

Tropical Forages

Cenchrus americanus

Scientific name



Cenchrus americanus (L.) Morrone

Synonyms

Basionym: *Panicum glaucum* L.; *Alopecurus typhoides* Burm. f.; *Chaetochloa glauca* (L.) Scribn.; *Chamaeraphis glauca* (L.) Kuntze; *Holcus spicatus* L.; *Panicum spicatum* (L.) Roxb.; *Pennisetum americanum* (L.) Leeke; *Pennisetum glaucum* (L.) R. Br.; *Pennisetum leonis* Stapf & C.E. Hubb.; *Pennisetum spicatum* (L.) Körn.; *Pennisetum typhoides* (Burm. f.) Stapf & C.E. Hubb.; *Pennisetum typhoideum* Rich.; *Setaria glauca* (L.) P. Beauv.

Family/tribe

Family: *Poaceae* (alt. *Gramineae*) subfamily:

Panicoideae tribe: *Paniceae* subtribe: *Cenchrinae*.

Morphological description

Erect, robust, annual grass with tillers (0.5–)1.5–3 (–4) m tall; tillering from the base, and sometimes branching from the lower nodes; extensive root system, thick prop roots from lower nodes. Stems 1–3 cm diameter, nodes glabrous to bearded. Leaf-blades 20–100 cm long, 8–80 mm wide, ciliate, glabrous or hairy, linear to linear-lanceolate, flat, apex attenuate, base rounded or subcordate; ligule a fringe of hairs 2–3 mm long. Sheath glabrous or with sparse to dense tubercular-based hairs, usually densely bearded near the collar. Panicle spiciform, linear, elliptic, or ovate; dense, 10–50 cm long, 1.5–5.0 cm diameter; peduncle densely pubescent. Spikelets in clusters of 1–9 subtended by a persistent involucre of many bristles, mostly 4–7 mm long; stipe pubescent, 1–5 mm long; spikelets obovate 3–6 mm long, pedicellate. Caryopsis globose to cylindrical or conical, 2.5–6.5 mm long, exposed between gaping lemma and palea at maturity; white, pearl-coloured or yellow to blue-grey or brown, occasionally purple. 95,000–140,000 (–180,000) seeds/kg.

Common names

Africa, Northern: duchn, duhn, duhun, dukhon, dukn (Arabic, Sudan); دُرْغُ dro'o (Tunisian Arabic), gssab (Tunisia); biltug (Tigrinya & Blin, Eritrea)

Africa, Southern: babala, manna (Afrikaans); leotsa (Pedi); nyalothi (Sotho); inyouti (Ndebele); mhuga, mhungu (Shangaan); droo, gssab (Tunisia); amabele, unyaluthi, unyawoti, unyawothi (Zulu); mahangu (Oshiwambo); mexoeira (Mozambique); mhunga, munga (Shona, Zimbabwe), inyawuthi (Northern Ndebele, Zimbabwe), lebelebele (Setswana, Botswana), zembwe (Ikalanga, Botswana)

Africa, Eastern: mwere (Kikuyu, Kenya); mahangu (Namibia); mawele, uwele (Swahili); mpyoli (Bemba, Zambia); amabele, unyaluthi, unyawoti, unyawothi (Zulu); mpyoli (Zambia)

Africa, Western: gero (Hausa, Nigeria), emeye, oka (Yoruba, Nigeria); amala, ignati (Togo); gero (Hausa); emeye (Yoruba); maiwa (Nigeria); boudouma, ba angoure, haini, kirei, soumno, zongo (Niger); souna, tiotioni, sanio (Mali); moufiri (Guinea); nara, zia (Ghana); mouri, yadiri (Cameroun); iniadi, haini, gouri, kazouya, ouine, dou fouâ (Burkina Faso); ignati, nara, amala (Benin); souna, sania, tiotandé (Senegal); dokane, dokona, ligui (Chad); arum (Borno Kanuri); sajo (Bambara); gawri (Fula); heyni (Zarma); masago (Somali)



Tillering from the base, Lawes, Queensland. (cv. Siromill)



Erect, robust, annual grass with tillers mostly 1.5–3 m tall, NT, Australia (cv. Katherine)



Inflorescence a spiciform panicle (linear inflorescence, cv. Ingrid)



Inflorescence a spiciform panicle (elliptic inflorescence, cv. Siromill)



Leafy, fine-stemmed forage type (cv. Siromill) NARI, Eritrea



Seeds



Grazing in coastal SE Qld, Australia

Asia: 粟 yu gu; 粳 zhen zhu su; 籼 la zhu bai; 稷 jin se gou wei cao (as *Setaria glauca*) (China); kinenokoro, kin enokoro, toujin kibi, tōjin bie, tōjin hie, parumitto (Japan); baajaraa (Nepal); proso afrikanskoe, proso amerikanskoe (Russia); khao fang nok (Thailand); ذخن dokhn (Yemeni Arabic)

Asia, South: கம்பு kambu (Tamil); kambam (Malayalam); बाजरी bajri, બાજો bajro (Gujarati); बाजरा bajri (Rajasthani, Marathi), साजे saje, ಕಂಬು kambu, ಕುಂಬು (Kannada); बाजरा bajra (Hindi, Urdu and Punjabi); సాజులు sajjalu (Telugu); বাজরা bajra in (Bengali); باجرا ba'ajra (Urdu, Kashmiri, Balochi, Pashto, Punjabi, Saraiki); باجيري Sindh

English: bulrush millet, candle millet, cattail millet, dark millet, horse millet, Indian millet, pearl millet, spiked millet

Europe: zeegroene naalbaar (Belgian); negerhirse, perlehirse (Danish); negergierst, parelgierst (Dutch); mil, mil à chandelles, mil africain, millet perle, millet d'Afrique, mil d'Égypte, pencillaire, petit mil (French); vesihaljas kukeleib (Estonian); Perhirse, Negerhirse (German); miglio africano, miglio perla, miglio perlato (Italian); pärlhirs (Swedish)

Portuguese: capim-tinga, milhete, milheto, milho africano, milho miúdo, painço, milha-paiceira, peniseto milha-amarelada

Spanish: almorejo glauco, cusanillo, lagartera, mijo candela, mijo negro, mijo perla, panizo negro

Distribution

Native:

The precise origin of *Cenchrus americanus* is unclear since it was domesticated some 4,000 years ago. It is thought to have originated in Sahelian Africa, in a diffuse belt stretching from western Sudan to Senegal.

Cultivated:

From its beginnings in the Sahel region, it reached eastern Africa and India about 3,000 years ago, and southern Africa about 2,000 years ago. It is now grown in much of the world sub-humid and semi-arid tropics and subtropics, sometimes extending into temperate zones.

Uses/applications

Forage

C. americanus is an alternative to *Sorghum* spp. and other warm season forage crops. It can be used for grazing, green chop and silage, and for hay, with appropriate management.

Environment

Pearl millet has been found to be effective in suppressing root-lesion nematodes (*Pratylenchus penetrans*) and has been used as an alternative to soil fumigation in tobacco and potato cropping in Canada.

Other

C. americanus is mostly grown as a grain crop, being the staple food in those parts of tropical Africa and India that are too hot, dry and sandy for sorghum production. Whole grains are fed to poultry and livestock, and the straw is used for bedding, thatching, fencing and fuel. Pearl millet also has application in a number of African folk medicines.

Ecology

Soil requirements

C. americanus is adapted to a range of soil types, but is best on sandy or light loam soils. It will grow on clays, but they must be well-drained, because it is very susceptible to waterlogging. Although it tolerates poor, infertile soils better than most other crop species, it is more productive on fertile soils. The ideal pH range is 5.5–7.0, but it will grow in soils with pH as high as 8.3. It can tolerate more acid soil than forage sorghums, growing in soils down to pH 4.5, with subsoils to as low as pH 4 and high in exchangeable aluminium. It is also slightly more salt tolerant than sorghum.

Moisture

C. americanus is perhaps the most drought tolerant of the grain species, and is used in areas where maize (*Zea mays*) and *Sorghum* spp. are more likely to fail. However, it is less tolerant of waterlogging and flooding than sorghum. While it evolved in a region with average annual rainfall about 250 mm, it is now cultivated in areas with as low as 125 mm and up to about 1,500 mm/yr, but most commonly between 250 and 750 mm. For forage production, it requires a minimum annual rainfall of 500 mm.

Temperature

It is grown between sea level and 1,800 m in the tropics, and to about 40° N in the USA. The optimum temperature for germination is 33–35°C, and the minimum, 12°C. Sowing is best done when soil temperatures reach 18 °C or above, and night temperatures are above 10 °C. The optimum temperature for tiller production and development is 21–24 °C, and for spikelet initiation and development about 25

°C. Pollen viability, panicle size and spikelet density are reduced by extreme, high temperatures before anthesis, thus reducing seed yield.

Light

Not shade tolerant.

Reproductive development

C. americanus is considered to be an obligate short day plant although the degree of photoperiod control varies among genotypes. There may also be an interaction between photoperiod and temperature. Cultivars vary in time to maturity from 55 to 280 days, but mostly from 75 to 180 days. Later-maturing varieties are favoured for forage production.

Defoliation

Quality is maintained by relatively frequent but lenient defoliation. Crops can be cut initially when they reach 75 cm to 1 m tall, since if plants are allowed to grow taller, quality declines, and there is difficulty in drying the hay. High regrowth yields after defoliation can best be obtained if the cutting height is above the apical meristem, which means adopting a stubble height of 15–20 cm. Grazing can start earlier when the stand reaches 30–50 cm, but still with the same after-grazing residue to facilitate regrowth. Earlier defoliation encourages tillering. A rotational system favours efficiency of forage utilisation and facilitates better regrowth compared with continuous grazing, particularly when *C. americanus* appears susceptible to trampling. The crop should not be allowed to grow above 1 m high before subsequent grazing. The first cut is usually at 60–65 days after planting, and successive cuts 30–35 days after the preceding cut. Regrowth in successive harvests declines rapidly, the final cut coinciding with early head production. Harvesting for silage is recommended any time from boot to soft dough stage.

Fire

Not applicable.

Agronomy

Guidelines for establishment and management of sown forages.

Establishment

Sowing recommendations vary considerably in relation to sowing method, application and soil type. Seed can be placed to 3 cm deep in light soil, but no more than 1 cm in heavier soils. For a grazing crop, seed can be drilled in to 35 cm rows at 5–15 kg/ha, or broadcast at 25–30 kg/ha. Heavier sowings result in fewer tillers per plant, but finer stems, which is more suitable for hay-making. Lighter sowings result in greater tiller numbers, of 12–15/plant, which is better for grazing. Seedlings emerge about 5 days after sowing, initially yellow in colour, and remaining so for 8–10 days. Colour improves and rapid growth occurs after about 14 days. Earlier sowing increases the likelihood of multiple cuts or grazings.

Fertilizer

C. americanus is adapted to, and produces reasonably well on low fertility soils, but responds to improved fertility. Soil phosphorus and potassium levels should be monitored using soil analysis, but in the absence of a soil test on a suspected infertile soil, applications of 20–30 kg/ha P and 40–50 kg/ha K prior to sowing should improve performance. In intensively managed systems where large amounts of forage are removed from the field, maintenance applications of 20–30 kg/ha P and up to 100 kg/ha K will also be necessary. Nitrogen fertility is also an important consideration, but must be approached with caution due to plant nitrate implications (see “Toxicity”). There is usually no need to apply nitrogen Fertilizer at sowing if using a well-prepared seedbed where significant amounts of nitrogen have been released during cultivation. However, application of 50 kg/ha N after each grazing or harvest helps to maintain productivity.

Compatibility (with other species)

Compatible with forage legumes, particularly those with erect, ascendant or twining growth habit.

Companion species

Grasses: Normally not sown with other grasses.

Legumes: *Alysicarpus rugosus*, *Centrosema pascuorum*, *Crotalaria juncea*, *Lablab purpureus*, *Vigna unguiculata*. Inter-row with *Leucaena leucocephala*.

Pests and diseases

C. americanus is host to numerous diseases caused by bacteria, fungi, viruses, and nematodes, parasitised by other plants, and subject to attack by numerous insects and birds, the impact of any one varying from country to country, and region to region. Some of the more important diseases are downy mildew caused by *Sclerospora graminicola*, smut (*Moeszimyces (Tolyposporium) penicillariae*), ergot (*Claviceps fusiformis*), rust (*Puccinia substriata*) and pyricularia leaf spot (*Pyricularia grisea*).

Stem borer (*Coniesta ignefusalis* Lepidoptera: Pyralidae), millet head miner (*Heliocheilus albipunctella* Lepidoptera: Noctuidae) and millet gall midge (*Geromyia penniseti* Diptera: Cecidomyiidae) are the major insect pests.

C. americanus is susceptible to parasitisation by angiosperm species, *Striga hermonthica* and *S. asiatica*.

Ability to spread

There is little opportunity for spread in the presence of grazing livestock and insects.

Weed potential

Extremely low.

Feeding value

Nutritive value

C. americanus has a higher leaf to stem ratio than other forages including the forage *Sorghum* spp. If managed correctly, with appropriate harvest intervals, *C. americanus* can provide high quality feed, with crude protein levels of (8–) 10–14 (–17)%, acid detergent fibre (ADF) of 35–40% and neutral detergent fibre (NDF) 55–70%. As with other tropical grasses, dry matter productivity, NDF, and ADF concentrations increase with time, while leaf:stem ratio and CP decrease linearly. Consequently, the standover value is usually poor because of low nutrient levels and low digestibility.

Palatability/acceptability

Young, leafy growth of *C. americanus* is very palatable to livestock, although palatability declines with age. Forage intake can vary from about 3 kg DM/100 kg body weight on immature forage to a low of 1.4 kg on mature forage. Some varieties have been reported as becoming unpalatable as a result of drought set-back. This tends to occur if soil nitrate-N levels are higher than available soil phosphorus levels. Conversely, unpalatability is less likely if P levels are higher than N levels. Palatability tends to recover in affected crops within 10 days of a significant fall of rain, provided it falls in the growing season and plants are able to resume growing.

Toxicity

C. americanus can develop high levels of nitrates under conditions favouring high levels of available soil nitrogen, particularly during periods of depressed growth such as caused by moisture stress or cold.

These conditions include:

1. Application of high levels of nitrogen fertilizer.
2. Sowing into land that has had a productive legume green manure crop in the preceding season.
3. Prolonged dry period followed by sudden improvement in moisture conditions.
4. Also, any condition that kills the leaves while roots and stems remain active, can initiate the accumulation of nitrates (frost, hail, grazing and trampling, or sometimes drought and overcast weather).

Conservation of high nitrate material as hay does not reduce nitrate levels in the feed, but as silage, levels can be reduced by 40–60%. Levels of nitrate in the dry matter above about 0.9% can cause toxicity.

Feedipedia link

<https://www.feedipedia.org/node/399>

Production potential

Dry matter

Dry matter yield potential is strongly influenced by environmental conditions (soil fertility, soil moisture, temperature) and variety. Under rain-fed conditions in semi-arid environments, DM yields range from 0.25 to 3 t/ha, while under ideal conditions they can be as high as 27 t/ha, but more often they are about 20 t/ha in the tropics, and 8–10 t/ha in the subtropics.

Animal production

Beef cattle on standover *C. americanus* in northern Australia gained 296 kg/ha over a 16-week period. Heifers (320 kg) in the USA gained about 0.7 kg/head/day and about 540 kg/ha over a 12-week period.

Genetics/breeding

$2n = 14, (15, 21, 28)$; outcrossing. Cultivars have been produced through selection from wild collections, and through genetic manipulation. *C. americanus* is compatible with related species such as *C. violaceus* and *C. purpureus*, providing ample opportunity for genetic improvement for both grain and forage traits. Large and diverse collections of germplasm are held by ICRISAT and ORSTOM and other national centres. *C. violaceus* has been used as a source of germplasm for improved resistance to disease and the hemiparasitic weed, *Striga hermonthica*. Interspecific hybrids between *C. americanus* ($2n = 2x = 14$, AA genome) and *C. purpureus* ($2n = 4x = 28$, A'A'BB genome) have produced low fertility or sterile triploids that have improved forage characteristics over both parents. Crosses with the more distantly related *C. squamulatus* ($2n = 54$), an apomict, are being used to insert apomixis to ensure genetic stability in highly heterozygous progenies of interspecific crosses. Breeding incorporating the brown-midrib (BMR), low-lignin trait has been used to improve forage quality.

Seed production

Seed yields of about 250 kg/ha are obtained in the lowest rainfall areas, and (500–) 670–790 (–1,500) kg/ha in the main production areas in Africa and India. Under optimal conditions, yields may be as high as 5 t/ha, but are often reduced by disease and bird attack.

Herbicide effects

Pre-emergence herbicides, atrazine, propazine, prometryne and simazine are used for weed control in crops. Atrazine usually gives better control of weeds than propazine, but propazine is generally safer. Atrazine or propazine or prometryne at 1.0 kg a.i./ha is recommended to control emerging weeds after the sowing of pearl millet. There should be optimum soil moisture at the time of application of atrazine. Metalochlor (1 kg a.i./ha) is used to control weeds in crops intersown with pulses like *Vigna unguiculata*. 2,4-D at 0.5–1.0 kg/ha can be used for broadleaf control when *C. americanus* plants are 10–30 cm tall (or about 21 days after sowing). Spraying later can reduce seed set, and earlier can be injurious to the crop root system.

Strengths

- Adapted to acid, low fertility soils
- Drought tolerant
- Good leaf:stem ratio
- Does not cause prussic acid poisoning
- Safe to feed to horses

Limitations

- Intolerant of poor drainage
- May cause nitrate poisoning
- Hay difficult to cure

Internet links

https://research.csiro.au/cultivars/wp-content/uploads/sites/162/2017/03/ingrid_pearl.pdf

https://research.csiro.au/cultivars/wp-content/uploads/sites/162/2017/03/katherine_pearl.pdf

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Cultivars

'Ingrid Pearl' Released in Australia (1968). Derived from CPI 28818 ex Centre des Recherches Agronomiques, Bambey, Senegal, West Africa. Robust, freely tillering type to 3.8 m high; flowers 1–2 weeks earlier than Katherine Pearl, with less hairy, wider, and lighter green leaves and longer inflorescence.

'Katherine Pearl' Released in Australia (1971). Derived from CPI 11378 introduced from the Department of Agriculture, Accra, Ghana. Robust, variable, freely tillering annual up to 3 m high; leaves flat, dark green, and up to 8 cm wide, generally hairy but not always so; 3–4 months from sowing to flowering.

'Siromill' Released in Australia (1996). Derived from CPI 114994a, which was selected from ICRISAT 8846, a landrace from Chavuta, Central Province, Zambia. A late flowering, leafy cultivar to about 3.5 m tall.

'Tamworth' Released in Australia (1967). Bred line, selected after three generations of inbreeding of the progeny of a selected F3 plant of Gahi-I (Georgia hybrid No. 1). Mid season to late in maturity; tillers well, grows 2–3 m tall; stems are of moderate diameter and normally not prone to lodging; leaves medium to broad, glabrous.

'Tifleaf-1' Released in USA (1980). F1 hybrid between Tift 23DA and Tift 383. Low- growing; leafier and easier to manage than taller varieties. Although it yields less dry matter, it produces better ADG and more LWG per ha; suitable for grazing.

'Tifleaf-2' Released in USA. Developed from a cross between 'Tift 85D2A1' and 'Tift 383'. Similar to 'Tifleaf 1', but higher yielding and immune to rust (*Puccinia substriata*) and leafspot, through incorporation of dominant genes for immunity to these diseases transferred from *C. violaceus* with repeated backcrosses.

'Tifleaf-3' Released in USA (1995). A 3-way dwarf leafy forage hybrid between the dwarf CMS single-cross F1 hybrid Tift 8593 and the dwarf pollinator Tift 383. IVDMD and heifer grazing gains similar to those of 'Tifleaf 2'.

Hybrid cultivars released around the world include Elite II, HyPearl, Justleaf, Milkstar, Nutrifeed, Pearler, Pennleaf, PP102M, Sabala and Speedfeed, but little information on origin and relative characteristics has been published.

Promising accessions

None reported.

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