

Avenue Toppling

Avenue toppling is the term used in the scientific literature when live trees are upended (uprooted) usually as a result of extreme weather events (eg storms, cyclones). Severe damage to forests in western Europe in the 1990s led to what little research has been done on the topic. There are two main lines of research:

1. study of the characteristics of trees that have fallen so as to establish correlations between key characteristics and the propensity to fall. (The difficulty here is not being able to readily measure the below ground characteristics of trees that have not fallen).
2. experimental manipulation of possible variables under controlled or measured conditions. (The difficulty here is that such experiments of necessity need to be long-term to be meaningful).

Perhaps we could also add anecdotal observations and extrapolations from other horticultural experience.

Not unexpectedly, isolated trees or single lines of trees (avenues) are more susceptible to toppling than groups of trees. This becomes an issue where 'specimen' trees are grown.

It would be a truism to say toppling occurs where a strong root structure has not developed. This does not necessarily imply however that a strong tap root is necessary since a well-established system of laterals will also support quite large trees. The most common cause of poor root structure is where the roots cannot penetrate the soil. This can occur where there is a clay pan or where the water table is high. This was a common feature in the maritime pine (*Pinus pinaster*) plantations in Europe which tended to be located on poorer soils. A related situation occurs in environments where trees (usually in urban situations) are overwatered and not encouraged to develop deep root systems. This was a common feature in trees that toppled in Cyclone Marcia in central Queensland last year. The converse was also demonstrated in the cyclone. Quite large-and isolated- eucalypts along Frenchmans Creek for example withstood the cyclone with only shedding of branches rather than toppling. By and large these were natural remnants of the original creek-line vegetation and presumably had developed strong root systems over many years).

One of the few experimental studies (Khuder et al 2007) investigated the effects of removal of the tap root at planting in *P. pinaster* (- a common forestry practice). They also tested the response of cuttings (- although these are rarely used in production plantations). The trees were tested for mechanical resilience after 7 years and there were surprisingly small differences once the trees were established. Stokes (1999) discussed what most horticulturalists already know, namely that mechanical stress (wind load) allows adaptive growth to occur resulting in increased resistance to overturning. (The corollary, long known to horticulturalists is the weakening effect of staking trees for too long and producing a spindly specimen).

Khuder et al(2007) noted 'The optimal root system architecture for increased tree anchorage has not yet been determined....' and this remains largely true a decade later, however a number of practices can be recommended on the basis of what we now know.

While large/tall trees are clearly not suitable for strictly urban/street environments, with proper management, there is no reason they cannot be incorporated into parks and gardens in a relatively risk-free manner. The key issue is to ensure good natural root development. Clay pans, over-watering and staking, as well as isolated plantings are best avoided. These issues are particularly challenging in botanical gardens where typically, plants from a range of habitats are brought together, often with a few 'specimen' trees. One strategy here is to group plants from common environments and manage them as closely as possible to their natural environments. Many plants from central Queensland would be best managed with minimal watering (even though this may mean slow growth).

[The views expressed herein are largely those of the author (R. Newby) and not necessarily Native Plants Capricornia-]