



Tree species for cracking clay soils

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Tree Species for Cracking Clay Soil

1. Introduction

Vertisols is a type of expanding clay soil with a high total clay content (>30%) and particularly rich in montmorillonite, a clay mineral with chemical structure composed of the silicate-gibbsite-silicate group. It has no or very little horizon development, consisting basically of A and C horizon. The soil swells at high water content and contracts when dry, leaving a characteristic polygon shape of dry soil, hence the word 'cracking clay' soil. Cracking is mostly pronounced at the upper 5-10 centimetres where desiccation is strongest.

The cracks can be more than 1 cm wide at the surface and reach a depth of more than 50 cm. It consequently affects mostly seedlings and young trees with superficial roots. However, since all species start as seedlings, cracking can be a serious regeneration hazard for most species. Drainage of vertisols is generally poor. Wetting causes the soil to swell. It gets compact, which practically blocks any water movement. Flooding is common if the soil gets over-saturated with water. As there is no leaching, the soil usually has a good nutrient content and pH is above 7. Vertisols are common on flat plains in semi arid areas with pronounced climatic seasonality. They occur on all continents but are particularly common in Africa. Vertisol areas are usually quite large coherent areas. The prevailing natural vegetation type is wooded grassland (savannah). The soil can support quite a prolific vegetation albeit diversity is usually low. They are generally difficult to cultivate because of their poor drainage and their tendency to form large hard clods when ploughed. In agriculture context they are often called 'black cotton soil'.

2. Physiological and other adaptations to cracking soil

Plants growing on cracking clay soil encounter two key stress factors during the dry season.

1. The physical contraction can pull the roots apart and thus destroy them mechanically.
2. The cracks leave part of the roots exposed

to strong desiccation. A third stress factor occurs during the wet season, where soil is often waterlogged. This impedes aeration of the roots. Since the soil is rich in nutrients but with pronounced seasonal stress, herbal vegetation and grass tend to grow extremely fast during the beginning of the rainy season. Strong competition from weed, primarily large grass, is thus a current hazard for the establishment of tree vegetation.

Trees adapted to growing on cracking clay soil have strong roots with a high tolerance to mechanical stress. Seasonal desiccation or drought tolerance is expressed as pronounced phenological seasonality usually as deciduousness. Survival during seasonal flooding and water logging depends on the duration of these stress events. Species with aerial tissue in the wood can transport air which allows some root respiration, and thus survival during waterlogged periods.

3. Afforestation on cracking clay soil

Timing is particularly critical for both crop cultivation and planting. Completely barren plains can be prepared mechanically e.g. by disk harrowing or ploughing. Ploughing can also be used to prepare planting ridges and drainage trenches. In enrichment planting, planting spots are prepared manually. During rehabilitation or plantation establishment it is advisable to leave any large size tree for microclimate improvement and drainage until new trees have established. The soil may be very hard during the dry season, and planting spots are preferably prepared at the end of the rainy season prior to the coming planting season. Planting spots should be approx. 50 cm in diameter and 25-35 cm deep. Mixing of soil during soil preparation together with application of soil from the pots during planting help seedlings overcoming stress and ease establishment. In order to reduce mortality in the stressed environment it is recommended not to use oversize seedlings and assure appropriate hardening-off before planting.

Vertisols can be afforested by direct sowing on bar-





Acacia seyal, one of the most common species on cracking clay soil in Lower Shire, Malawi. Photo Lars Schmidt



Drainage of vertisols around plants reduces the stress of waterlogging. Left. Planting on ridges between drainage trenches. Right. Circular draining trench around each seedling



The cracking pattern of vertisols during drought. Moving surface particles can be deposited in the cracks and thus cause inversion of the horizons. Vegetation cover reduces desiccation and thus cracking.

Photo: University of Idaho (http://soils.ag.uidaho.edu/soilorders/vertisols_06.htm)

ren soil, but this is less suitable for sites with prolific vegetation. Both sowing and planting must be done immediately after the first rain. Water logging may be mitigated by digging a trench around each seedling or by planting on ridges between which are draining trenches.

4. List of species adapted to cracking clay soil

The largest vertisols areas in the world are found in Africa, Australia and India. Species from these continents are prevalent on the list of species adapted to the soil type. Some species are more common on 'heavy clay soil' without the cracking feature.

<i>Acacia abyssinica</i>	<i>Combretum ghasalense</i>
<i>Acacia decurrens</i>	<i>Dalbergia sissoo</i>
<i>Acacia leucophloea</i>	<i>Diospyros mespeliformis</i>
<i>Acacia karroo</i>	<i>Eucalyptus camaldulensis</i>
<i>Acacia mearnsii</i>	<i>Eucalyptus globulus</i>
<i>Acacia mellifera</i>	<i>Eucalyptus microtheca</i>
<i>Acacia nilotica</i>	<i>Faidherbia albida</i>
<i>Acacia polyacantha</i>	<i>Hardwickia binata</i>
<i>Acacia salicia</i>	<i>Leucaena collinsii</i>
<i>Acacia senegal</i>	<i>Leucaena leucocephala</i>
<i>Acacia seyal</i>	<i>Millettia thonningii</i>
<i>Anogeissus leicocarpus</i>	<i>Nauclea orientalis</i> (Syn. <i>Mitragyna parvifolia</i>)
<i>Azadirachta indica</i>	<i>Pongamia pinnata</i> (Syn. <i>Derris indica</i>)
<i>Boaehinnia thonningii</i>	<i>Prosopis pallida</i>
<i>Bursera simaruba</i>	<i>Sesbania grandiflora</i>
<i>Busera graveolens</i>	<i>Sesbania sesban</i>
<i>Butea monosperma</i>	<i>Spondias mumbin</i>
<i>Cassia glauca</i>	<i>Tamarindus indica</i>
<i>Cassia mimosoides</i>	<i>Tephrosia elegans</i>
<i>Caesalpinia glabrata</i>	
<i>Calliandra calothyrsus</i>	
<i>Colophospermum mopane</i>	

5. References and selected readings

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