

Tropical Forages

Calliandra calothyrsus

Scientific name



Calliandra calothyrsus Meisn.

Synonyms

Anneslea acapulcensis Britton and Rose; *Calliandra acapulcensis* (Britton and Rose) Standl.; *Calliandra confusa* Sprague & L. Riley; *Calliandra houstoniana* var. *acapulcensis* (Mill.) Barneby; *Calliandra houstoniana* var. *calothyrsus* (Meisn.) Barneby

Family/tribe

Family: *Fabaceae* (alt. *Leguminosae*)
subfamily: *Caesalpinioideae* (mimosoid clade*) tribe: *Ingeae*.

* Azani, N. et al. [97 authors from 54 institutions] 2017. A new subfamily classification of the Leguminosae based on a taxonomically comprehensive phylogeny. *Taxon* **66**: 44–77.

Morphological description

Shrub or small tree, (2–) 5–6 (–12) m high, dense canopy; evergreen in humid climates and semi-deciduous in areas with long dry season. Trunk to 20 (–30) cm diameter, bark white-reddish brown bark; stems thornless. Leaves bipinnate, alternate; rachis 10–20 cm long, aglandular; pinnae (3–) 15–20, jugate, rachilla of longer pinnae (4–) 5–8.5 cm long, bearing 19–60 pair of pinnules; pinnules linear, oblong, straight or gently incurved, acute, 4–9 (–10) mm × 0.7–1.9 mm.

Inflorescence a terminal panicle raceme with flowers opening acropetally borne in umbelliform clusters, along 10–30 cm long axis. Sepals and petals green, commonly glabrous, rarely micropuberulent; calyx 1.6–2.3 mm long, corolla 5–6 (–10) mm long. Staminal filaments numerous, red, 4–6 cm long. Fruits broadly linear, flattened, 8–11 (–14) cm × 1.0–1.8 cm with thickened and raised margins, finely pubescent or glabrous, attenuate to the base and sharply acute at the apex, brown and dehiscent elastically from the apex when mature, 8–12 seeded. Seeds ellipsoid, flattened, attenuate to the base and sharply acute at the apex, 7–8 mm × 5–6 mm long, shiny, dark brown, sometimes mottled. 14,000–17,000 seeds/kg.

Common names

Africa: kaliisambuzi (Luganda); mkaliandra (Swahili)

English: calliandra, powderpuff tree, red calliandra; fairy duster tree (Kenya)

French: calliandre

Indonesia/Malaysia: kaliandra, kaliandra merah



Thornless, multi-branched shrub or small tree



Bipinnate leaves with mostly 15-20 pairs of pinnae, each with 19-60 pairs of pinnules



Inflorescence a terminal or sub-terminal, panicle raceme.



Immature pods with thickened and raised margins; attenuate to the base and sharply acute at the apex



Inflorescence and pollinating bat



Ripening seed crop North Qld Australia



Ripening pods



Seeds



Calliandra calothyrsus Meisn. - 1, flowering branch; 2, branch with fruits.

Line illustration



Coppice regrowth, CIAT-Palmira, Colombia

Latin America: barba de gato, barbillo, barba de chivo, barbe jolote, barbe sol, cabello de ángel, carboncillo, carbonero, clavellino, pelo de ángel (Spanish)

Distribution

Native:

Northern America: Mexico (Campeche, Chiapas, Colima, Durango, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Sinaloa, Veracruz)

Central America: Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua; Panama

Cultivated:

Earliest written record of cultivation dates back to 1936 when seed of a probable Mexican genotype was sent from Guatemala to Java, Indonesia, by the Dutch Colonial Forest Service as a replacement for *Leucaena leucocephala* in higher altitude, humid locations, where heavy seed production and competitive root growth of that species were considered problematic. Since then it has been distributed more widely in Indonesia, and to Costa Rica, India, Samoa, Taiwan, Thailand, Australia, Africa, Bolivia, China, Colombia, Guinea, Haiti, Jamaica, Papua New Guinea, Philippines, Rwanda, Sri Lanka and Zimbabwe. It is now widely used for fodder for dairy cows in the East African highlands of Kenya, Uganda, Tanzania and Rwanda.



Browsing cattle, humid tropics, North Qld Australia



After browsing, North Qld, Australia



Cut forage



Cut forage (Calliandra + Glicicidia), Bali Indonesia



Rows established in a stand of *Ischaemum ciliare*, Upolu, Samoa



With buffalo grass (*Stenotaphrum secundatum*) Bali, Indonesia

Uses/applications

Forage

A multipurpose species grown for high protein forage to supplement low quality roughages for ruminant livestock, primarily in cut-and-carry systems.



Alley cropping with maize

Environment

Calliandra is used as a green manure due to its ability to fix atmospheric nitrogen and to produce high yields of nitrogen-rich foliage, which also contains relatively high level of tannins that slow the rate of microbial breakdown of the organic matter. In alley-cropping systems on less fertile soils, this slow breakdown maintains mulch and provides a slow release source of nutrient. The green manure effects together with its deep and well-developed lateral rooting system are used in land rehabilitation and soil erosion control on slopes and stream banks. As it contributes to rehabilitation of land exhausted by

Other

The plant is suitable for hedgerow boundaries, for provision of shade for coffee and tea, as a nurse tree for partially shade-tolerant timber trees such as *Agathis* species, as a host for the semiparasitic crop, sandalwood (*Santalum* spp.) and for the lac insect (*Kerria lacca*) for shellac production. The flowers provide a rich source of nectar and pollen for honey bees, and the wood can be used as fuelwood and for charcoal production. Calliandra stems are used in parts of Africa as stakes for climbing beans.

Ecology

Calliandra calothyrsus occurs in primary, secondary or disturbed, lowland to pre-montane, seasonally dry to wet sub-tropical forests, especially along river margins.

Soil requirements

It occurs naturally on a range of often acidic soils of various depths (alluvial deposits, clays, sandy loams). It has been found to grow well on a wide range of soils providing they are well-drained, from deep volcanic loams to less fertile acidic metamorphic sandy clays and other light-textured soils. It will grow on soils with pH of (4.5–) 5–6.5 (–7.5), but is poorly adapted to alkaline soils. While tolerant of low fertility, it responds to application of appropriate fertilizer on such soils.

Moisture

Annual rainfall in its native range varies from 700 to 4,000 mm with 1–7 months dry season. Calliandra does not tolerate inundation or waterlogged conditions, plants dying within 2 weeks if the soil remains waterlogged. While it can withstand dry periods, it makes limited growth except in riverine environments, or where a perched watertable is present. It is evergreen in humid climates, but semi-deciduous in areas with a long dry season. It is largely grown in areas with rainfall (700–) 2,000–4,000 (–5,000) mm, mostly with a 3–6 month dry season.

Temperature

Its natural distribution is quite tropical from 9 to 19° N, where mean annual temperatures range from 22 to 28 °C. It is now grown in areas with mean monthly maximum temperatures of 24–28 °C and mean monthly minimum temperatures of 18–24 °C. Although frost susceptible, it possesses considerable cool tolerance for a tropical species, growing naturally to 1,800 m asl in Guatemala and exotically to 2,000 m asl in Indonesia and Kenya. The optimum temperature range for growth is considered to be between 22 and 30 °C.

Light

It makes best growth in full light. It is intolerant of heavy shade, but moderately tolerant of medium shade. In Uganda and Tanzania it is being adopted in home garden systems where it is planted under banana where shading is not extreme.

Reproductive development

Flowering can occur throughout the year given sufficient soil moisture, but in its native environment is concentrated between October and January (late wet season). Flowering can cease during dry seasons of more than 4–5 months. Flowers are andromonoecious, bearing both hermaphrodite (bisexual) and staminate (male) flowers. Anthesis normally occurs between 15:30 and 17:00 h, although in Kenya it was recorded to occur as early as 14:00 h, and is followed by anther dehiscence once the flowers are fully open. The stigma is normally receptive from 19:00 h, but by 06:00 h the following morning receptivity has declined and the flowers begin to wilt. Predominantly outcrossing with a weak, possibly late-acting, self-incompatibility system. The level of selfing is influenced by provenance, age, floral phenology, population size and pollinator behaviour. Pollination is achieved by hawkmoths (Sphingidae), bats of the genus *Glossophaga* and other less specialised fruit bats.

Defoliation

First cut 8–12 months after sowing. For maximum leaf production, cut to a height of 0.5–1.0 m every 2–3 months. To prevent leaf loss in the dry season, cut at the end of the wet season. Calliandra is generally recommended for cut-and-carry feeding rather than for use in direct grazing systems. Direct grazing by cattle, sheep and goats will normally result in high rates of plant mortality. Slashing calliandra to less than 30 cm above ground level and allowing ruminants to graze the regrowth can reduce plant mortality under direct grazing. This practice reduces the stripping of bark and cambium from the stem.

Fire

Unknown. Probably tolerant once established.

Agronomy

Guidelines for establishment and management of sown forages.

Establishment

Seed requires scarification. Good results are achieved by soaking seed in cold water for 48 hours. Hot water treatment can be used but there is a risk of killing seed through excessive exposure to high temperature. Mechanical scarification is also used. Use scarified seed planted at 1–3cm depth or seedlings raised in nurseries when the plants are 20–50cm tall. Seedlings can be planted 0.5–1.0 m apart in hedgerows spaced 3–4 m apart, or in fodder banks spaced 0.5–1.0 m apart in a grid pattern. Attention to early weed control will shorten the establishment period. Although promiscuous in its *Bradyrhizobium* requirements, calliandra may benefit from inoculation in new areas. Early growth is slow. Once the species is mycorrhizal, growth is vigorous and the tree reaches a height of 3.5 m in 6 months. Does not establish well from cuttings.

Fertilizer

Use of fertilizer on infertile soils will improve early growth, but it is less responsive to fertilizer than some other tree species.

Compatibility (with other species)

Calliandra is not compatible with other species at the seedling stage and should be a sole component of the stand until reasonably developed at which time grasses can be introduced. If the calliandra is planted in rows, the row spacing and defoliation management of the calliandra will determine light availability to the interrow, and hence compatibility of the grass with the calliandra. Shade tolerant grasses may be the best option.

Companion species

Grasses: Has been grown as a hedgerow in signal grass (*Urochloa decumbens*), buffalo couch (*Stenotaphrum secundatum*), guinea grass (*Megathyrsus maximus*) pastures and in stands of *Imperata cylindrica*.

Other: Generally grown as line plantings along fencelines and paddock boundaries, as hedgerows, or integrated into garden systems

where it is grown with a wide range of crop species. Used as a shade tree over coffee and tea. Suitable host for sandalwood (*Santalum album*).

Pests and diseases

As calliandra is spread around the tropics, a wide range of pests and diseases are proving adapted to the species and adversely affecting its productivity, even causing death. Damaging insects include cerambycid and scarabaeid beetles, scale insects, aphids, termites and the larvae derived from various moth families. An undiagnosed problem has appeared with symptoms of poor vigour, dieback, wilting, chlorosis, stunting, premature flowering, and darkening and hardening of the branches. *Fusarium* and *Phomopsis* fungi have been isolated from affected plants, but are not necessarily the cause. Bruchid beetles can destroy a high proportion of stored seed if seed is not kept under cold conditions.

Ability to spread

Has not spread when utilised in agricultural systems and subjected to intermittent defoliation.

Weed potential

Can be an aggressive coloniser of disturbed habitats, depending on seed set, which varies with the availability of suitable pollinators. Has colonised disturbed habitats and is consequently not recommended as a fallow species.

Feeding value

Nutritive value

In vitro digestibility of dried leaf from 19 provenances ranged from 24 to 47%. Wide variation in condensed tannin (CT) concentrations has also been reported (1.5–19.4%). Several studies have reported negative nitrogen balances resulting from high levels of supplementation with calliandra leaf. Despite this, reasonable animal production is achieved where calliandra has been adopted as a supplement to poor quality basal diets or as a partial replacement of concentrate feeds. Good source of the vitamin, carotene.

Palatability/acceptability

Freshly harvested leaves of calliandra are generally highly palatable to ruminants where animals have prior experience with the forage, although some problems with palatability have been reported from Mexico and Central America. Provenances vary in palatability to some extent. Palatability is significantly reduced when wilted or dried leaves are fed at high levels of supplementation. At normal supplementation rates (20–40%), wilting or drying of leaves will have no effect on intake.

Toxicity

No known toxicities to ruminants.

Feedipedia link

<https://www.feedipedia.org/node/586>

Production potential

Dry matter

Produces DM yields of 3–14 t/ha/year, depending on climate and soil fertility. The Nicaraguan provenance of 'San Ramon' is superior for leaf production, but should not be promoted for fodder, as its nutritive value is significantly lower than that of other provenances, including 'Patulul' (Guatemala) and the Kenyan land race ('Embu'). Indonesian landraces from Bandung and Maduin performed well as multipurpose accessions, producing high levels of both leaf and wood.

Animal production

Generally used to improve the utilisation of low quality grasses or as a replacement for concentrate feeds. In Zambia, goats fed a basal diet of poor quality hay lost weight at 20 g/day. Weight gains of 24 g/day were achieved when supplemented with 140 g/day DM of calliandra leaf. In Indonesia, sheep liveweight gains increased from 26 up to 52 g/day when supplementation levels of fresh calliandra leaf increased from 0 to 35% of total ration. Cattle direct grazing calliandra over a 12-month period in Indonesia gained 0.33 kg/head/day compared with 0.16 kg/head/day from those grazing an *Imperata cylindrica* control. Despite the promising early results, calliandra proved unable to withstand direct grazing and experienced 100% plant mortality over a 2-year period.

Experimentally in Kenya, 3 kg of fresh calliandra leaf plus 2 kg of concentrate feed provided a similar response in milk yield and butterfat to 3 kg of concentrate feed. The response may arise from the provision of tannin-protected protein that can be efficiently absorbed post-ruminally. In Kenya, the recommendation to farmers is that 500 plants, managed in a hedgerow, will provide enough leaf to supplement the diet of one dairy cow. A dairy goat needs 100–150 plants.

Not suitable as a feed for monogastric animals due to its high levels of astringent CTs. Small amounts may be fed to chickens as leaf meal: the carotene content gives a dark yellow yolk which can increase the market value of the eggs.

Genetics/breeding

2n = 22. *C. calothyrsus* can be divided into 4 subgroups based on geographical, morphological and isozyme characters. Agronomic evaluations have identified superior provenances/landraces. Artificial hybridization has been carried out between 3 species of *Calliandra*. Hybrids between *C. calothyrsus* and *C. houstoniana* have shown early promise with potential for cultivar development.

Seed production

The species is said to be andromonoecious as individual trees bear both bisexual and functionally male flowers. Flowering may start in the 1st year, but good fruit set starts in the 2nd year. It may take 2–3 months for flowers in one panicle raceme to open acropetally (from the base), causing a spread of maturity in the fruit developed on that raceme. While under humid conditions flowering may occur year-round, peak flowering generally occurs just after the wet season in both native and exotic environments. Anthesis occurs late in the afternoon, followed by anther dehiscence once the flowers are fully open. The stigma is receptive overnight but by morning receptivity has declined and the flowers begin to wilt. Pollinators therefore must be nocturnal, the main ones being small insectivorous bats, but also hawkmoths/sphinx moths (Sphingidae) and honey bees (Apidae). It then takes a further 3 months from pollination for seed to mature.

High levels of seed production in Central America. Provenances/accessions should be separated by at least 2 km distance to prevent cross-pollination. For maximum seed production, trees should be widely spaced with an area of 9–16 m²/tree. Coppice trees to 1 m prior to the wet season to stimulate flower production. Well-fertilized soil will increase the production of hermaphrodite flowers. Seed crops are commonly poor in the first year of production. A lack of suitable pollinators has limited seed production in some exotic locations. Seed dispersal is through explosive apical dehiscence of the pods, seed being thrown up to 10 m. With the asynchronous ripening of pods, single harvest strategies will therefore result in seed losses from early dehiscing of pods, or varying quantities of unripe seed. Tarpaulins can be laid under seed trees to collect seed as it falls.

Herbicide effects

There appears to be little or no published work on herbicide effects on *calliandra*, except for one that suggests it can be controlled with glyphosate.

Strengths

- Highly productive in humid-tropical and highland-tropical locations.
- Multipurpose tree: forage, firewood, green manure, soil conservation, shade.
- Well-adapted to moderately acid soils and highland tropical environments.
- Fast-drying, high quality fuelwood for small fires/cooking.

Limitations

- Low *in vivo* digestibility/forage quality due to moderately high concentrations of condensed tannins.
- Cannot be direct-grazed by ruminant livestock.
- Some weed potential.
- Increasing incidence of pest and disease.

Internet links

https://hort.purdue.edu/newcrop/duke_energy/Calliandra_calothyrsus.html

Selected references

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Cultivars

No cultivars of *C. calothyrsus* have been formally released.

Promising accessions

'Patulul' provenance (CIAT 22316). Selected in Guatemala, collected by OFI, UK. Produced high levels of both leaf and wood in multi-location trials, and also shown to have superior nutritive value.

'Bandung' and 'Maduin' landraces. Indonesia, collected by OFI, UK. Produced high levels of both leaf and wood in multi-location trials. Widely distributed to exotic locations.

'Embu' landrace. KARI/ICRAF, Kenya. Closely related to Indonesian landraces.

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