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

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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).
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; Pavlis et 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)
The dark side of tree topping
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

From Balder, 2008 readapted
TOPPING also known as heading, stubbing or dehorning trees has several negative effects

- 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.
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!!!!**
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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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)
Experimental plot

24 trees/thesis
4 per each replicate

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)
  - **Ecophysicsology**  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 refer to 2017 sampling and measurements
Morphological and physiological data
Topped trees had much longer shoots compared to the unpruned trees.
Crown width was clearly affected by pruning.
As a consequence also the dripline area was much bigger in the control trees.
Topped trees had higher leaf weight on a single leaf basis compared to the unpruned trees in both species.
Control trees had much higher total leaf area compared to the unpruned trees.
Leaf area Index (LAI) 19th June, 2018

Control trees had higher LAI compared to the unpruned trees

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.

Limited effect on the SPAD index though topped tree sometimes showed higher value.
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 ($^\circ$C) and $Pa =$ Vapour pressure (kPa) (Conti et al., 2005).

<table>
<thead>
<tr>
<th>Class</th>
<th>HUMIDEX</th>
<th>Degree of comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$H&lt;27$</td>
<td>Comfort</td>
</tr>
<tr>
<td>1</td>
<td>$27 \leq H &lt;30$</td>
<td>Some discomfort</td>
</tr>
<tr>
<td>2</td>
<td>$30 \leq H &lt;40$</td>
<td>Great discomfort</td>
</tr>
<tr>
<td>3</td>
<td>$40 \leq H &lt;55$</td>
<td>Dangerous</td>
</tr>
<tr>
<td>4</td>
<td>$H \geq 55$</td>
<td>Very dangerous (heatstroke imminent)</td>
</tr>
</tbody>
</table>
This index was higher in the «topped plots» for the whole season, especially during the central part of the day.
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.

Heat discomfort index 1st August, 2017

From http://www.meteolive.it/news/
This index was higher in the «topped plots» for the whole season, during the whole day and this happened for all summer. July 2017.
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…
Conclusions

1) Phenological phases were delayed in topped trees (data not shown).

2) Shoot growth was much higher in topped trees.

3) Leaf area and LAI were much lower.

4) Physiological data (not shown in this presentation) confirm what found in the previous research: topped trees have an altered tree physiology that determines a shift to a more pioneer behavior.

5) Microclimate was strongly affected by topping.
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THANK-YOU FOR YOUR ATTENTION