Tree species for fire-prone areas

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1. Introduction

Fire is a threat to ecosystems rich in dry biomass, and the hazard of fire increases in tropical forests. Firstly, forests are being cut down by man, leaving a large amount of dry material behind. Secondly, fire is used actively to clear land for agriculture. Thirdly, opening forests allows seasonal dry micro-climate even in humid rain forests. Fourthly, accidental fires are becoming more frequent in connection with human activities, both as escaped fires from clearings and fires started for hunting or to improve grazing.

How destructive fire is depends on its intensity. Any organic material will burn if temperature is high enough, yet much material will escape a low intensity fire. Fire is a natural event and for many species and ecosystems fire is an important part of their regeneration and dynamics. Species grown in fire-prone areas often possess an inert fire protection. In other words fire-prone areas such as savannahs contain a resource of species adapted for growing in areas, where fire is a recurrent risk.

2. Destruction by fire

The temperature of fast grass fire will not reach more than a few hundred degrees and only for a few seconds at any place. Temperature of burning wood may reach several thousand degrees for a longer time. Grass fires will destruct most tree seedlings but not mature trees, because the high temperature is experienced only at low levels where trees are protected by a thick stem bark, and because the more sensitive branchlets and foliage borne at higher levels escape the high temperature. Any moisture will reduce the intensity of fire, but moist tissue is also where life processes take place which are easily destroyed by high temperatures. Fire is thus generally more destructive during the beginning of the rainy season than during the dry season, where many trees are deciduous and dormant. Wind makes fire spread faster but also takes away heat so that adult trees may not be caught by fire.

3. Physiological and other adaptations to fire

Resistance to fire often takes the form of morphological adaptations to shield or guard sensitive tissue from high temperature by some type of insulation. Examples of this is found in morphological structures of thick protecting bark on stems, and clusters of needles of, for example, *Pinus merkusii* grass-stage seedlings. In eucalypts high oil content in all parts of the tree protects against low intensity fires. However, when the oil burns very high temperatures are experienced which aggravate the fire hazard. The same applies to resins of pines, for example. A relatively high fire resistance is also found in salt tolerant species.

The heat generated by fires usually destroys leaves and flowers. However, a feature of the relative fire resistant tree species is that they are able to recover by setting fresh shoots soon after a fire. This applies to, for example, many dry zone acacias. Most species growing in fire prone areas show improved regeneration after fire. The high temperature helps opening fruits of species of *Hakea*, *Banksia* and *Pinus*. Hard seeds of both legumes and eucalypts usually show high germination rate after a fire. Although fire will damage all vegetation, species with some fire protection will have a relative advantage of fire which will eliminate competing vegetation and thereby promoting regeneration.

4. List of species with inert fire adaptation

Where natural or man-made fires have prevailed in an ecosystem, there has been a strong selection pressure for fire resistance and adaptation. Such areas occur primarily

Figure 1. Left: A grass fire that sweeps fast under mature trees of relatively fire resistant species may leave trees relatively undamaged. Fire may even stimulate regeneration from dormant seed or re-sprouting from shoots. Right: Low intensity fire in open grass / bushland. This type of fire may damage seedlings but adult trees will survive.

in African savannahs and in wooded grasslands of Australia. These ecosystems are consequently where we find most species adapted to fire. Fire climax also occurs, though to a lesser extent, in dry forest areas of S. SE. Asia and the Pampas in S. America. Oil-rich species like eucalypts and melaleucas are relatively resistance to low intensity fire. However, they are sometimes discouraged for planting in fire prone areas because once burning, the temperature gets very high and the fire is difficult to control. Both loose, fibrous and stringy bark, and retained dead shoots and branchlets can easily catch flames, which can then spread into the crown - such species should be avoided. Species tolerant to high salt concentration usually also show a high fire resistance. Some species showing moderate to strong fire resistance are listed here.

Acacia karroo	*Acacia erioloba*
Acacia mellifera	*Acacia mangium*
Acacia nilotica	*Acacia nubia*
Acacia tortilis	*Albizia procera*
Antidesma fructescens	*Araucaria angustifolia*
Banksia spp.	*Bridelia cambodiana*
Bombax ceiba	*Cassia ferruginea*
Casuarina decaisneana	*Casuarina junghuhniana*
Colona floribunda	*Commiphora spp*
Dipterocarpus obtusifolius	*Dipterocarpus tuberculatus*
Elaeocarpus reticulatus	*Eucalyptus camaldulensis*
Eucalyptus maculate	*Gardenia erythroclada*
Grevillea robusta	*Hakea spp.*
Melaleuca leucadendra	*Microcos paniculata*
Octomeles sumatrana	*Peltophorum dasyrhachis*
Peltophorum pterocarpum	*Pinus canariensis*
Pinus kesiya	*Pinus merkusii*
Pinus roxburghii	*Podocarpus elatus*
Pterocarpus angolensis	*Pterocarpus macrocarpus*
Quercus laotica	*Shorea robusta*
Spondias pinnata	*Syzygium cumini*
Tabebuia spp.	*Tamarix aphylla*
Tectona grandis	*Terminalia alata*
Terminalia brownii	

Figure 3. Fire adaptations in Pinus merkusii. *Left: thick bark protects the sensitive cambium. Centre: the so-called grass-stage seedling protects the sensitive shoot by a cluster of protective needles. Right: very dry, scaly bark is a fire adaptation for many dry bushland/savannah species.*

5. References and selected reading

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