ANATOMY OF CHAINSAW PROTECTION:
How the fibres that protect you differ

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ABSTRACT
Chainsaw protection is made from a variety of fabrics. The fibres that make up these fabrics may be classified as either 'standard' or 'technical'. The properties exhibited of these fibres vary greatly, making them either more or less appropriate for specific working conditions (such as around power lines). The number of layers used in the protection is not in itself an indicator of the garment's ability to stop a chainsaw. There is no single best fibre but there will be a garment which is best suited to an individual arborist and his/her needs. Chainsaw protective garments must be fit for purpose for the environment they will be used in and for the type of work they will be worn for.

INTRODUCTION
The main fibres used and how they are incorporated into a chainsaw protective fabric affects performance. How these fibres react to both a chainsaw and the general environment will have a bearing on how they act should the worst happen and they be called to stop a chainsaw. The purpose of this paper is to assist the reader with making an informed decision when choosing protection.

HOW FABRIC STANDS UP TO A CHAINSAW
Before we delve into the pros and cons of different fabric, we should discuss how it actually stops a chainsaw designed to cut through dense wood with ease. Some fabrics are constructed from hundreds of loosely knitted or woven fibres. These fibres pull out easily when hit by a moving chainsaw, the teeth of the chainsaw pulling them into and around the sprocket of the chainsaw. This effectively 'chokes' the saw and stops it. Typical fibres used in the fabrics that work by this method are polyester, nylon or polypropylene. They are relatively inexpensive and rely on bulk or mass to stop the chainsaw. Whilst many of the fibres do get cut through, the sheer number of them is sufficient that many get dragged out and into the sprocket area to stop the saw. This type of fabric can be considered as 'standard' chainsaw protection.

The other type of chainsaw protective fabric utilises cut-resistant fibres within the construction. As with the 'standard' chainsaw fabric, these fibres are designed to be easily pulled out by the chainsaw teeth. However, the resistance to cutting they provide exerts a breaking force on the chain, causing it to stop quicker. These types of fabrics can be considered 'technical'. Because the majority of the strands are not cut-through by the saw, less fibres are needed to provide the same level of protection, therefore protection constructed with technical fabric is considered less bulky and lighter.

Apart from bulk (and likely heat retention), the other major difference between standard and technical fabric is the cost. The cut-resistant yarns used in technical fabrics are considerably more expensive.

A CLOSER LOOK AT THE TECHNICAL FABRIC

Within the technical group of fabrics, there are three main types of fibre used:

- **Para-aramid.** Commonly known brand names include Kevlar, Twaron and Technora.
- **UHMWPE.** Known by such brand names as Dyneema and Spectra.
- **Polyarylate.** Most commonly known as Vectran.

Of these, Kevlar is possibly the most recognisable name and arguably the fabric that is most widely used. That, however, does not mean it is necessarily the most suitable for chainsaw protection. Indeed, each type exhibits different strengths and weaknesses, as detailed in the table below:

	Para-aramid	**UHMWPE**	**Polyarylate**
Commonly used Brand names	Kevlar Twaron Technora	Dyneema Spectra	Vectran
Tenacity g/d	23.6	40	23-27
Moisture absorption %	3.5	0	Less than 0.1
Density g/cm^3	1.44	0.97	1.4
Decomposition temperature °C	>500	150	>400

UHMWPE performs well in terms of *tenacity* (a measure of the strength of the fibre) and is light (*density*) but fares poorly in situations where heat (*decomposition temperature*) is a concern.

Para-aramids perform well in heat but absorb moisture and are the heaviest, with around 1.44 grams per cubic centimetre (*density g/cm^3*).

Polyarylate is a solid performer in all categories and makes for a good general choice. However, there are some important properties to consider for which hard data is not readily available. Namely, cut-resistance, flex fatigue and UV resistance.

From our own in-house experiments, we know that UHMWPE and Polyarylate display a cut-resistance of approximately twice that of Para-aramid. As previously discussed, adding cut resistance to chainsaw protection exerts extra braking force on the saw chain, helping to stop the saw.

Additionally, we found that whilst all three fibres are degraded by UV, Para-aramid is the most susceptible. It also suffers from flex fatigue, losing 65% of its tenacity after 2500 flex cycles (i.e. the fibres lose their strength gradually when being continually flexed, e.g. at the knee).

SO, WHICH IS BEST?

It depends on the situation. Where weight saving combines with high strength, UHMWPE is the preferred fibre. However, it melts at low temperatures and can start to shrink at temperatures above 70°C.

For situations where there is a risk of fire or an arcflash, then only Para-aramid and Polyarylate should be used. But given the susceptibility of Para-aramid to flex-fatigue, its higher rate of degradation to UV exposure, and its lesser cut resistant properties, Polyarylate has the edge.

WHAT ABOUT THE NUMBER OF LAYERS?

One of the most frequent questions about chainsaw protection is about the number of layers, but very simply this should never be used as a measure of a garment's effectiveness. Construction methods for chainsaw protective fabrics differ, meaning it is possible to produce lightweight, thin layers or heavy bulky layers. Any presumption that more layers equals a higher level of protection is misguided insomuch as technical fabric provides superior chain stopping, so not as many layers may be needed. Conversely, a presumption that more layers will make the garment hotter and heavier is also not true, e.g. a system comprising 6 layers of 120 gsm 'technical' fabric weighs less overall than a system of 4 layers of 260 gsm 'standard' fabric and is probably more effective. In summary, the best method of comparing the performance of a garment is by the chain speed at which it has been tested to.

CONCLUSION

There is no 'best' in chainsaw protection insomuch as everyone's criteria for protection is likely different. Each fabric has some strength and weaknesses. Similarly, the construction of the entire garment and the material used to 'house' the chainsaw protection will have a considerable effect on the overall feel of the garment.

However, whilst there is no 'best', there will be something which is the 'best' for you and your working environment. Standard chainsaw protection performs adequately at a lower cost. Technical fabrics offer enhanced protection at a significantly less weight.

If your environment requires FR protection then you should make sure your protection has the appropriate arc rating and the chainsaw protection itself is constructed from heat-resistant fibres (it's worth noting this is not always the case, so choose wisely). If general heat and sun exposure is a consideration, then you may want to choose a garment which is lightweight and will not degrade under UV rays.

Professional chainsaw operators must be aware of the hazards they may encounter and protect themselves with garments that are designed appropriately for those hazards.

Reference

1. Matweb: material property data
2. Vectran Publication.