

# Use of Trees by Livestock

## *CASSIA*

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R.T. Paterson and N.J.L. Clinch

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## Foreword

The importance of trees and shrubs in the feeding of animals in the tropics and sub-tropics has long been recognized by livestock owners. In arid areas where the growth of herbaceous plants is limited by lack of moisture, leaves and edible twigs of trees and shrubs can constitute well over 50% of the biomass production of rangeland. At high altitudes, tree foliage may provide over 50% of the feed available to ruminants in the dry season, branches being harvested and carried to the animals. Even in regions of higher rainfall where grass supplies the major proportion of the dry matter eaten by ruminants, tree leaves and fruits can form an important constituent of the diet, particularly for small ruminants.

In the last two decades interest in the planting of trees as a source of feed for livestock has been encouraged by workers in research and development, but in contrast to the hundreds of indigenous species which are used as fodder, attention has focussed on a limited number of introduced species. Thus there are many publications reporting the chemical composition of *Leucaena leucocephala* leaves and suggesting management

strategies for utilization of the tree for fodder, but it is more difficult to find information on alternative genera which might be equally, or more, appropriate.

The aim of this series of publications is to bring together published information on selected genera of trees which have the potential to increase the supply of fodder for ruminants. Each booklet summarizes published information on the fodder characteristics and nutritive value of one genus, with recommendations on management strategies, where available. Further, since the leaves of woody species frequently contain secondary compounds which may have an anti-nutritional, or toxic, effect, a separate booklet summarizes the effects of a number of these compounds. It is hoped that the booklets will provide useful resource material for students, research and extension workers, interested in promoting the use of trees as a source of fodder for ruminants.

Further copies of this booklet or others in the series can be obtained by writing to Publishing and Publicity Services at the Natural Resources Institute.

Margaret Gill  
Livestock Production Programme

# Genus *Cassia*

**Family** LEGUMINOSAE  
**Subfamily** CAESALPINIOIDEAE  
**Tribe** CASSIEAE

## Principal

**species** *Cassia alata*  
*Cassia acutifolia* (syn. *C. senna*)  
*Cassia angustifolia* (syn. *C. medicinalis*)  
*Cassia auriculata*  
*Cassia fistula*  
*Cassia grandis*  
*Cassia javanica*  
*Cassia leiandra*  
*Cassia nodosa*  
*Cassia obovata*  
*Cassia occidentalis*  
*Cassia rotundifolia* (syn. *Chamaecrista rotundifolia*)  
*Cassia siamea* (syn. *C. florida*)  
*Cassia sieberiana*  
*Cassia sturtii* (syn. *C. nemophila* var. *coriacea*)  
*Cassia tora*

**Common names** Shower tree  
Senna

# Summary

Taken in its widest sense, the genus *Cassia* is one of the largest in the family Leguminosae, containing some 600 species. Plants range in size from herbs to shrubs and trees, and they have a pantropical and subtropical distribution. Members of the genus have varying commercial uses, but for such a large taxon, its economic importance is relatively limited. While it is best known as an ornamental tree and as a provider of senna for use as a laxative, several species, including both herbs and woody types, show promise as multi-purpose plants for the provision of both fuelwood and forage, particularly in subhumid and semi-arid environments. In such areas, it could be one of a number of potentially useful alternatives to the ubiquitous *Leucaena leucocephala*, helping to prevent a dangerous over-reliance on this popular and widely used species. Further research is necessary to define the ecosystems where it is best suited, and to clarify the situation regarding the anti-nutritive effects which have led to the manifestation of toxicity symptoms in a range of livestock. Once this is done, *Cassia* has the potential to assume a more important role in tropical animal production.



## Description and distribution

Although there have been a number of attempts to subdivide *Cassia*, for example by elevating the section *Chamaecrista* to the level of a separate genus, many botanists still favour the division of *Cassia* into three subgenera: *Fistula*, *Senna*, and *Lasiorhegma*. This organization, shown in Table 1, will be followed here. Under this arrangement, *Cassia* is the fourth largest genus in the family Leguminosae and the largest in the subfamily Caesalpinioideae (Allen and Allen, 1981).

*Cassia* consists of a total of some 600 species (Uphof, 1968; Willis, 1973) ranging in size and growth habit from annual herbs (e.g. *C. absus*) to shrubs (e.g. *C. angustifolia*) and moderately large trees (e.g. *C. fistula*). Bentham (1871, quoted by Allen and Allen, 1981) considered *Cassia* to be a large, widely distributed, much varied, but well-defined group. The genus is characterized by paripinnate leaves with one, to many pairs of leaflets. The flowers, which may be white, yellow, pink or orange, are often large and attractive, leading to the use of several species (e.g. *C. fistula*, commonly called golden shower) as ornamental trees. The pods are

linear and commonly dehiscent. They may be flat or cylindrical, but often have corky, or pulpy septations between the ovate, compressed seeds.

Nodulation, and therefore presumably the ability to fix atmospheric nitrogen in a form that can be used by the plant, is differentiated along lines that closely follow the taxonomic subdivision shown in Table 1. While almost all of the tested species within the subgenus *Lasiorhegma* have been shown to nodulate, only a small minority of the tested members of the subgenera *Fistula* and *Senna* have this ability. Allen and Allen (1981) suggest that these observations are consistent with the theory that *Lasiorhegma* is the most highly evolved taxon within the genus and that nodule formation is a relatively recent physiological adaptation. Those species that nodulate accept bacteria of the cowpea group and thus seldom require inoculation.

*C. siamea* is one of the non-*Lasiorhegma* species which reportedly fails to form nodules in Java, Hawaii and the Philippines (Allen and Allen, 1981). It has been shown, however, (Yatazawa *et al.*, 1983) that the warty bark has the ability to fix atmospheric nitrogen both *in situ* and when detached from the trunk. The importance of this effect in the nutrition of

the tree and its occurrence in other members of the genus are yet to be determined.

**Table 1** Subdivision of the genus *Cassia*

Subgenus	No. of species	Habitat	Habit
<i>Fistula</i>	15	Tropics	Trees
<i>Senna</i>	270	Tropics and subtropics	Trees, shrubs, few herbs
<i>Lasiorrhagma</i>			
Section <i>Absus</i>	100	Tropical N. and S. America	Trees, shrubs
Section <i>Apocouita</i>	6	Tropical S America	Trees
Section <i>Chamaecrista</i>	270	Tropical and temperate N and S America	Trees, shrubs

Source: Allen and Allen, 1981.

*Cassia* spp. may be propagated from stem cuttings, but they are usually good seed producers and establish readily from both planted and broadcast seed.

The genus is commonly found in tropical and warm temperate regions excluding Europe, but it does not thrive in cool temperate areas. It usually occurs naturally in moist or dry thickets, thinly forested hillsides, waste or cultivated land and along roadsides (Uphof, 1968; Allen and Allen, 1981). Species are adaptable and grow well at varying altitudes and in a wide variety of climatic and edaphic conditions, ranging from arid and semi-arid areas of North Africa to wet forest regions of the Indian subcontinent (Duke, 1981).

## Fodder characteristics

In general, *Cassia* species are not highly successful as either browse plants, green manure or soil cover because of slow growth, low yields, susceptibility to fungal and insect attacks, slow decomposition and problems of poor animal acceptability and toxicity (Allen and Allen, 1981). *C. tora*, a common weed of warm climates, is evil-smelling and unpalatable, but





probably non-toxic (Whyte *et al.*, 1953). *C. occidentalis*, with a pantropical distribution, is generally avoided by animals but when consumed it may have a mildly toxic effect on various species of livestock (Duke, 1981).

Nevertheless, in such a large genus, it is not surprising that there is much inter-specific and, according to D. Thomas (pers. comm.), intra-specific variation. Some species of *Cassia* provide useful browse for both wild and domesticated animals, particularly in arid and semi-arid areas, although there may be differences between provenences in their acceptability to livestock. Lamprey *et al.* (1980) noted that the bark of *C. abbreviata* was consumed by elephants in East Africa. It contained some 10.5% crude protein (CP), 32.9% crude fibre (CF) and was high in both calcium and potassium, although low in phosphorus (*see* Table 2 for proximate analysis).

*C. mimosoides* is sometimes eaten by livestock in Southeast Asia and Northern Australia but it is not very palatable (Whyte *et al.*, 1953). In the Sudan, while the leaves remain green, it is much sought-after by sheep and cattle even though it is avoided by other animals. It appears to be largely ignored in Chad. Green shoots contained 15.3% CP and 23.2% CF.

*C. siamea* is lopped for fodder in Malaysia and India (Whyte *et al.*, 1953) and is a cultivated browse species in the Guinean Zone of Africa (Audru, 1980). In a trial in Thailand where annual rainfall was about 1200 mm, 17 accessions of 14 mainly leguminous tree species were cut at a height of 1 m on five occasions in a period of 30 months. *C. siamea* showed the highest levels of dry season leaf retention and survival over the experimental period. Together with *Enterolobium cycloarpium* and *Leucaena leucocephala*, it produced the highest yields of both edible foliage (leaves and twigs of less than 5 mm diameter) and wood (twigs and branches of greater than 5 mm diameter). Crude protein content and *in vitro* dry matter digestability (IVDMD) levels were adequate for animal production (*see* Table 2), although caution was advised in the feeding of livestock because of possible toxicity (Akkasaeng *et al.*, 1989). Pigs were considered to be particularly susceptible (NAS, 1980).

In Kenya, where a bimodal rainfall pattern averaged 700 mm/year, *C. siamea* grew to a height of 4.73 m in 6.3 years. Out of a total of 29 multi-purpose accessions, it was third in productivity behind *Grevillea robusta* and *Leucaena leucocephala* cv. Peru and ahead of *L. leucocephala* cv. Cunningham and a

**Table 2** Proximate and fibre analyses of *Cassia* spp.

	Dry matter	Crude protein	Crude fibre (% of dry matter)	Ash	Ether extract	NFE	<i>In vitro</i> DMD	NDF	Source
<i>C. abbreviata</i> BARK		10.5	32.9	15.1	1.3	40.2			1
<i>C. mimosoides</i> SHOOTS		15.3	23.2	3.9	3.0	54.6			2
<i>C. rotundifolia</i> HAY		13.8					55.5		3
<i>C. siamea</i> LEAVES									
wet season		18.8		5.2			65.5	53.5	4
dry season		12.9		7.2			62.1	45.1	4
<i>C. sieberiana</i> TWIGS and FLOWERS	32.9	15.9	21.5	6.1	2.5	54.0			5
<i>C. sturtii</i> LEAVES and TWIGS	38.7	11.0	16.7	5.7	5.2	61.4			6

**Notes:**

NFE - Nitrogen free extract; DMD - Dry matter digestibility; NDF - Neutral detergent fibre.

**Sources:**

- |   |                              |   |                                |
|---|------------------------------|---|--------------------------------|
| 1 | Lamprey <i>et al.</i> , 1980 | 4 | Akkasaeng <i>et al.</i> , 1989 |
| 2 | IBPGR, 1984                  | 5 | Le Houerou, 1980 a             |
| 3 | Ahn <i>et al.</i> , 1988     | 6 | Le Houerou, 1980 c             |



range of Hawaiian Giant cultivars. It showed potential for fuelwood, soil conservation and organic manure and was thought to merit further evaluation as a source of forage (Jama *et al.*, 1989).

*C. ferruginea* is browsed by cattle in the semi-arid regions of Brazil (Whyte *et al.*, 1953). *C. auriculata* is consumed by both cattle and goats in India, despite having a high tannin content in the bark (Duke, 1981). In the Sahel, pods of *C. sieberiana* are consumed by livestock. The leaves are rejected, even though they contain some 15.9% CP and 21.5% CF (Le Houerou, 1980 a). *C. excelsia* is listed as one of the important browse species in shrub-dominated ecosystems in Latin America and *Cassia* spp. are important components of mixed woodland communities in Australia (Le Houerou, 1980 b).

*C. sturtii* is grazed in South and Western Australia where it occurs naturally in regions receiving 100-400 mm of annual rainfall, but it is considered to be of limited importance due to its poor acceptability by livestock. It is reported to contain 14% CP and to have an IVDMD of 55% (Wilson and Harrington, 1980). It is, however, considered to be an introduced browse shrub of great promise in the Negev Desert of Israel. Where annual rainfall was about 200 mm, *C.*

*sturtii* was reported to have the best year-round palatability of all bushes tested for small ruminants, producing some 1000 kg/ha/year of edible dry matter (DM) with a CP content of about 12% (NAS, 1979). The contrast in reported acceptability between Australia and Israel may be due to varietal differences within the plant species, but Wilson and Harrington (1980) considered it more likely to be an artifact created by the infrequent occurrence of the plant in the Negev Desert, where it exists only in plant introduction areas. They noted that shrubs of low occurrence may be heavily browsed, while failing to maintain that level of utilization when the incidence is high.

The most important species for animal production is *C. rotundifolia* (syn. *Chamaecrista rotundifolia*), commonly known in Australia as roundleaf cassia. This is a prostrate to semi-prostrate, herbaceous, subwoody, short-lived perennial or self-regenerating annual. It is native to savannah habitats in the Americas from Florida to Brazil and Uruguay, and also to the islands of Cuba, Jamaica and Puerto Rico. It produces stems 30-110 cm long which radiate from the rootstock. Flowering time varies widely and some early provenances flower only a few weeks

after germination. However, due to an indeterminate growth habit, plants continue to grow after flowering if temperature and moisture regimes remain favourable. It is a summer-growing plant and production is stopped by light frosts, although in subtropical regions they rarely lead to plant mortality (O'Reilly, 1987; Skerman *et al.*, 1988).

After comprehensive evaluation the cultivar Wynn, derived from an introduction from Brazil, was released for commercial use in Queensland, Australia, in 1983. This cultivar shows widespread adaptation to moderately acid, sandy, well-drained soils receiving from 600 to 1500 mm of annual rainfall. It is essentially a prostrate variety that will withstand relatively heavy grazing. It is seen as complementary to Siratro (*Macroptilium atropurpureum*), being able to extend the use of legume-based pastures into semi-arid regions. Yields of over 7 000 kg/ha of DM have been recorded at Beerwah and Gatton in Queensland where it outyielded the standard legumes (Siratro and *Desmodium intortum*) in spring and early summer and gave similar yields in late summer and autumn (Skerman *et al.*, 1988).

Palatability appears to be limited early in the

season, but it is well accepted in autumn. O'Reilly (1987) noted that while the effect of cv. Wynn on animal performance was less in the first year of grazing than might have been predicted on the basis of proximate and mineral analyses, nitrogen fixation by the legume led to improved grass growth and satisfactory liveweight gains in subsequent years.

A recent series of trials evaluated grasses and both herbaceous and tree legumes in the humid and sub-humid region of Central and West Africa, where annual rainfall was 800-1200 mm and soils were sandy with a pH of 5.5-6.9. Here, the cv. Wynn produced rapid ground cover, but the yields in both wet and dry seasons were considerably less than those recorded from the best legume species (*Stylosanthes hamata*, *S. guianensis* and *Centrosema macrocarpum*). It would appear that conditions might not have been dry enough for the *Cassia* to realize its comparative advantage (Amezquita *et al.*, 1993).

Some attempts have been made to use seeds of *Cassia* spp. in the preparation of concentrate rations. In India, hoggets fed a diet based on wheat straw were supplemented with a ration of wheat bran and guar meal, plus 15%, by weight, of boiled and dried seed of *C. tora*. Feed conversion was more efficient



and feed cost per unit of weight gain was lower than with the control concentrate containing chaffed lucerne hay (Bhagoji and Dave, 1983).

## Anti-nutritive factors

When consumed voluntarily, many species of *Cassia* produce mild toxicity symptoms in a range of livestock. Fresh ground shoots, leaves and fruits of *C. italica*, when introduced as aqueous suspension by stomach tube at levels ranging from 0.5-10 g/kg liveweight, were equally toxic to young sheep (6-9 months old) and goats (3-6 months old), producing diarrhoea, dyspnoea, ataxia and anaemia which was followed by death after periods of feeding which ranged from 1 day to 8 weeks. The shorter survival periods were produced by the higher doses (Galal *et al.*, 1985).

Raw beans of *C. occidentalis* poisoned goats of 14-16 months of age. Roasting reduced, but did not eliminate the effects, which included damage to the liver, vascular system, heart and lungs (Suliman and Shommein, 1986). The toxic effects depended on the daily dose rates, rather than on the cumulative intake. The authors speculated that the toxic

principle could be an alkaloid or a toxic albumen, both of which would be at least partially deactivated by heat. Feeder pigs consuming a diet contaminated with as little as 1% of ground seeds of this species developed severe ataxia and neuromuscular dysfunction, leading to death within 4-8 weeks, depending on the dose rates (1-4% of dietary DM) (Colvin *et al.*, 1986). In chickens, the primary site of involvement in *Cassia* toxicosis would appear to be the smooth muscle. Experimental results indicated that the active principle was absorbed into the blood stream, and acted systemically to express its toxicity (Venugopalan *et al.*, 1984).

While the chemical characteristics of some *Cassia* spp. have been well studied (Rai and Shok, 1983; Ganguly *et al.*, 1985), the work has been aimed mainly at the medicinal properties of the plants and little is known about their anti-nutritive effects. Basically the same active constituents are found in *C. acutifolia*, *C. angustifolia* and *C. obovata*, the commercial sources of senna, as are found in numerous other species such as *C. occidentalis* (Duke, 1981); *C. hirsuta* (Janhavi-Singh and Singh, 1986); *C. obtusifolia* (Kitanaka and Takido, 1986); *C. sophora* (Joshi *et al.*, 1985) and *C. abbreviata* (Verdcourt and

Trump, 1969). The compounds responsible for the laxative action of these species (Lemli, 1986) are a range of anthraquinone derivatives (sennosides), which are essentially irritant purgatives in nature (Verdcourt and Trump, 1969). While the toxic principles involved in stock poisoning have not been specifically identified (e.g. Nicholson *et al.*, 1985; Galal *et al.*, 1985), it may be that the sennosides are implicated in some way, since symptoms of toxicity usually include diarrhoea.

Aqueous extracts of raw and cooked seeds of *C. tora* were shown by Bhat *et al.* (1985) to act as proteinase inhibitors in both humans and cattle. In addition to anthraquinones, *Cassia* spp. are rich sources of flavonoids and polysaccharides, compounds which could also be involved in complex reactions.

## Management

There is little information in the literature regarding appropriate management for *Cassia* spp. It is known, however, that freshly harvested seed of a number of both woody and herbaceous species is extremely hard, leading to problems of uneven germination.

In the case of *C. rotundifolia*, the hard seededness is reportedly over 90% (Skerman *et al.*, 1988). Mechanical scarification is recommended to ensure satisfactory germination. Fully prepared seedbeds are advisable, but cv. Wynn has some ability to spread into native grass pastures. Seedling survival under harsh conditions is good, being second only to *Stylosanthes humilis* in Queensland. In well-prepared seedbeds, a sowing rate of 2-4 kg/ha is usually adequate. Spread is facilitated by its prolific seed production, yields of clean seed from small plots having reached 800 kg/ha from two harvests in a single season (Skerman *et al.*, 1988). The prostrate growth habit results in a tendency towards plant mortality if the companion grass is allowed to grow too tall. The persistence of roundleaf cassia is therefore favoured by relatively heavy grazing pressure to reduce the competition from companion species (O'Reilly, 1987).

With regard to the introduction and the production of woody species in plantation systems, many reports refer to establishment by the transplanting of seedlings raised in nurseries (e.g. NAS, 1979; Duke, 1981; Jama *et al.*, 1989). However, in view of the ease of establishment from scarified



seed of most species, this may be due more to problems of seed availability than to any advantage to be gained from the practice of transplantation. *C. auriculata* may be commercially propagated either by seed or by stem cuttings (Duke, 1981).

Within the genus *Cassia*, there is great variation in size of the plants and it is therefore difficult to generalize regarding inter- and intra-row spacings. For *C. auriculata*, a shrub or small tree growing to a height of 7.5 m and used to produce bark for the extraction of tannin, seeds were planted in India at a depth of 10-15 cm and within-row distances of 5-12.5 cm, with one row covered by the ploughing of the next row. Thinning then took place during the first season, resulting in a mature population of some 9 000 plants/ha at 4 years of age (Duke, 1981).

With *C. acutifolia*, a low shrub growing to a height of 40-60 cm and producing leaves and pods as sources of Alexandrian senna, nursery seedlings of 15 cm high were transplanted at both inter- and intra-row spacings of 90 cm, resulting in a population of about 12 000 plants/ha. Weeds were not seen as a major problem, but weeding led to increased tree vigour (Duke, 1981). In Northwest India, highest yields of both leaf and sennoside from *C. angustifolia*

(Arabian senna) resulted from much closer spacings of 45 x 30 cm (74 000 plants/ha) with the application of 50 kg/ha of nitrogen. Removal of flower buds and opened flowers increased the yield of foliage (Pareek *et al.*, 1983).

Despite their inclusion in the list of limitations to the use of *Cassia* spp. (Allen and Allen, 1981), pests and diseases do not appear to present serious problems for the commercially important members of the genus. A number of fungi are reported to occur on *C. alata* and *C. occidentalis* (Duke, 1981), while a *Pleospora* leaf spot has been noted on *C. rotundifolia* (Skerman *et al.*, 1988), but these are of minor importance. *C. rotundifolia* accessions have been severely attacked by anthracnose (*Colletotrichum gloeosporioides*) in Brazilian savannahs (D. Thomas, pers. comm.). Nematodes have also been isolated from roots of *C. occidentalis*, although the level of damage does not appear to be great. The shrub has a reputation for the ability to clean fields of the harmful plant parasite *Striga senegalensis* (Duke, 1981). Insect pests generally appear to avoid commercial plantings of *Cassia* spp., possibly as a result of the presence of the anti-nutritive factors that are commonly found in all plant parts. Attempts to

remove these factors by breeding could lead to the loss of resistance to pests and diseases, thereby creating agronomic problems (D'Mello, 1982).

## Alternative uses

*Cassia* species have varied economic uses, although their importance is less than might be expected from the large size of the genus. A number of general texts (Uphof, 1968; Allen and Allen, 1981; Mabberley, 1987) list the following uses.

*C. acutifolia*, *C. angustifolia* and *C. obovata* are known respectively as commercial sources of Alexandrian, Arabian and Italian senna and are valued for the cathartic properties of the dried leaves and pods. The fruits of many species are used as purgatives, the active constituents being anthraquinone derivatives (Lemli, 1986). Decoctions of various parts of many *Cassia* spp. have long been used in traditional medicine to treat leprosy, dropsy, eczema, ringworm, eye diseases, rheumatism and a range of other ailments in many tropical countries (e.g. Dalziel, 1937; Watt and Breyer-Brandwijk, 1962; Bokemo, 1984). Dried and powdered leaves are used on ulcers, wounds, burns and insect stings, while

some species are reputed to act as antidotes to snake bite. The fruits and seeds often have vermifugal and anthelmintic properties.

In general, *Cassia* wood is considered to be of reasonable quality but it lacks commercial value. It is often hard and dense, frequently showing resistance to termites. *C. javanica* and *C. sieberiana* are used for house construction in Indonesia and West Africa respectively, while *C. nodosa* and *C. timoriensis* make good posts and handles for a range of tools. The heavy, strong, hard wood of *C. siamea* is used for bridges, telephone posts and mine props in Southeast Asia and is a valued fuelwood in Java.

*C. emarginata* is used in Jamaica as a dyewood while the seeds of *C. tora* are used as a mordant in the dyeing of cloth. The bark of *C. auriculata* is valued for the tanning of heavy hides, since it contains 15-22% tannin.

In Mexico and Central America, the seeds of *C. laevigata*, *C. tora* and *C. occidentalis* are used as coffee substitutes, while a decoction of leaves of *C. mimosoides* is drunk as tea in Japan. Young leaves of *C. surattensis* are boiled as vegetables in Indonesia. In the Sahelian region of Africa, naturally occurring *C. obtusifolia* is an important source of vitamins and





minerals for the local population (Becker, 1983; 1986; Finckh and Kunert, 1985), while in Tanzania, leaves of *C. tora* had the highest protein content of a range of 22 cultivated and wild vegetables (Sreeramulu, 1982).

*C. leschenaultiana* and *C. pumila* are planted as green manures in India, Malaysia and Indonesia, particularly in tea and coconut plantations.

In Argentina, stems and twigs of *C. aphylla* and *C. crassiramea* are used to make brooms.

*C. alata* and *C. sieberiana* are employed as fish poisons while leaves of *C. nigricans* are stored with cowpeas (*Vigna unguiculata*) as a means of controlling bruchid beetles (Lambert *et al.*, 1985). Extracts of wood and bark of *C. fistula* had noticeable juvenilizing effects on fifth instar nymphs of the cotton stainer (*Dysdercus koenigii*), inhibiting metamorphosis (Jaipal *et al.*, 1983). Similarly, extracts of seeds of *C. tora* caused mortality in the same pest (Chandel *et al.*, 1984). Purified extracts may be made which could potentially serve as efficient, organic pest control agents.

Species of the subgenus *Fistula* are popular as flowering ornamentals in parks, gardens and along avenues in warm climates, where they are known as

shower trees since their fallen petals carpet the ground beneath them. They have long flowering periods, and attractive, spreading, open crowns. The best known species include *C. fistula* (golden shower), *C. grandis* (pink or coral shower), *C. javanica* (rainbow shower), *C. leiandra* (bronze shower), *C. nodosa* (pink and white shower) and *C. siamea* (kassod tree, Siamese cassia). The flowers of some species such as *C. chamaecrista* are recognized as sources of honey.

## References and further reading

AHN, G.H., ELLIOTT, R. and MINSON, D.J. (1988) Quality assessment of the fodder legume *Cassia rotundifolia*. *Tropical Grasslands*, 22:63-67.

AKKASAENG, R., GUTTERIDGE, R.C. and WANAPAT, M. (1989) Evaluation of trees and shrubs for forage and fuelwood in northeast Thailand. *International Tree Crops Journal*, 5:209-220.

ALLEN, O.N. and ALLEN, E.K. (1981) *The Leguminosae: a Source Book of Characteristics, Uses and Nodulation*. Madison, USA: University of Wisconsin Press.

AMEZQUITA, M.C., LASCANO, C., RAMIREZ, G. and FRANCO, L.H. (1993) Analysis of performance of herbaceous and woody forage species in Central and West Africa. Presented at the 4th Annual Meeting of the African Feed Resources Network (AFRNET), Bamako, Mali, March 1993.

AUDRU, J. (1980) Ligneous and subligneous forage and fruit trees in the Guinean zone: prospects for utilization in animal production. In: LE HOUEROU, H.N. (ed.). *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

BECKER, B. (1983) The contribution of wild plants to human nutrition in the Ferlo (Northern Senegal). *Agroforestry Systems*, 1:257-267.

BECKER, B. (1986) Wild plants for human nutrition in the Sahelian zone. *Journal of Arid Environments*, 11:61-64.

BHAGOJI, G.P. and DAVE, A.D. (1983) Protein supplements in the growth ration of Patanwadi sheep. *Gujvet*, 11/12:3-9.

BHAT, A.V., PATTABIRAMAN, T.N. and VISHNU-BHAT, A. (1985) Action of proteinase inhibitors in six under-utilized seeds on human and bovine pancreatic proteinases. *Journal of Food Science and Technology*, 22:277-281.



BOKEMO, W. (1984) Les plantes antilepreuses de Kisangani (Haut-Zaire). *Bulletin de la Societe Royale de Botanique de Belgique*, 117:305-311.

CHANDEL, B.S., PANDEY, U.K. and SINGH, A.K. (1984) Insecticidal evaluation of some plant products against red cotton bug, *Dysdercus koenigii* Fabr. *Indian Journal of Entomology*, 46:187-191.

COLVIN, B.M., HARRISON, L.R., SANGSTER, L.T. and GOSSER, H.S. (1986) *Cassia occidentalis* toxicosis in growing pigs. *Journal of the American Veterinary Medical Association*, 189:423-426.

DALZIEL, J.M. (1937) *The Useful Plants of West Tropical Africa*. London: Crown Agents for the Colonies.

D'MELLO, J.P.F. (1982) Toxic factors in tropical legumes. *World Review of Animal Production*, 18:41-46.

DUKE, J.A. (1981) *Handbook of Legumes of World Economic Importance*. New York: Plenum Press.

FINCKH, B.F. and KUNERT, K.J. (1985) Vitamins C and E: an antioxidative system against herbicide-induced lipid peroxidation in higher plants. *Journal of Agricultural and Food Chemistry*, 33:574-577.

GALAL, M., ADAM, S.E.I., MAGLAD, M.A. and WASFI, I.A. (1985) The effects of *Cassia italica* on goats and sheep. *Acta Veterinaria, Yugoslavia*, 35:163-174.

GANGULY, A., CHOUDHURY, R., MITRA, S.R. and BHATTACHARYYA, A. (1985) Chemical investigation of *Cassia mimosoides*. *Planta Medica*, 6:540.

IBPGR (1984) *Forage and Browse Plants for Arid and Semi-Arid Africa*. Kew, UK: International Board for Plant Genetic Resources (IBPGR).

JAIPAL, S., ZILE-SINGH and CHAUHAN, R. (1983) Juvenile hormone-like activity of some common Indian plants. *Indian Journal of Agricultural Science*, 53:730-733.

JAMA, B., NAIR, P.K.R. and KURIA, P.W. (1989) Comparative growth performance of some multipurpose trees and shrubs grown at Machakos, Kenya. *Agroforestry Systems*, 9:17-27.

JANHAVI-SINGH and SINGH, J. (1986) A bianthraquinone and a triterpenoid from the seeds of *Cassia hirsuta*. *Phytochemistry*, 25:1985-1987.

JOSHI, T., DASS, A., PANDEY, S. and SHUKLA, S. (1985) An anthraquinone 3-neohesperidoside from *Cassia sophera* root bark. *Phytochemistry*, 24:3073-3074.

KITANAKA, S. and TAKIDO, M. (1986) Studies on the constituents in the roots of *Cassia obtusifolia* L. and the antimicrobial activities of constituents of roots and seeds. *Yakugaku Zasshi*, 106:302-306.

LAMBERT, J.D.H., GALE, J., ARNASON, J.T. and PHILOGENE, B.J.R. (1985) Bruchid control with traditionally used insecticidal plants *Hyptis spicigera* and *Cassia nigricans*. *Insect Science and its Application*, 6:167-170.

LAMPREY, H.F., HERLOCKER, D.J. and FIELD, C.R. (1980) Report on the state of knowledge on browse in East Africa in 1980. In: LE HOUEROU, H.N. (ed.) *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

LE HOUEROU, H.N. (1980 a) Chemical composition and nutritive value of browse in West Africa. In: LE HOUEROU, H.N. (ed.) *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

LE HOUEROU, H.N. (1980 b) The role of browse in the management of natural grazing lands. In: LE HOUEROU, H.N. (ed.) *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

LE HOUEROU, H.N. (1980 c) Browse in Northern Africa. In: LE HOUEROU, H.N. (ed.) *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).



LEMLI, J. (1986) The chemistry of senna. *Fitoterapia*, 57:33-40.

MABBERLEY, D.J. (1987) *The Plant-Book*. New York: Cambridge University Press.

NAS (1979) *Tropical Legumes: Resources for the Future*. Washington: National Academy of Sciences (NAS).

NAS (1980) *Firewood Crops: Shrub and Tree Species for Energy Production*. Washington: National Academy of Sciences (NAS).

NICHOLSON, S.S., FLORY, W. and RUHR, L.P. (1985) Sicklepod poisoning in cattle: a new development. *Louisiana Agriculture*, 29:18-19.

O'REILLY, M.V. (ed.) (1987) *Better Pastures for the Tropics*, 2nd edn. Toowoomba, Australia: Yates Agricultural Seeds.

PAREEK, S.K., SRIVASTAVA, V.K., MAHESHWARI, M.L., MANDAL, S. and GUPTA, R. (1983) Investigation in agronomic parameters of senna (*Cassia angustifolia* Vahl) as grown in North-Western

India. *International Journal of Tropical Agriculture*, 1:139-144.

RAI, P.P. and SHOK, M. (1983) Anthraquinone glycosides from plant parts of *Cassia occidentalis*. *Indian Journal of Pharmaceutical Sciences*, 45:87-88.

SKERMAN, P.J., CAMERON, D.G. and RIVEROS, F. (1988) *Tropical Forage Legumes*. 2nd Edition. FAO Plant Production and Protection Series No.2. Rome: Food and Agriculture Organization (FAO).

SREERAMULU, N. (1982) Chemical composition of some green leafy vegetables grown in Tanzania. *Journal of Plant Foods*, 4:139-141.

SULIMAN, H.B. and SHOMMEIN, A.M. (1986) Toxic effect of roasted and unroasted beans of *Cassia occidentalis* in goats. *Veterinary and Human Toxicology*, 28:6-11.

UPHOF, J.C.Th. (1968) *Dictionary of Economic Plants* (2nd Edition). New York: Verlay von J. Cramer.

VENUGOPALAN, C.S., FLORY, W., HEBERT, C.D. and TUCKER, T.A. (1984) Assessment of smooth muscle toxicity in *Cassia occidentalis* toxicosis. *Veterinary and Human Toxicology*, **26**:300-302.

VERDCOURT, B. and TRUMP, E.C. (1969) *Common Poisonous Plants of East Africa*. London: Collins.

WATT, J.M. and BREYER-BRANDWIJK, M.G. (1962) *Medicinal and Poisonous Plants of Southern and Eastern Africa*. 2nd edn. Edinburgh: Livingstone.

WHYTE, R.O., NILSSON-LEISSNER, G. and TRUMBLE, H.C. (1953) *Legumes in Agriculture*. Rome: Food and Agriculture Organization (FAO).

WILLIS, J.C. (1973) *A Dictionary of the Flowering Plants and Ferns*. 8th edn. Cambridge, UK: University Press.

WILSON, A.D. and HARRINGTON, G.N. (1980) Nutritive value of Australian browse plants. In: LE HOUEROU, H.N. (ed.) *Browse in Africa: the Current State of Knowledge*. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

YATAZAWA, M., HAMBALI, G.G. and UCHINO, F. (1983) Nitrogen fixing activity in warty lenticellate tree barks. *Soil Science and Plant Nutrition*, **29**:285-294.

