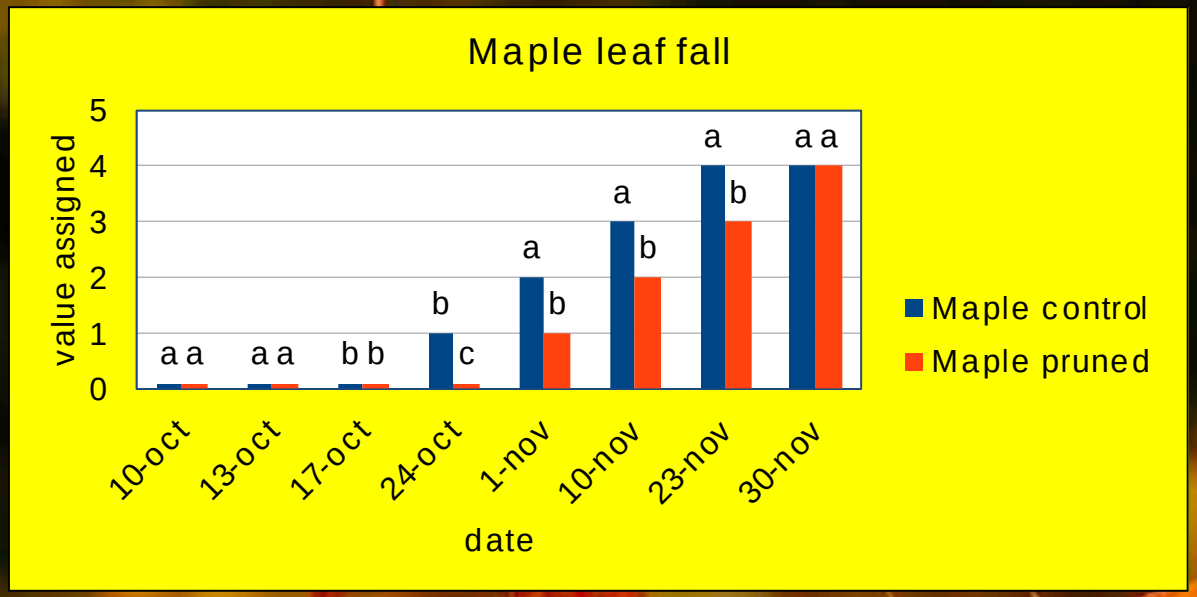
Effects on phenology, 2017

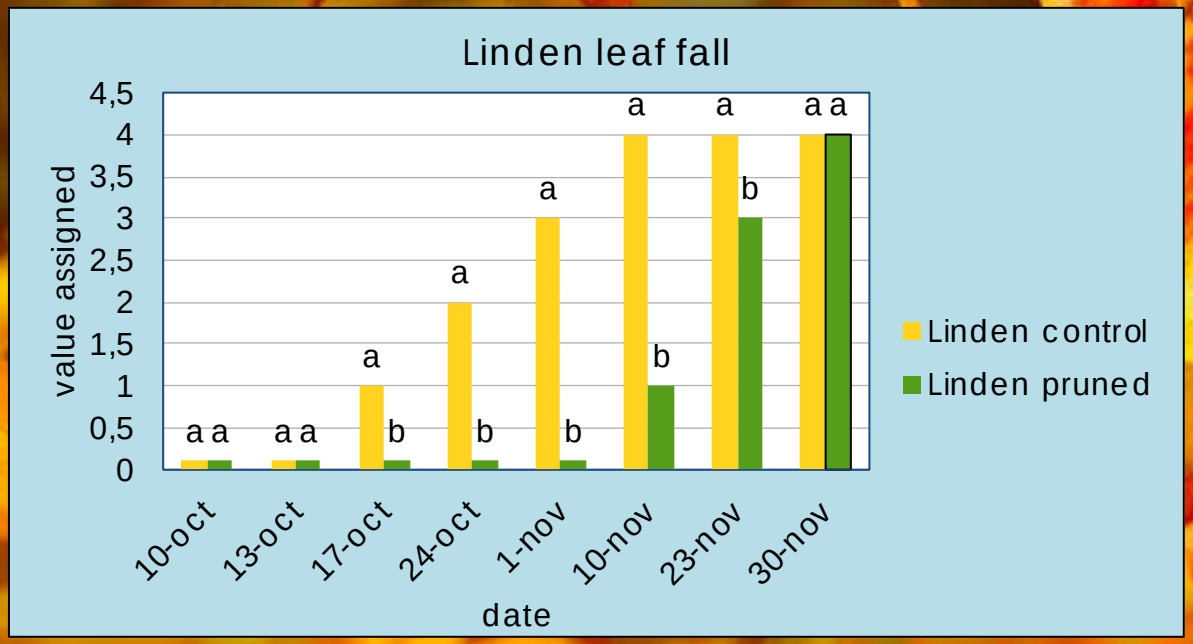




Yellowing was delayed by topping in both species

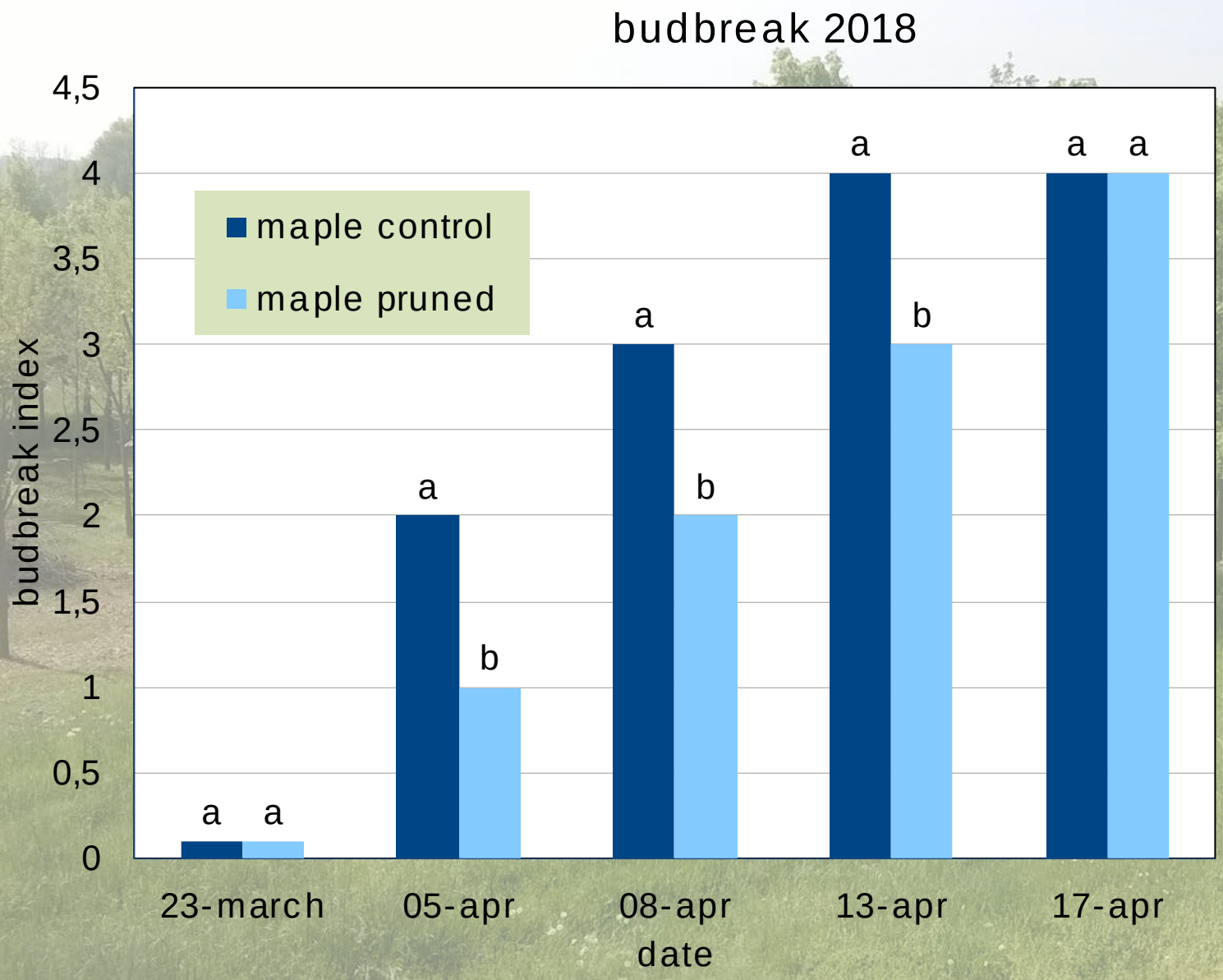
Effects on phenology, 2017





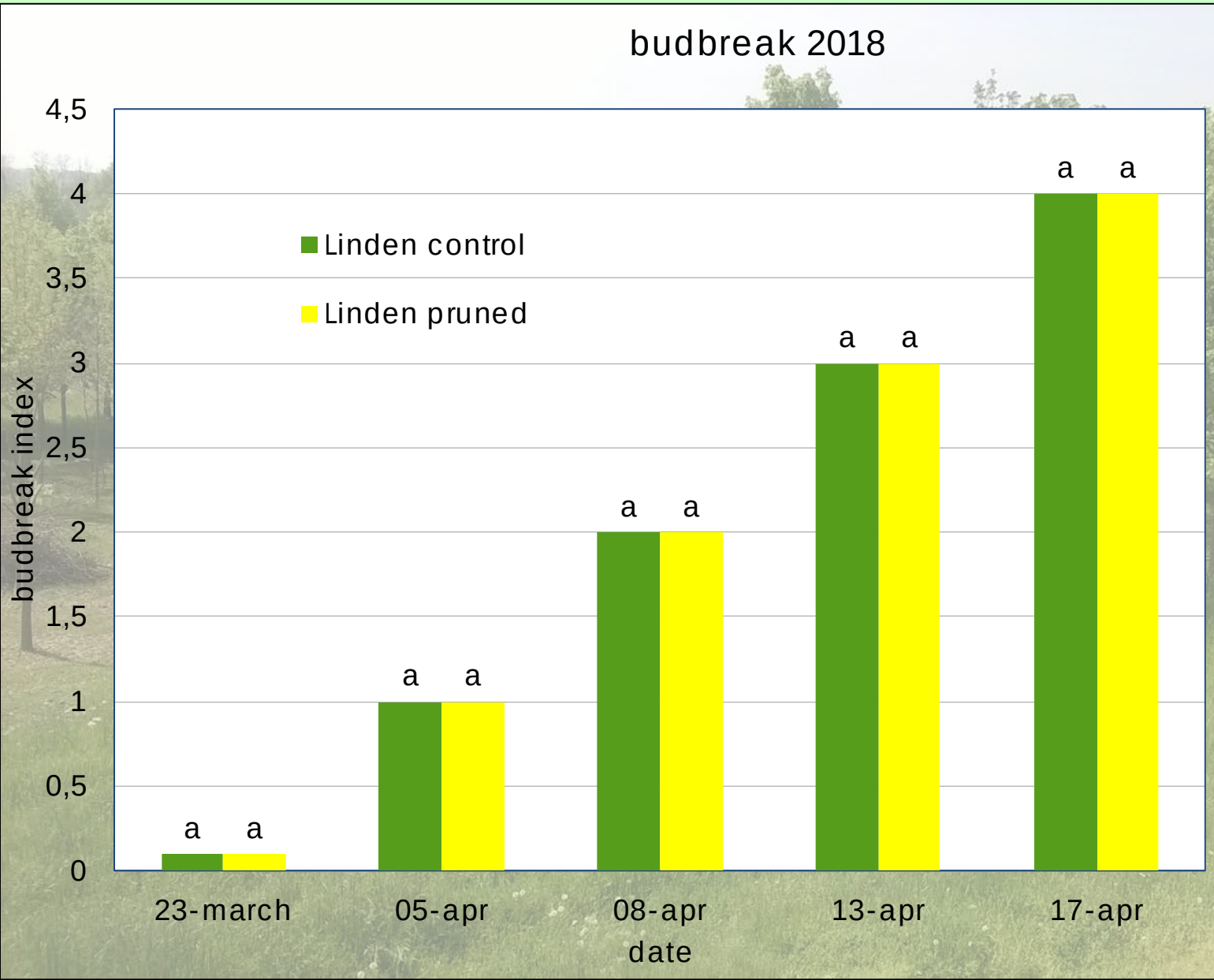
Leaf fall was delayed by topping in both species

Budbreak date



Bud break date was delayed by topping in maple

Budbreak date



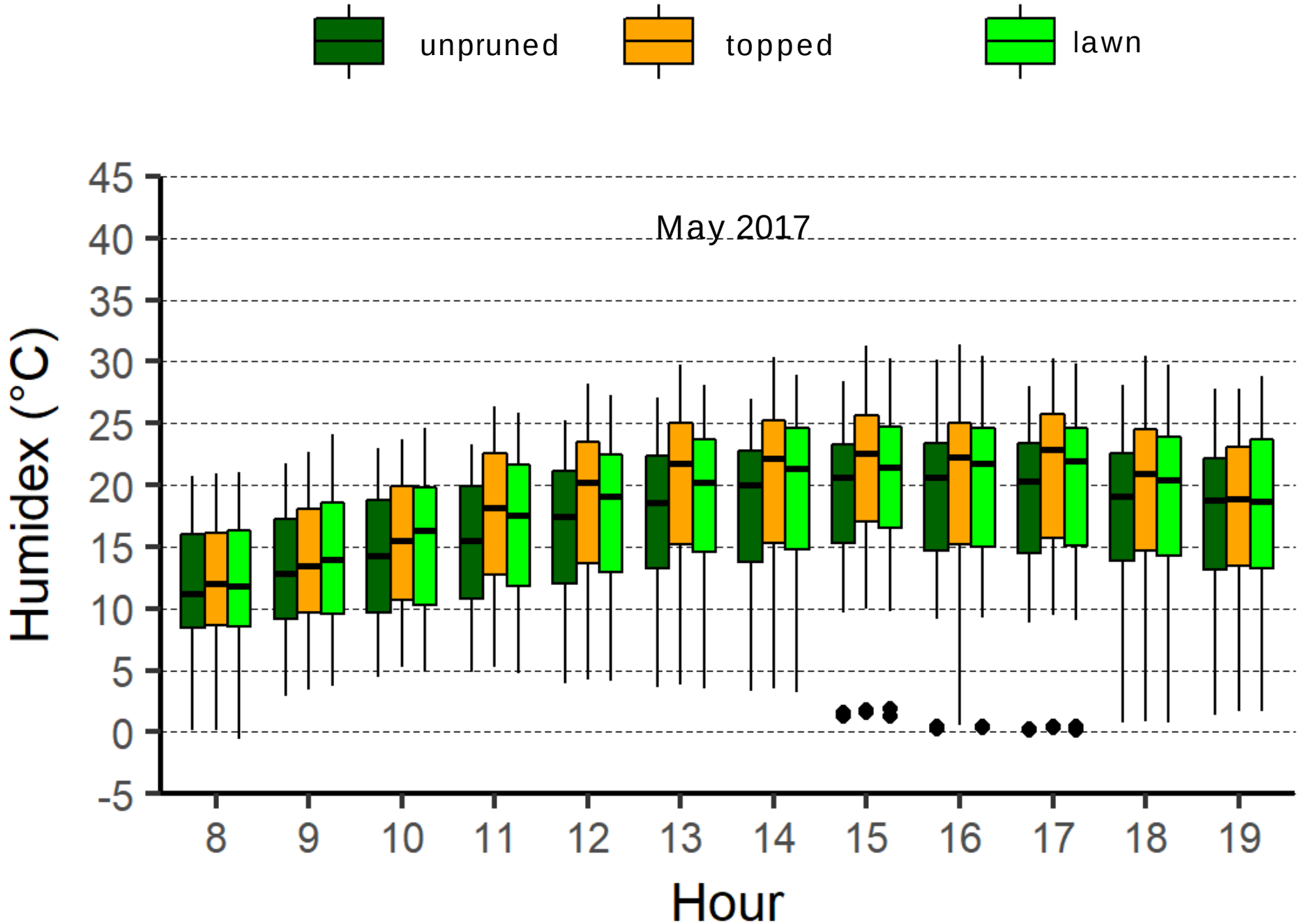
Bud break date was not affected in Linden

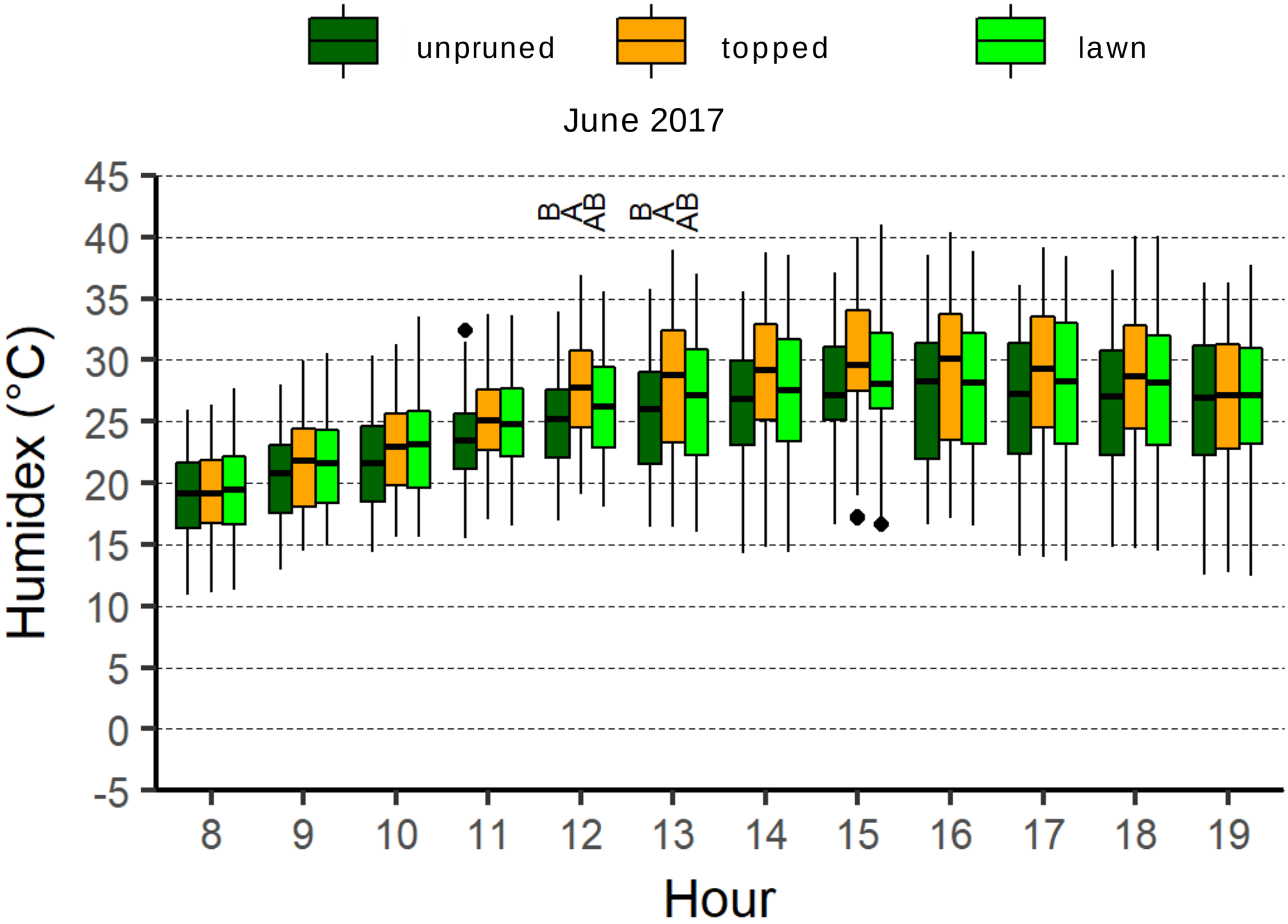
Microclimatic data

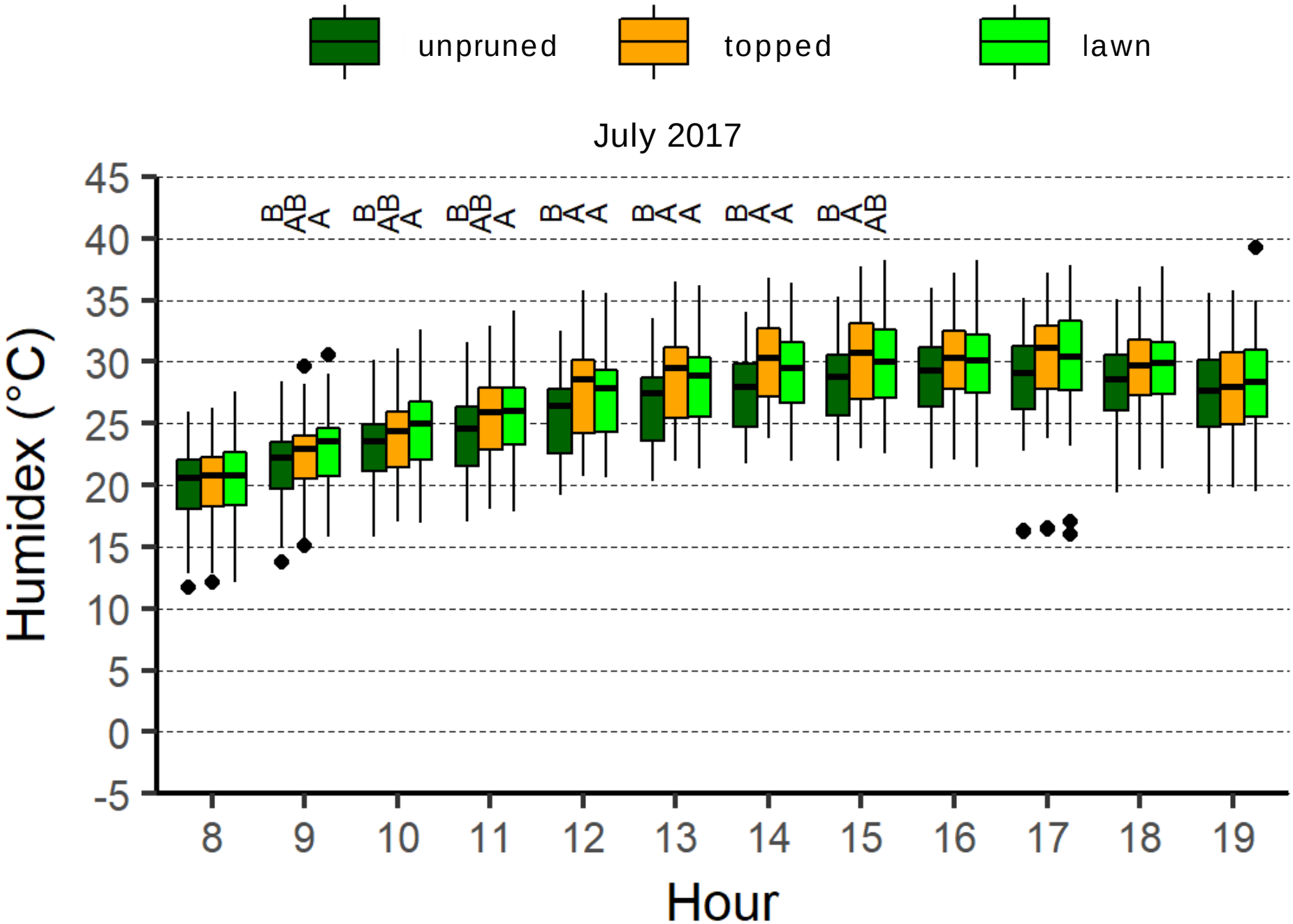
Humidex developed in Canada (Masterson and Richardson, 1965) reviewed in 1979 (Masterson and Richardson, 1979). It's still used by the Canadian Meteo Service to estimate the perceived temperature in high temperature and humidity conditions. $H = Ta + (0,5555 \times (Pa - 10))$

Where H= Humidex; Ta= Air temperature(°C) and Pa= Vapour pressure (kPa)(Conti *et al.*, 2005).

Class	HUMIDEX	Degree of comfort
0	H<27	Comfort
1	27≤H<30	Some discomfort
2	30≤H<40	Great discomfort
3	40≤H<55	Dangerous
4	H≥55	Very dangerous (heatstroke imminent)


unpruned
topped
lawn
May 2017
Humidex (°C)
45
40
35
30
25
20
15
10
5
0
-5
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
June 2017
Humidex (°C)
45
40
35
30
25
20
15
10
5
0
-5
B
A
AB
B
A
AB
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
July 2017
Humidex (°C)
45
40
35
30
25
20
15
10
5
0
-5
B
AB
A
B
AB
A
B
AB
A
B
A
A
B
A
A
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A
B
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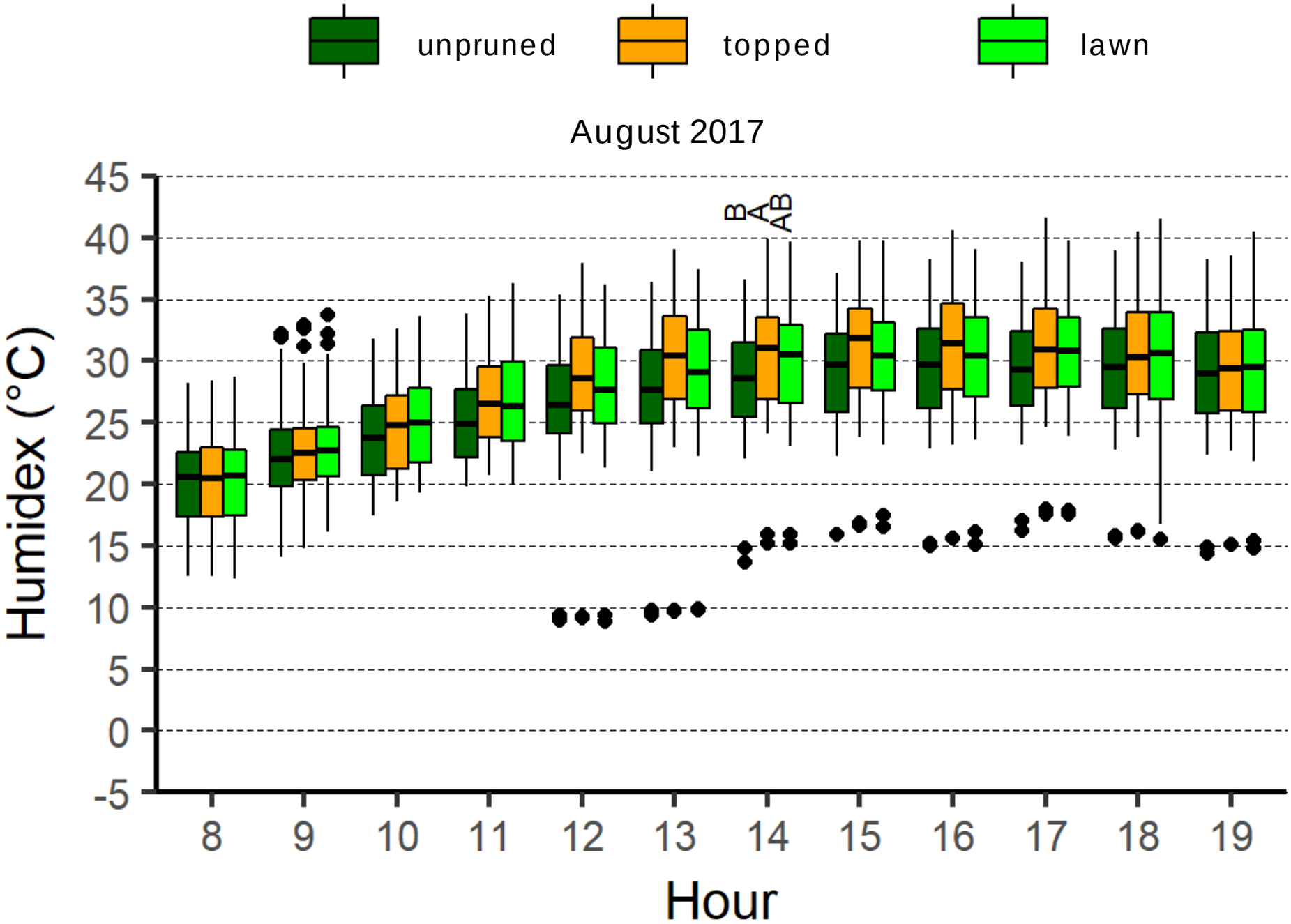
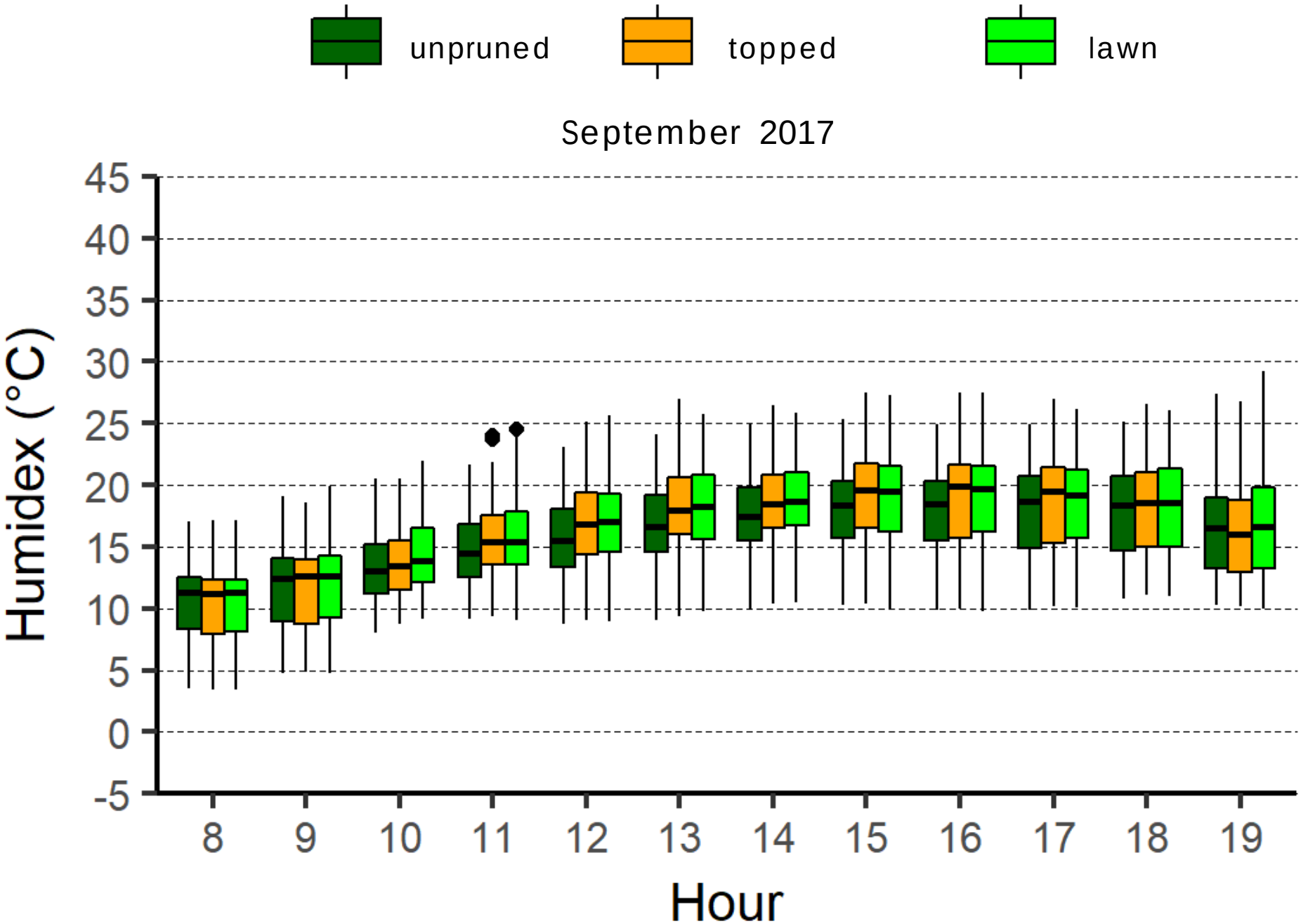
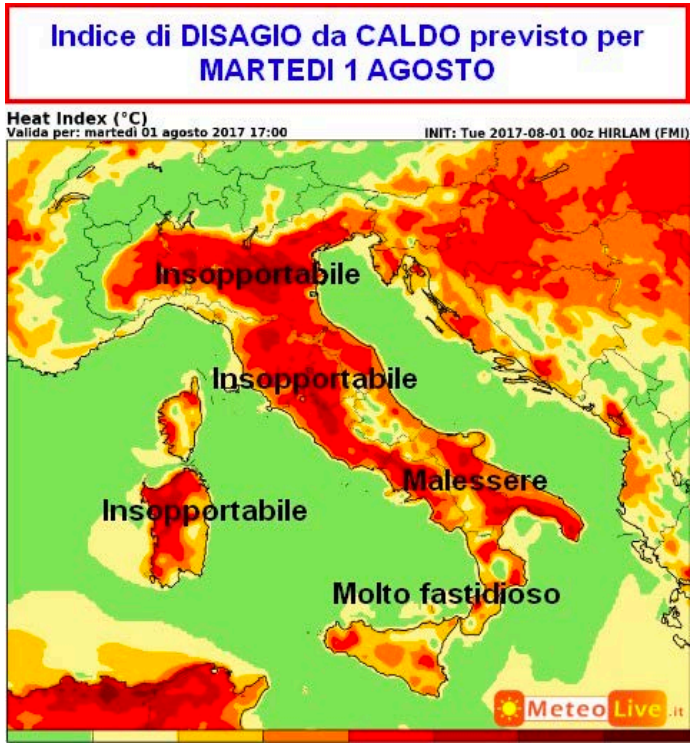
AB
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
August 2017
Humidex (°C)
45
40
35
30
25
20
15
10
5
0
-5
B
A
AB
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
September 2017
Humidex (°C)
45
40
35
30
25
20
15
10
5
0
-5
8
9
10
11
12
13
14
15
16
17
18
19
Hour

ATI - Apparent Temperature Index: Developed by Steadman (Steadman, 1979) reviewed by (Steadman, 1994) which combines in a formula the temperature and wind (Wind Chill) or temperature and humidity (Heat Index) for the indicated hour



From http://www.meteolive.it/news/

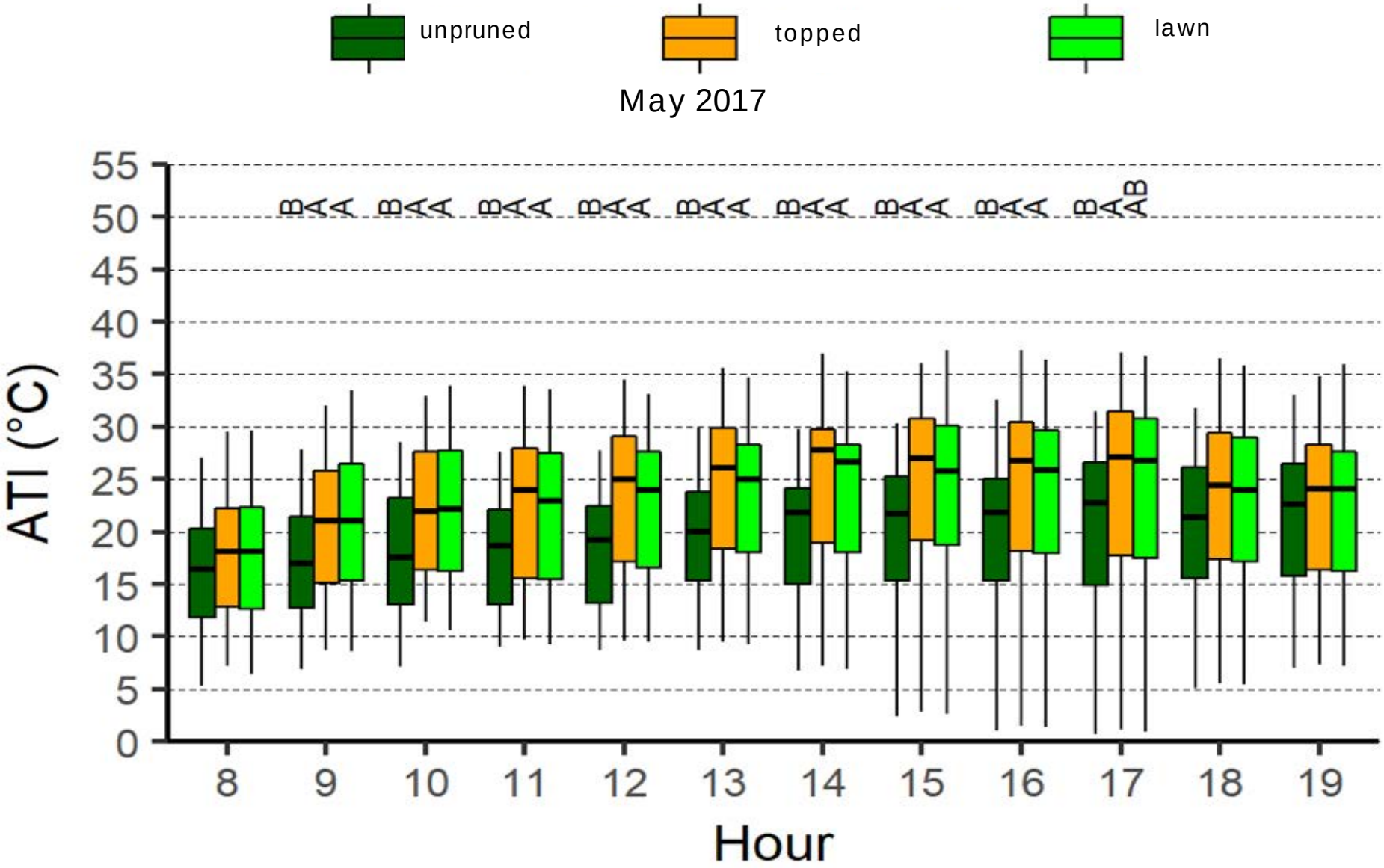
NWS Heat Index — Temperature (°F)

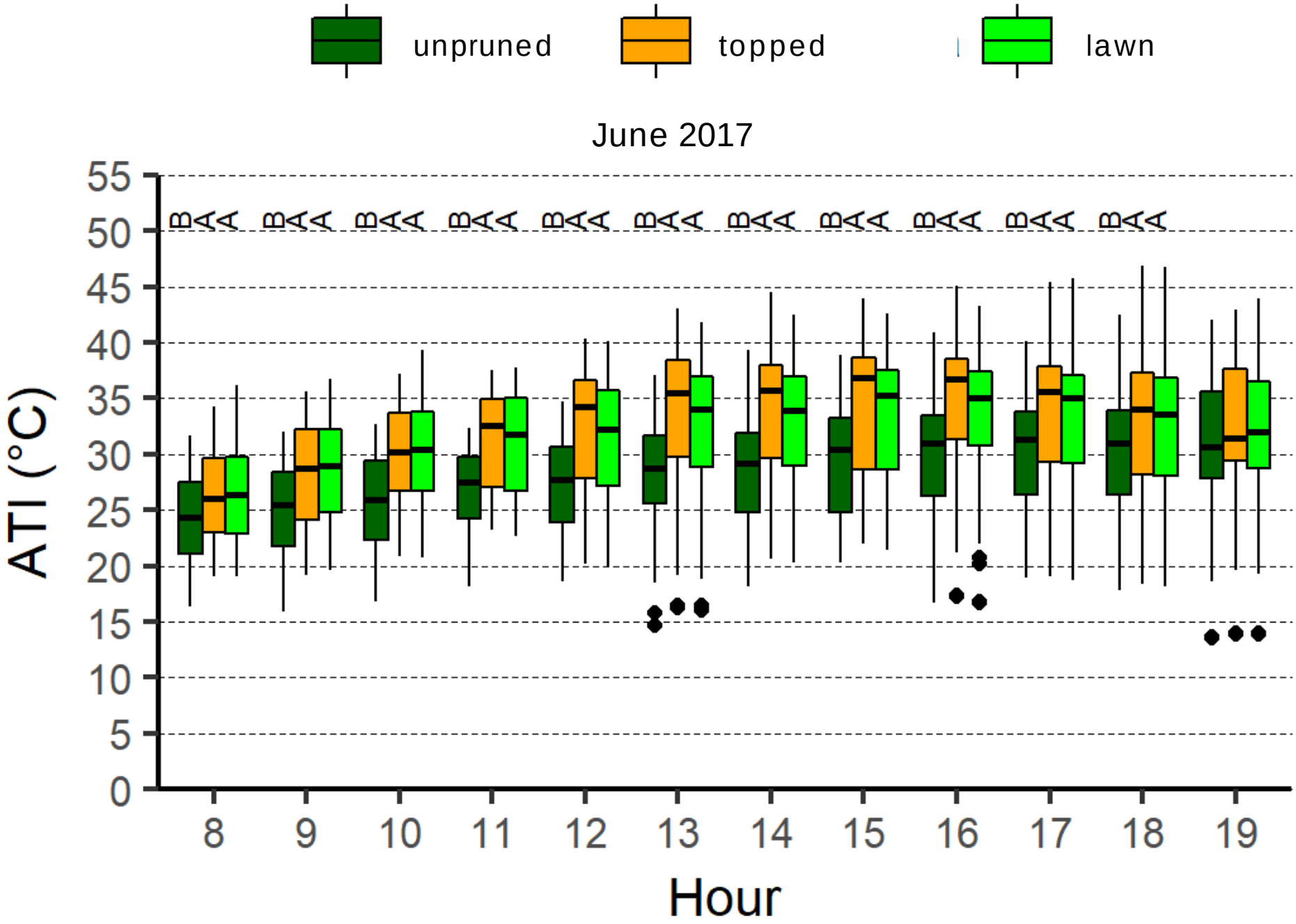
Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

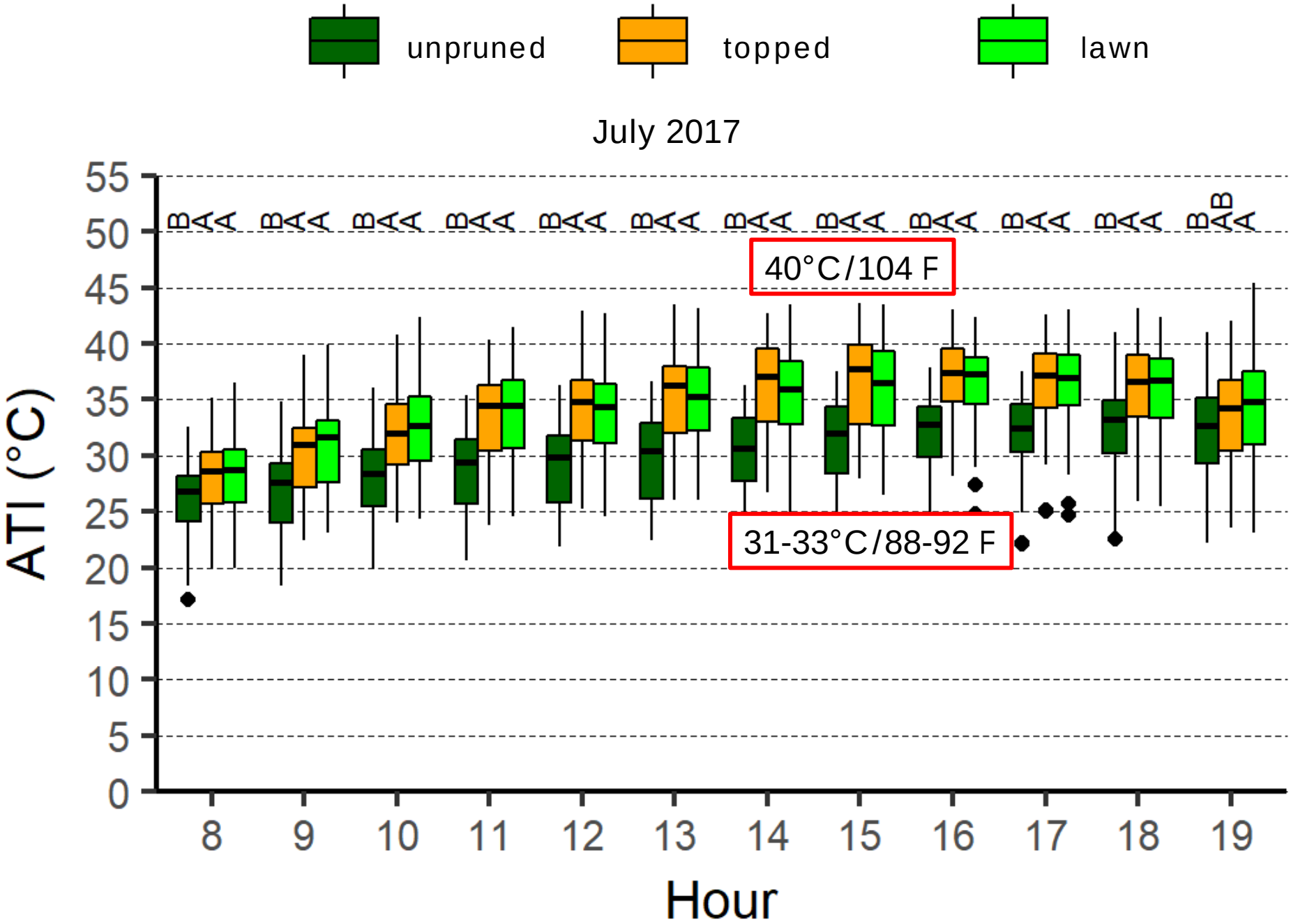
Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

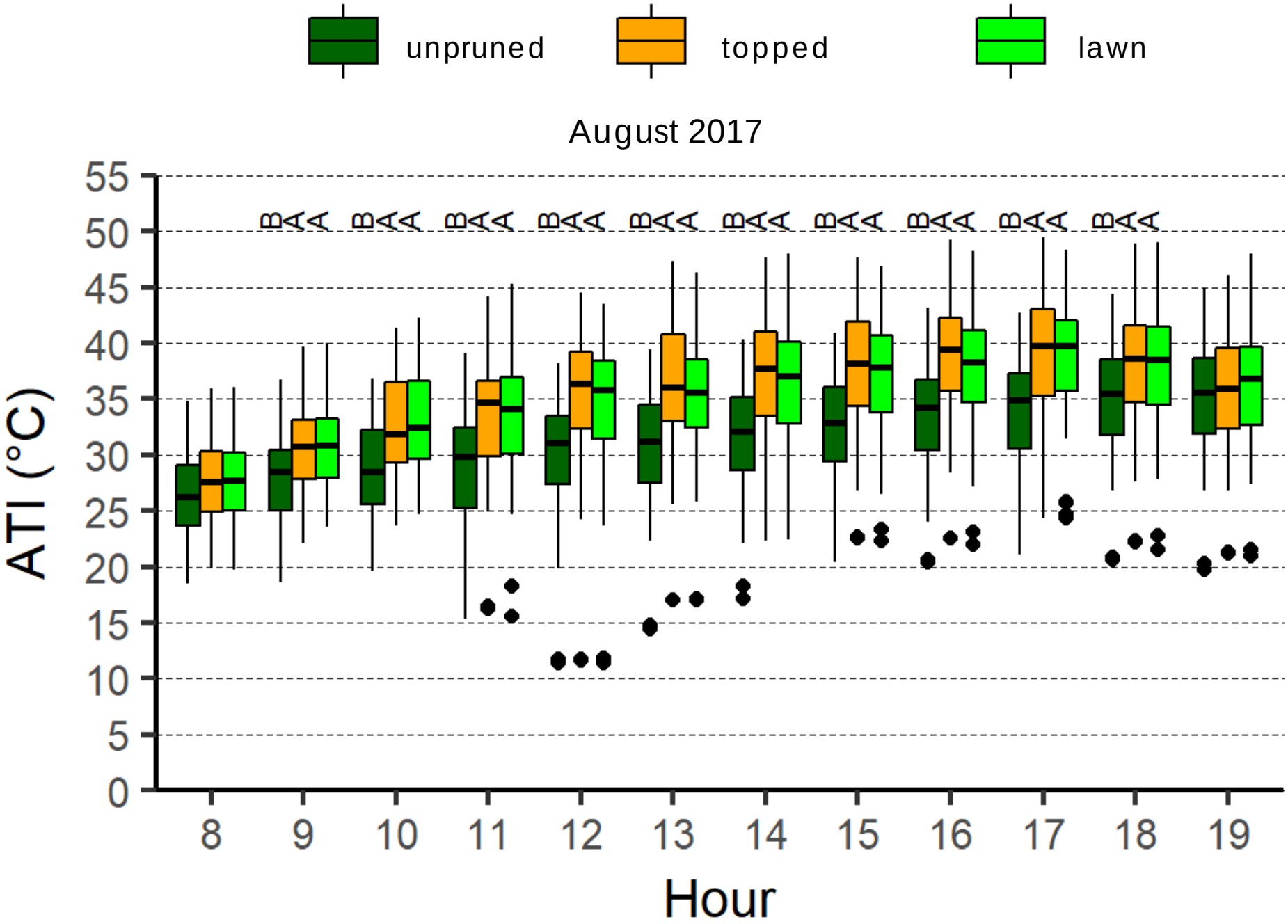
Caution — Extreme Caution — Danger — Extreme Danger

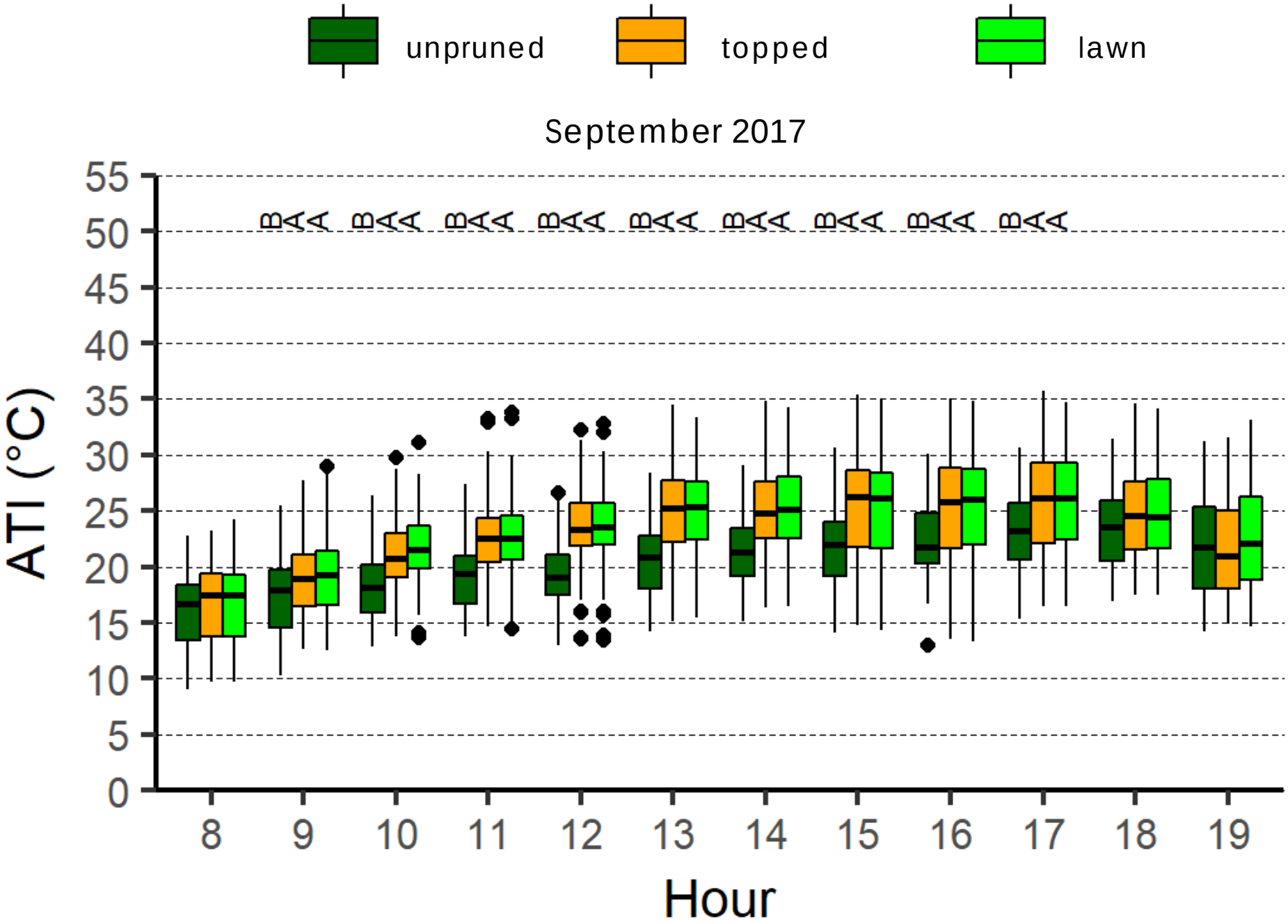
https://www.weather.gov/safety/heat-index


unpruned
topped
lawn
May 2017
ATI (°C)
55
50
45
40
35
30
25
20
15
10
5
0
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A AB
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
June 2017
ATI (°C)
55
50
45
40
35
30
25
20
15
10
5
0
B A A
8
9
10
11
12
13
14
15
16
17
18
19
Hour


unpruned
topped
lawn
July 2017
ATI (°C)
Hour
40°C/104 F
31-33°C/88-92 F
0
5
10
15
20
25
30
35
40
45
50
55
8
9
10
11
12
13
14
15
16
17
18
19
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B A A
B AB A


unpruned
topped
lawn
August 2017
ATI (°C)
Hour
0
5
10
15
20
25
30
35
40
45
50
55
8
9
10
11
12
13
14
15
16
17
18
19
B A A

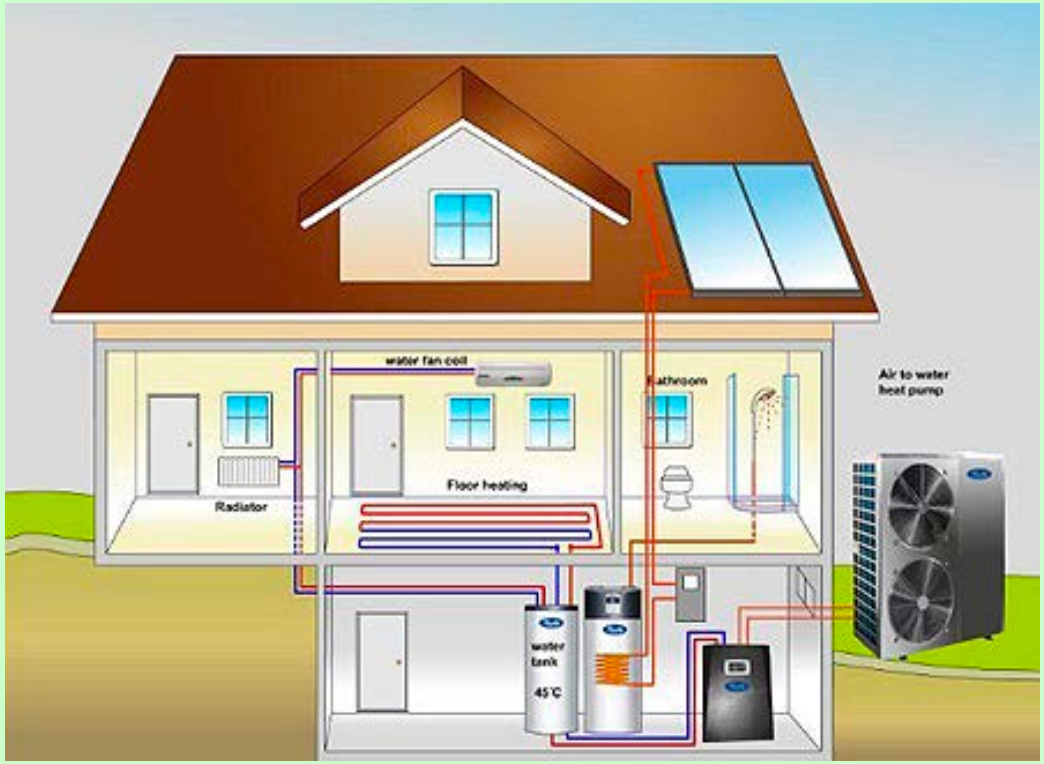

unpruned
topped
lawn
September 2017
ATI (°C)
55
50
45
40
35
30
25
20
15
10
5
0
B A A
8
9
10
11
12
13
14
15
16
17
18
19
Hour

Power = K x l_1 x l_2 x h where K factor = 25 for cooling, 35 for heating

P = 25 x 10 x 10 x 3 = 7500 Watt equivalent to 25.500 Btu/h (British thermal units). 1 BTU = 1,055 joules, 252 calories, 0.293 watt-hour or the energy released by burning one match. 1 watt is approximately 3.412 BTU per hour.

About 7.5 Kwatt/hour

Metri Qadri	Btu / ora	K watt / ora
20 mq	5.000	1,5
30 mq	8000	2,3
40 mq	11000	3,2
50 mq	13000	3,8
60 mq	16000	4,7
70 mq	19000	5,6
80 mq	21000	6,1
90 mq	24000	7
100 mq	27000	7,9
110 mq	30000	8,8
120 mq	32000	9,4



A domestic air conditioning system that operates for 8 hours a day for 4 months will consume approximately 1,000-2,000 kWh (of which about 1/10 only to power the fan), assuming a cost of electricity 0.22 euros / kWh corresponds to a charge of 220-440 euros for summer cooling…

Photo courtesy: http://www.consulente-energia.com/iq756.jpg

Conclusions

1) Microclimate was strongly affected by topping
2) Phenological phases were delayed in topped trees
3) Shoot growth was much higher in topped trees while leaf area and LAI where much lower
4) The first physiological data confirm what found in the previous research that topped trees have an altered tree physiology that determines a shift to a more pioneer behavior

“Pruning is expensive and the results of such "surgical" operations on a tree have the same effect they would have on an animal. The vision of trees, not only in the streets, but also in parks, with their trunks marked by large scars or dead stumps, is very stressful and is, above all, the cause of many diseases and the death of plants. The spectacle of unprepared operators who "slaughter" trees is painful but common. The art of pruning is to cut in time the branches that must be removed, that is when they are small, less than 2 cm in diameter”

http://www.advancedtreehealth.com/wp-content/uploads/2016/01/pruning-picture.jpg

THANK-YOU FOR YOUR ATTENTION

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TREE FUND
Cultivating Innovation