



## **PRODUCTIVITY AND CHAINSAW PROTECTION: HOW HEAT AFFECTS YOU AND YOUR WALLET**

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### **ABSTRACT**

The effects of heat on an arborist can be felt both physically and financially. Core body temperature is affected by a number of factors, including clothing. Where chainsaw protective clothing is worn, the particular clothing chosen will have an effect on the regulation of body temperature. Further, any effect is directly linked to productivity, which in turn is quantifiable as a \$ amount.

A chainsaw protective trouser that helps alleviate the effects of heat can also have positive financial implications for the arborist (when compared to a trouser which does not provide the same level of defence against the effects of heat).

### **INTRODUCTION**

Arborists are expected to work in environments which experience extremities of weather. During the summer months, the temperatures experienced may present a clear and present danger to the arborist. Even in the colder seasons, in locations not normally associated with high average temperatures, the effect of heat can be both significant and pronounced. There has been some excellent research into the importance of hydration but little to date on the effect of PPE, specifically chainsaw protective trousers. This paper does not include any primary research, rather it draws on existing scientific study which may be relevant to the arborist, drawing parallels between such research and the arborist in order to underline the importance of safety when working in hotter conditions. Further, it will use existing formula to highlight the cost of heat-related productivity losses.

### **HIGH TEMPERATURES AND PHYSICAL SAFETY**

Humans have a core body temperature of 37°C. This core temperature is finely balanced and can be altered by a change in 6 fundamental factors :

1. Air Temperature
2. Radiant temperature
3. Humidity

4. Air movement (wind speed)
5. **Clothing**
6. The metabolic heat generated by human physical activity

An arborist will generate significant metabolic heat due to the physical nature of the work. This is often in situations where the air temperature may be high, wind speed little, humidity high and PPE is legislated to be worn at all times (as in Australia and New Zealand). In particular, PPE can become burdensome and heighten the effects of heat, clothing being the biggest heat trap, contributing to the problem.

The effects of heat can be pronounced and deadly. As the core body temperature rises above 38°C, there is a diminishing effect on the working capacity of the arborist, both physical and mental. At 39°C acute heat disorders, such as heat stroke may occur. From 40.6°C upwards, life-threatening 'severe hyperpyrexia' may occur<sup>2</sup>.

The risk to the arborist is magnified inasmuch as they are likely to be working at height and with potentially dangerous machinery. In such an environment, mistakes could end up being deadly.

#### **WHEN CHAINSAW PROTECTIVE CLOTHING IS REQUIRED**

In situations where chainsaw protective clothing is either required by legislation, is mandated by the employer, or is worn by the arborist's own volition – there are steps that can be taken to help reduce the danger from excessive heat build up.

The human body will try to regulate the core body temperature by taking three progressive steps<sup>3</sup>. First, blood flow to the skin is increased, moving heat from the core. Next, breathing is intensified and becomes heavier as you expel heat. Finally, you begin to sweat. However, for sweat to be an effective coolant it must be able to evaporate. If it is trapped under clothing, and/or in a situation where high humidity is present, sweating may not be as efficient.

With chainsaw protective clothing in order for the final stage of core body temperature regulation to be effective, there has to be some consideration to the fabrics used and worn. The use of moisture wicking fabrics assist by transferring moisture away from the body. Some fabrics even have what is regarded as 'cooling capabilities' for their ability to transfer heat away from the body and allow circulation of air.

Other aids in chainsaw protective clothing include the use of mesh vents to assist with air circulation (and sweat evaporation).

Additionally, the design of the trouser can have an effect. A trouser designed purposely for an arborist, taking into account their movement and body positions required, will include full stretch. Other subtle differences which could have an effect also include the positioning of pockets and seam at the crotch. Finally, the weight of the trouser must be taken into consideration. Simply put, the lighter the trouser the less effort is required to move your body when wearing it.

Overall, the trouser should work with the arborist, rather than against them, decreasing the effort required to move through the trees or on the ground.

## **DRAWING THE LINE BETWEEN HEAT AND PRODUCTIVITY**

The effect of heat on the body can manifest itself not only physically but also financially. It is possible, through previous research on temperatures in working environments, to correlate incremental increases in temperature to productivity loss, then quantify that loss financially.

There have been a number of studies which have measured the mental capacity of office workers as the temperature increases. It would be reasonable to suggest this would also hold true for other working environments. Taking into account numerous studies and then averaging the results<sup>4</sup> shows a 2% decrement in productivity per degree temperature rise, when the temperature is above 25°C. This is represented in the following equation:

$$P (\%) = 2 \times (\text{Temp}, ^\circ\text{C}) - 50$$

This draws a linear line between productivity and the temperature, with a 2% drop in productivity realised at 26°C, rising to a 20% decrease in productivity at 35°C.

An arborist working in Brisbane, Australia, will experience 8 months of the year where the average high exceeds 25°C. In the United States, Florida will see 7 months of the year with an average high above 25°C. For North Carolina, it will be 5 months. For New York, 3 months.

If we take the scenario of one week in summer where the temperature rises above 25°C for 5 hours per working day, peaking at 28°C, then we can quantify the loss of productivity cost based upon the billable rate charged by the company. That is:

*For 1 hour of the day the temperature is at 26°C = 2% productivity lost (represented as 0.02hrs)*

*For 1 hour of the day the temperature is at 27°C = 4% productivity lost (represented as 0.04hrs)*

*For 1 hour of the day the temperature is at 28°C = 6% productivity lost (represented as 0.06hrs)*

*For 1 hour of the day the temperature is at 27°C = 4% productivity lost (represented as 0.04hrs)*

*For 1 hour of the day the temperature is at 26°C = 2% productivity lost (represented as 0.02hrs)*

**Total = 0.18 hours x NZ\$80/hour = \$14.40/day.**

If you were to extrapolate this scenario out over a week, it equates to \$72. Over a month, that's \$288. This is per person, the larger the crew the larger the potential loss in productivity (\$) for the company. For those locations where the average high temperature exceeds 25°C for multiple months, with many of the peak weeks seeing the temperatures above those used in the scenario, then the cost could be quite staggering.

It can then be assumed that a trouser which is designed to help protect from the perils of heat would also have a positive financial impact by negating some of the detrimental effect on productivity in hot environments. That is, a trouser which helps maintain the core body temperature and full function of the arborist is likely to offset productivity losses to a limited degree (dependent upon both the arborist and the control environment) by keeping the arborist cooler for longer.

## **COST-BENEFIT OF CHAINSAW PROTECTIVE TROUSER SELECTION**

When considering both the physical and financial well-being of the arborist, the choice of chainsaw protection worn is of significant importance. In the case of the Clogger Zero trousers, the specialty fabric utilised as the outer material has been proven to lower the body temperature by almost 1

degree (research conducted by Centexbel Textile Research Centre, Belgium). The addition of large mesh vents and stretch for ease of movement, plus a weight of under 1kg, all contribute to chainsaw protection which helps protect against the effects of heat.

Given the direct link between heat and productivity, it is therefore reasonable to assume the Zero trousers will have a positive financial benefit by helping limit the decrease in productivity caused by heat exposure.

## **CONCLUSION**

It is evident that clothing does have an effect on core body temperature of an arborist. This effect is not limited to the physical and is correlated to productivity, which is then quantifiable as a \$ amount. The degree to which chainsaw protective clothing can assist in preventing heat related injury will vary by the type of clothing worn, among a number of other variables. Clogger Zero trousers contain design elements which have been suggested to aid the fight against heat, including scientifically tested fabric which is proven to help keep body temperature lower.

These elements, when combined, are likely to offset some productivity loss, providing a financial benefit, (\$), to the wearer of Zero trousers.

## **REFERENCES**

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