



Cordia subcordata (kou)

Boraginaceae (borage family)

anau (Chuuk), beach cordia, sea trumpet (English), cordia, island walnut, kerosene wood (Papua New Guinea), *galu* (Yap), *ikoak* (Kosrae), *ikoik* (Pohnpei), ironwood (Australia), *kalau* (Palau), *koa* (Guam), *kanava* ('Uvea, Futuna, Tokelau, Tuvalu), *kou* (Hawai'i), *motou* (Niue), *narwanarwa* (Fiji), *niyoron* (Guam, Northern Marianas), *puataukanave* (Tonga), *tauanave* (Samoa), *te kanawa* (Kiribati), *tou* (Societies, Cooks, Marquesas, Tuamotus), *vaua asi* (Solomon Islands)

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PHOTO: J. B. FRIDAY

Mature kou tree at Lahaina, Maui, Hawai'i.

IN BRIEF

Distribution Native throughout the Pacific as well as parts of the Indian Ocean and East Africa.

Size Reaches 7–15 m (23–49 ft), although typically seen smaller at about 5–7 m (16–23 ft).

Habitat Generally sea level to 30 m (100 ft), can grow at elevations up to 150 m (500 ft); rainfall 1000–4000 mm (40–160 in).

Vegetation Associated with species of coastal forests.

Soils Sandy and clay soils, rocky limestone or lava headlands; prefers neutral to alkaline soils.

Growth rate Early growth can be rapid on favorable sites, over 1 m/yr (3.3 ft/yr) for the first few years.

Main agroforestry uses Coastal protection, windbreak, homegardens.

Main uses Wood for crafts, ornamental, ceremonial.

Yields No data available.

Intercropping Compatible with many coastal species, although requires full sun.

Invasive potential Has potential to spread easily by seeds, but rarely does so; since it is native to Pacific islands, the tree is not considered invasive.

INTRODUCTION

Kou (*Cordia subcordata*) is an attractive small to medium-size tree that averages 7–10 m (23–33 ft) in height at maturity but may grow up to 15 m (49 ft). It prefers warm coastal areas on the leeward side of islands, and plentiful sunlight, but it can tolerate semi-moist inland forests. Kou has a native range including the Pacific, tropical Asia, and east Africa. While it is native to Hawai‘i, seeds were probably also carried to some Pacific islands by the early Polynesian settlers as part of their indigenous agroforestry systems.

There are many traditional uses of kou, including as a shade tree around homesteads, because it provides a broad, dense crown. The large, beautiful orange flowers are used to make leis. Leaves were used to dye tapa or combined to make medicinal products. The main product of the tree is its wood, which is lightweight, soft, easily workable, little-shrinking, long-lasting, and durable. In the past, kou would occasionally be used to make canoes (especially on atolls, “plank canoes”), but it was more often used for food vessels and utensils, as it has no strong flavor that would impart taste to food. Other objects such as paddles, boxes, small furniture, and carved figures were also often made from the wood. Today the wood is prized for handicrafts and carving of traditional figures by traditional artisans from Papua New Guinea through the Solomon Islands to the Cook Islands, and it provides a significant source of income in those places.

Environmentally, the tree is very useful in Pacific islands for shade and windbreaks. Kou prefers coastal areas and direct sunlight while easily withstanding frequent salt spray. Kou’s shallow and extensive root system makes it useful for the conservation of eroding coastal areas. Unfortunately, kou’s susceptibility to the kou leaf worm (*Ethmia nigroapicella*) has caused many horticulturists and ornamental growers in Hawai‘i to replace it with the non-native Geiger tree (*Cordia sebestena*). Losing the kou tree would mean losing part of the native culture in Hawai‘i.

DISTRIBUTION

Native range

Kou is native throughout Pacific, from tropical Asia through Melanesia, Micronesia, and Polynesia to the Marquesas and northward to Hawai‘i. Its native range includes the islands of the Indian Ocean and the eastern coast of Africa (Mueller-Dombois and Fosberg 1998).

Current distribution

Kou was probably one of the trees brought to Hawai‘i by

the original Polynesian settlers, although it had naturalized in Hawai‘i previously (Wagner et al. 1999). It is now naturalized on all main Hawaiian islands except Moloka‘i and Kaho‘olawe. Throughout the Pacific, kou is increasingly rare, both from over-exploitation for carving and attacks from exotic pests. It is reported as disappearing in parts of its range (Clarke and Thaman 1993).

ORIGIN OF KOU IN HAWAI‘I

Kou had been thought for years to have been introduced to Hawai‘i by the early Polynesian navigators, along with candlenut (*Aleurites moluccana*, kukui), milo (*Thespesia populnea*), and kamani (*Calophyllum inophyllum*). However, in 1997 scientists excavating a sinkhole on Kaua‘i found abundant fossilized kou seed in sediment layers dating 5,000 years before present, millennia before the first people arrived in Kaua‘i. Kou is clearly a native plant to Hawai‘i (Burney et al. 2001).

BOTANICAL DESCRIPTION

Preferred scientific name

Cordia subcordata Lam.

Family

Boraginaceae (borage family)

Non-preferred scientific names

Cordia orientalis R.Br.

Cordia moluccana Roxb.

Cordia rumphii Blume

Common names

anau (Chuuk)

beach cordia, sea trumpet (English)

cordia, island walnut, kerosene wood (Papua New Guinea)

galu (Yap)

ikoak (Kosrae)

ikoik (Pohnpei)

ironwood (Australia)

kalau (Palau)

koa (Guam)

kanava (‘Uvea, Futuna, Tokelau, Tuvalu)

kou (Hawai‘i)

motou (Niue)

nawanaawa (Fiji)

niyoron (Guam, Northern Marianas)

puataukanave (Tonga)
tauanaave (Samoa)
te kanaawa (Kiribati)
tou (Societies, Cooks, Marquesas, Tuamotus)
vaua asi (Solomon Islands)

Size

Kou is a small evergreen tree with a broad, dense, wide crown that typically reaches 7–10 m (23–33 ft) in height. The canopy may spread 8 m (25 ft) across, often as wide as the tree is tall. The bark is pale gray and furrowed or flaky. The trunk is usually less than 40 cm (16 in) in diameter but may be larger in very old trees. The boles of the trees are often crooked and shaped by the wind. Through the 19th century in Hawai‘i trees grew up to 15 m (50 ft) in height with stems 1 m (3.3 ft) across, and such giants may still be seen in remote areas in the Marshall Islands and perhaps elsewhere in the Pacific (McClatchey, pers. comm.), but today growth in Hawai‘i is much reduced by defoliation caused by the kou leaf worm (Rock 1974).

Flowers

Kou bears clusters of orange flowers at the terminal ends of its branches and in leaf axils. The large, funnel-shaped flowers are 2.5–4 cm (1–1.5 in) long and broad, with five to seven slightly wrinkled lobes. The short-lived flowers are scentless.

Leaves

Kou leaves are alternate and broadly egg-shaped to elliptical with blunt-pointed ends. They are light green, shiny above and dull below, 8–20 cm (3–8 in) long and 5–13 cm (2–5 in) wide.

Fruit

Kou fruits are round or egg-shaped balls 2–3 cm (0.75–1.25 in) long, hard and woody when mature. They grow in clusters and turn brown and fall from the tree as they ripen. Kou fruits all year long; green and ripe fruits are often found on trees at the same time the trees are flowering.

Seeds

Each fruit contains four or fewer delicate, white, narrow seeds 10–13 mm (0.4–0.5 in) long. Kou fruits float easily and are carried from island to island on the ocean.

Similar or look-a-like species

Kou-haole or Geiger tree, *Cordia sebestena* L. is another ornamental tree that looks similar to kou. *Cordia sebestena* is smaller in size than kou with smaller, rough-textured



Top: Leaves, flowers, and ripe fruits. Bottom: Fruits (pen-knife for scale). PHOTOS: J. B. FRIDAY

leaves, darker orange flowers, and fleshy white fruit. Other ornamental species of *Cordia* include *C. dichotoma*, *C. alba*, *C. glabra*, and *C. superba*. Only *C. dichotoma* has naturalized in Hawai‘i. *C. alliodora* is a much taller, straighter plantation timber tree. *C. aspera* is a forest tree in Samoa, and *C. speciosa* occurs in New Caledonia. There are about 250

species in the genus *Cordia*; most grow in the New World tropics.

Species variability

Variation is little known aside from minor variations such as in flower color. Kou has been identified as a priority species on several different Pacific islands for further genetic research by the South Pacific Regional Initiative on Forest Genetic Resources (SPRIG 1999).

Known varieties

No established varieties are known, although sometimes a sport with variegated leaves occurs.

ASSOCIATED PLANT SPECIES

Kou trees grow in coastal habitats, both in shrubby beach forests and lowland forests. The trees also occur on the inland edges of mangroves, although they are not a mangrove species. Kou is a frequent component of secondary forests and former habitations.

In native habitat

Kou trees are found in beach forests along with small trees and shrubs such as beach hibiscus (*Hibiscus tiliaceus*, hau), naupaka (*Scaevola sericea*), beach heliotrope (*Tournefortia argentea*), screwpine (*Pandanus* spp., hala), and Indian mulberry (*Morinda citrifolia*, noni), and in tall coastal forests along with milo (*Thespesia populnea*), kamani (*Calophyllum inophyllum*), *Pisonia grandis*, tropical almond (*Terminalia catappa*), beach she-oak (*Casuarina equisetifolia*), and fish poison tree (*Barringtonia asiatica*). Native herbaceous plants commonly include *Canavalia* spp., beach morning glory (*Ipomoea pes-caprae*), and beach pea (*Vigna marina*) (Mueller-Dombois and Fosberg 1998).

As aboriginal introduction in Pacific islands

Kou may be found growing alongside or mixed into coconut and breadfruit plantations, especially on atolls in Micronesia (Mueller-Dombois and Fosberg 1998). Kou trees frequently occur along with introduced coastal stands of *Casuarina* spp., tropical almond, beach heliotrope, and milo in Hawai'i.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

Kou most frequently grows in coastal forests and stands,

but it may also occur along the margins of mangroves and mixed in with coconut and breadfruit plantations. It occasionally forms small pure stands or thickets. It is a tropical tree and does not grow at higher elevations.

Elevation range

Generally sea level to 30 m (100 ft); it may grow at elevations up to 150 m (500 ft).

Mean annual rainfall

1000–4000 mm (40–160 in)

Rainfall pattern

Grows in climates with summer, winter, or uniform rainfall patterns.

Dry season duration (consecutive months with <40 mm [0.16 in] rainfall)

3–4 months

Mean annual temperature

24–28°C (75–82°F)

Mean maximum temperature of hottest month

28–36°C (82–97°F)

Mean minimum temperature of coldest month

17–25°C (63–77°F)

Minimum temperature tolerated

12°C (54°F)

Soils

Kou grows in sandy and clay soils, and on rocky limestone or lava headlands. It prefers neutral to alkaline soils. Experience in Hawai'i suggests that kou may not be suitable for use on acid soils, particularly former sugarcane lands.

Soil texture

The tree tolerates light to heavy soils (sands, sandy loams, loams, sandy clay loams, sandy clays, clay loams, and clays).

Soil drainage

Freely draining soils are required.

Soil acidity

Kou prefers neutral soils with pH 6.1–7.4.

Special soil tolerances

It can grow in saline soils.

Tolerances

Drought

Kou is moderately drought tolerant.

Full sun

The tree prefers full sun but can tolerate slight shade.

Frost

It does not tolerate frost.

Waterlogging

Kou grows in coastal areas and along the edges of mangroves where it is subject to occasional waterlogging.

Salt spray

Kou grows in exposed coastal areas where it tolerates steady winds and regular ocean spray.

Wind

Tolerates wind, although constant wind produces leaning and crooked trees (flagging).

Abilities

Regenerate rapidly

Kou is a prolific seeder and may naturally regenerate from seed.

GROWTH AND DEVELOPMENT

Kou is moderately fast growing when young, if established on a good site, in full sun, near the coast but sheltered from the wind, in rich neutral loamy or sandy soil, with sufficient water. Once the trees reach mature size, 7–10 m (23–33 ft) in height, growth is slow.

Growth rate

On good sites, trees may reach 1–1.5 m (3–5 ft) in height 1 year after planting, 4–5 m (13–16 ft) in 2-year-old plantations, and 7 m (23 ft) after 4 years. Growth is significantly slower in drier or more exposed sites, or if trees are attacked by the leaf worm.

Flowering and fruiting

Flowering may begin when the trees are 3–5



Although tolerant of light salt spray, heavy spray can badly injure leaves.

PHOTO: C. ELEVITCH



Alley cropping system with kou (foreground) and kamani (*Calophyllum inophyllum*, background) on Moloka'i, Hawai'i. The lean is caused by persistent winds. PHOTO: J. B. FRIDAY

years old. Kou fruits all year long; green and ripe fruits are often found on trees at the same time the trees are flowering.

Yields

No data is available for wood yields.

Rooting habit

Kou has an extensive, shallow root system. It is adapted to shallow and sandy soils and drought.

Reaction to competition

Kou grows poorly in stands of dense, tall grasses.

PROPAGATION

Kou is propagated only by seed. Ripe fruits with viable seeds may be collected under mature trees or picked from the tree. Whole fruits may be sown directly into seedbeds or pots, or they may be soaked overnight. Clipping the ends of the fruits may hasten germination. Fresh seeds are usually used, but they may be stored for up to a year.

Seed collection

Kou seeds all year (most abundantly in the spring), and ripe fruits may be collected at any time. Seedlings may also be found growing under mother trees and may be transplanted if desired.

Seed characteristics

There are 560–700 fruits/kg (250–320 fruits/lb), each containing one to four seeds.

Seed storage

Kou seed is orthodox, meaning that the seed may be dried and stored for a long time. Whole fruits may be dried and stored in cool, dry conditions for up to a year, but viability decreases over time. Fresh seeds picked from trees may have 100% germination; seed picked off the ground may be less viable.

Pre-planting treatments

The woody fruits may be soaked overnight or for up to 2 days to hasten germination. The end of the capsule may be clipped off prior to soaking in water, which is also thought to hasten germination. Seeds are usually not removed from the fruits because it is difficult to do so without damaging them. Whole fruits are sown one to a pot; if multiple seedlings germinate, the extras must be transplanted or rogued out.



Left: Ripe seed capsule (fruit) soaked overnight in water. Above right: The capsule end is clipped off, and one of the delicate seeds is exposed as it begins to germinate. Below right: The outer part of the capsule adjacent to germinating seeds comes loose. PHOTO: C. ELEVITCH

Growing area

Seedlings may be grown in partial shade, and some cover of the growing area is desirable to protect young seedlings from hard rains, but if shaded, seedlings must be hardened off in full sunlight for 4–6 weeks. Germinating seeds must be protected from rats.

Germination

Seeds will take 3–4 weeks to begin germinating, and most will germinate within 6 weeks. Whole fruits may be sown in a germination bed, and the newly-germinated seedlings may be transplanted to pots. Transplants of the seedlings may be made at the cotyledon stage.

Media

A well drained medium is best. A soilless mix of peat moss, perlite, and vermiculite is better drained and less apt to contain diseases than a potting mix containing garden soil. Potting media should be amended with slow-release fertilizers and compost.

Time to outplanting

Kou seedlings may stay in the nursery 6–8 months. Seedlings usually grow slowly for the first 6–10 weeks, then grow more rapidly. The rapid growth phase in the nursery may last 4–6 months, including hardening off in full sun during the last 4–6 weeks before planting.

Approximate size at time of outplanting

Seedlings ready for outplanting are approximately 40–50 cm (16–20 in) in height.



Left: Pregerminated seedlings in flats, showing one ready to outplant grown in a container measuring 6 x 6 x 13.3 cm (2.4 x 2.4 x 5.25 in). **Right:** Nursery-grown seedlings showing symptoms of fungal disease. PHOTOS: C. ELEVITCH

Guidelines for outplanting

Survival is typically high, although transplanted seedlings grow slowly at first and need to be protected from weeds until the tree canopies are well above the weeds.

Other comments on propagation

Seedlings may be susceptible to fungal diseases, especially if over-watered or grown in wet, cool areas. Watering in the early morning allows leaves to dry out during the day. Spacing seedlings widely in the nursery allows more light penetration into the canopy and better air circulation. Establishing the nursery in a coastal area may also help prevent diseases. Seedlings should be hardened off in full sun with infrequent watering before outplanting, and they should be kept in their containers until outplanting.

DISADVANTAGES

Kou is a hardy tree in coastal environments but unsuitable for uplands and acid soils. It is occasionally attacked and sometimes killed by the kou leaf worm. The heartwood is valuable, but the tree does not grow rapidly. Boles are small and often crooked. Kou trees seed prolifically, and the round, hard fruits may be a hazard for pedestrians when the tree is planted in urban areas.

Potential for invasiveness

Kou seeds prolifically and could become a weedy pest in new areas. It is native to almost the entire Pacific, though, and as such would not be considered an alien weed.

Diseases and pests

Kou is highly susceptible to damage from the kou leaf worm (*Ethmia nigroapicella*). The small moth has pinkish forewings with black spots and yellowish hind wings. Isolated trees in exposed areas may be killed by this pest. The tree was once more common in Hawai'i before the introduction of the moth, which was first recorded there in 1883 (Swezey 1943). The wood is very termite resistant (Grace and Tome 1995). Large trees may develop heart rot.

Other disadvantages or design considerations

Kou has failed to survive or grow well in plantation trials in Hawai'i on deep, acid soils at 380 m (1250 ft) elevation with 2000 mm (80 in) rainfall at Ōpae'ula, O'ahu; on deep, acid soils with 2000 mm (80 in) rainfall at 150 m (500 ft) elevation at Maunawili, O'ahu; on thin, acid soil derived from organic matter over 'a'a lava rock, at elevation 180 m (600 ft) and rainfall 4000 mm (160 in) at Waiākea, Hawai'i; and on deep, acid soils at 125 m (415 ft) elevation with 1100 mm



Natural regeneration of kou under a mother tree. PHOTO: J. B. FRIDAY

(43 in) rainfall in Kīpū, Kaua‘i. All trials were fertilized and planted in single-species blocks.

AGROFORESTRY/ENVIRONMENTAL PRACTICES

Homegardens

Kou is frequently planted around homes, particularly for shade on the hot, leeward sides of islands.

Living fences

Kou trees are used for living fences and to mark boundaries and former settlement areas.

Boundary markers

In former times, kou trees marked settlements.

Windbreaks

Kou trees are fairly resistant to coastal winds and salt spray and are used for windbreaks. Because the crown on exposed trees may be sparse, other species should be combined with kou if good protection is needed. Naupaka (*Scaevola sericea*) would make a good, thick, low barrier if planted between kou trees while beach she-oak (*Casuarina equisetifolia*), where native, and milo (*Thespesia populnea*) would work well to create a denser windbreak.

Coastal protection

Kou’s tolerance of wind and salt spray, preference for sandy soils, and drought tolerance make it an excellent species for

coastal protection. The abundant natural regeneration can form dense stands protecting coastal areas.

Ornamental

Kou is a favored ornamental tree in coastal areas in the Pacific because of its relatively small size, its salt and wind tolerance, and its beautiful flowers. The tree’s cultural importance also is another reason to plant it, even if it will never be harvested for wood.

USES AND PRODUCTS

Nut/seed

The seeds, carefully removed from the woody fruit, have been eaten in times of famine (Clarke and Thaman 1993).

Medicinal

The leaves have been reported to have medicinal properties.

Beautiful/fragrant flowers

The beautiful orange kou flowers have been used for leis, although they only last a short time.



Kou makes a very attractive ornamental in public areas and shopping centers. PHOTO: C. ELEVITCH



Left: Kou flower. Right: A kou bowl by Ed Pavao, Hawai'i, showing creamy sapwood and dark heartwood. PHOTOS: J. B. FRIDAY

Animal fodder

Kou leaves have been used as fodder for pigs in Kiribati and elsewhere.

Fuelwood

Kou burns readily, and wood that is left over after the best pieces have been used for carving or other purposes may be used for fuelwood. The flammability of the wood has earned it the nickname “kerosene wood” in Papua New Guinea.

Craft wood/tools

Kou wood is light to moderately dense, ranging in specific gravity from 0.45 to 0.65. The sapwood is light tan colored, occasionally pinkish, while the heartwood is brown with dark brown to black streaks, sometimes with purple tones, often nicely figured. The wood is finely textured, moderately durable, shrinks little, and takes a fine polish. In ancient times the wood was used for cups, bowls, and calabashes. Small pieces were made into small storage boxes, containers, and lids for calabashes. Kou wood was favored because it was easily worked and did not impart a taste to the food. Ancient Hawaiians made large calabashes, called ‘umeke lā‘au, from kou for storing and fermenting poi. These could hold 8–16 liters (2–4 gal) of food (Abbott 1992). Today the wood is used for ornamental carving, turning, storage containers, small furniture, and carved figurines. In the Cook Islands the wood is used for carving traditional figures and making musical instruments.

Canoe/boat/raft making

Kou is sometimes used for canoes or paddles if large enough trees are found.

Body ornamentation/garlands

The bright orange flowers are traditionally favored for leis. The flowers have a wide floral tube that makes for easy stringing with the materials available to the ancients, such as beach hibiscus (*Hibiscus tiliaceus*, hau) fiber. It is easy to see how this lei was made in days of old without metal lei needles.

Tannin/dye

In old Hawai'i, the leaves were used to dye *kapa* (bark) cloth tan and for coloring fishing lines to make them less visible (Abbott 1992).

Ceremonial/religious importance

The tree is significant culturally and in traditional religions in the Pacific. Kou groves were often planted around sacred places, and kou figures in Pacific island mythology.

URBAN AND COMMUNITY FORESTRY

In old Hawai'i and other Pacific islands, kou trees were planted around houses and living areas to give shade in the hot coastal areas and provide wood for carving and flowers for leis. An introduced insect pest, the kou leaf worm, decimated kou populations in Hawai'i a century ago, and the tree has become much less common. Overharvesting elsewhere in the Pacific has also contributed to the tree's scarcity. Growing kou trees brings a native Pacific island tree back into the urban landscape and may in time create a supply of wood to perpetuate local wood carving traditions.

Size

In a landscape or homegarden setting, kou trees usually

reach only about 7–10 m (23–33 ft) in height and are often smaller in exposed environments. Canopy spread may be as wide as the tree is tall.

Rate of growth in a landscape

Kou trees may grow up to 1.5 m (5 ft) in height per year in the first few years, but height growth is more typically 1 m (3.3 ft) per year with stem diameter growth of 1.5–3 cm/yr (0.6–1.2 in/yr). The tree's canopy may be sparse for the first few years.

Roots

Kou has an extensive, shallow root system. Its root system is probably very competitive with other plants nearby.

Products commonly used in a Pacific island household

The rich brown wood is easily worked and was traditionally used for carving calabashes and other food vessels. Unlike koa (*Acacia koa*), another prime Hawaiian timber used in woodcarving, and some other woods, kou wood does not impart a taste to food. Today kou wood is sought after by bowl turners and carvers. In areas where kou is abundant it makes excellent firewood. The bright orange, tubular flowers are strung into beautiful but short-lived leis.

Light requirements

Kou prefers full sun but will tolerate light shade.

Water/soil requirements

The tree grows in rocky or sandy soils along shorelines. It generally does not do well in heavy acid clay soils. Kou is tolerant of salt spray and is moderately wind tolerant.

Expected life span in a homegarden

Huge old kou trees are seldom seen in Hawai'i and most Pacific islands today, but the trunk can grow to over a meter (3.3 ft) in diameter. Such giants must be over a century old.



Top: Densely planted kou hedge around a home, Hōnaunau, Hawai'i. PHOTO: C. ELEVITCH **Bottom:** Kou leaf worm and the typical damage it does to leaves. PHOTO: J. B. FRIDAY

Varieties favored for use in a homegardens or for street trees

Trees with green and white variegated leaves have been known to occur.

Seasonality of leaf flush, flowering, fruiting

Kou flowers and fruits year round.

Exceptional ornamental values

It is an attractive tree with smooth gray bark and dense foliage interspersed with bright orange flowers.

Use as living fence, hedge, or visual/noise barrier

Kou trees, planted densely, make an effective barrier or windbreak in coastal areas.

Maintenance requirements

Kou trees require care when transplanting. Root injuries or excessive wetness in transplanting sites can lead to diseases. Holes for transplanting should be dug twice as wide as the root ball but no deeper. Seedlings should not be root-bound; any roots curving along the bottom of the container should be gently unwound before planting. Seedlings grown in dibble tubes or specialized tree-growing containers are best for windbreaks or forestry projects. Larger trees up to 1.5 m (5 ft) tall grown in large containers may be planted for landscaping purposes. Trees benefit from initial applications of fertilizer or compost. Mulch helps retain water in dry areas and keeps down weeds. Young trees should be watered until they are well established, especially if they are planted in sandy soils with low water-holding capacity. Mature trees are moderately drought tolerant.

Kou trees are usually crooked and may have multiple stems. Proper pruning is necessary to establish good form. Young seedlings may be spindly for the first couple of years until the full canopy develops. Thickets of young trees may grow up from seeds around mature trees.

Special considerations regarding leaf, branch, and fruit drop

Kou trees can sometimes be difficult to establish and generally do not do well away from the coast. They grow best below about 30 m (100 ft) in elevation. The prolific regeneration under the trees may also pose a problem if other ground-covers are desired.

Nuisance issues

None.

Hazards

The trees seed prolifically and drop large quantities of hard, marble-sized fruits. People walking on streets or sidewalks with these fruits underfoot could easily slip—a very real hazard.

Common pest problems

The kou leaf worm (*Ethmia nigroapicella*) attacks and defoliates kou, and severe infestations may kill trees. Kou was much more common in Hawai'i before the introduction of the leaf worm in the late 1800s. Today attacks seem to be less severe, and most healthy trees recover from occasional attacks of the moth.

Kou seedlings are susceptible to attack by several pathogenic fungi, including *Pythium*, *Phytophthora*, and *Fusarium*. These fungi can be controlled by avoiding both overwatering in the nursery and injuring the roots when the trees are transplanted.

Other comments

In plantings in urban areas in Hawai'i, the true kou, *Cordia subcordata*, has often been replaced by the Geiger tree, *Cordia sebestena*, mainly because the Geiger tree is not attacked by the kou leaf worm. The Geiger tree has similar foliage to the kou tree but red instead of orange flowers and soft white fruits. While it is an acceptable ornamental, Geiger tree is native to the West Indies and has no traditional uses in the Pacific.

KOU LORE

In Tuamotuan mythology kou is believed to be one of the first trees created. In a Tongan legend, the demigod Maui discovered fire and hid it in the kou tree, the breadfruit, and the coconut. The tree is a clan totem in Kiribati (Neal 1965).

In Hawai'i kou was traditionally planted around houses and the flowers were used for leis. One story is told of a young chieftess who saw an old woman at the seashore in 'Ewa on leeward O'ahu stringing a lei of kou blossoms. The girl asked for the lei, whereupon the old woman angrily told her to make her own. The girl went and bathed in the sea and returned, again asking for the lei. The third time she asked for the lei, the old woman called for the sharks to come and eat her, and they heard the old woman and came and pulled the girl into the ocean and devoured her. The people of 'Ewa since that time have refused to wear kou leis (Neal 1965).

A Hawaiian verse runs:

*The cold wind of Kahaloa
Scattering the blossoms of the kou,
Stringing them into garlands and carried,
To wreath the sea of Kapua.*

(Handy et al. 1991)

In Melanesia the wood is used for fuel and fires reportedly may be started by rubbing two pieces of kou wood together, hence the name "kerosene wood" in Papua New Guinea.

COMMERCIAL PRODUCTS

While kou wood is valuable, stands of kou trees have seldom been planted for wood production. Rather, wood has been harvested from ornamental trees or those planted in homegardens. Kou's value may be even more as a landscaping tree and cultural icon than for its wood.

Spacing for commercial production

When planting kou trees in a landscape setting, it should be kept in mind that the trees may grow to be broader than they are tall. Kou tends to be crooked, even when it grows in dense natural thickets, so close spacing of timber trees would be unlikely to produce straight boles. In a landscape setting, trees should be at least 6 m (20 ft) apart, while in a forestry setting they could be planted as close as 3 m (10 ft) apart.



Alley cropping system with kou, ornamental ginger, and kava in understorey on Moloka'i, Hawai'i. PHOTO: J. B. FRIDAY

Management objectives

Kou trees are intolerant of shading, and seedlings need to be kept weeded when they are young.

Design considerations

When using kou as a landscape tree, it should be planted far enough away from sidewalks so that the seeds do not fall on the sidewalk and cause a hazard for pedestrians. Kou tolerates light shade and may be grown in mixed gardens with coastal agroforestry trees such as breadfruit and coconut.

Yields

No data available.

Market

The markets for kou wood are usually local carvers, bowl turners, and artisans. In Hawai'i the wood is often reserved for the most highly skilled carvers. A single large log could sell for thousands of dollars, but large logs are very rare.

INTERPLANTING/FARM APPLICATIONS

Example system 1

Location

Moloka'i, Hawai'i.

Description

An alley cropping demonstration was planted by the University of Hawai'i on former agricultural land on the island of Moloka'i in 1995 with kou, kamani (*Calophyllum inophyllum*), milo (*Thespesia populnea*), and kukui (*Aleurites moluccana*). The site is dry and windy, with only 460–530 mm (18–21 in) of rainfall annually, and is 150 m (500 ft) above sea level. The soil is classed as a typic Torrox in the USDA classification, with pH 6.5. Alfalfa for forage was grown between the trees until the canopies closed; after that a number of shade-tolerant crops were planted, including ornamental ginger, edible mushrooms, kava, and cacao.

Yields

Tree growth is satisfactory; kou trees averaged 7 m (23 ft) in height with the tallest growing 9 m (30 ft) in 7 years. The constantly high winds have caused the trees to lean over, however, and the effect of the stress on wood quality is unknown. Crop production is less than would be expected in full sun but is nonetheless significant.

Crop/tree interactions

Crop yield, even for the shade-tolerant crops (except for the edible mushrooms), is reduced because of shading. However, the trees also serve as windbreaks, without which fragile crops such as kava would not grow at all. The crops receive supplemental irrigation, which also benefits the trees.

Spacing/density of species

The trees were planted in wide rows 5 m (15 ft) apart with 3 m (10 ft) spacing within the rows.

Example system 2

Location

Aitutaki, Cook Islands.

Description

In an effort to conserve the increasingly rare trees, kou and milo have recently been planted along roadsides in coastal areas (Clarke and Thaman 1993).

Yields

Kou is used by local woodcarvers to make traditional figurines and musical instruments.

PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

Extension offices for agroforestry and forestry in the Pacific:
<http://www.traditionaltree.org/extension.html>

INTERNET

A description of the use of kou in old Hawai'i: Canoe Plants of Ancient Hawai'i: <<http://www.canoeplants.com>>.

A detailed description of kou propagation: Native Plants Network: <<http://www.nativeplantnetwork.org>>.

Photos of kou: Campus plants at the Mānoa Campus of the University of Hawai'i: <<http://www.botany.hawaii.edu/faculty/carr/16owebindex.htm>>.

Examples of wood carving using kou in the Cook Islands: <<http://www.atiutourism.com/carving.htm>>.

University of Hawai'i College of Tropical Agriculture and Human Resources Landscape Series: <<http://www2.ctahr.hawaii.edu/ctahr2001/PIO/FreePubs>>.

How to Prune Trees, USDA Forest Service: <http://www.na.fs.fed.us/spfo/pubs/howtos/ht_prune/pruno01.htm>.

BIBLIOGRAPHY

(☛ indicates recommended reading)

- ☛ Abbott, I.A. 1992. *Lā'au Hawai'i—Traditional Hawaiian Uses of Plants*. Bishop Museum Press, Honolulu.
- ☛ Allen, J.A. 2002. *Cordia subcordata*. In: J.A. Vozzo (ed.) *Tropical Tree Seed Manual*. USDA Forest Service Agriculture Handbook 721. Washington, DC.
- Burney, D.A., H.F. James, L. Pigott Burney, S.L. Olson, W. Kikuchi, W.L. Wagner, M. Burney, D. McCloskey, D. Kikuchi, F.V. Grady, R. Gage II, and R. Nishek. 2001. Fossil evidence for a diverse biota from Kaua'i and its transformation since human arrival. *Ecological Monographs* 71 (4): 615–641.
- ☛ Clark, W.C., and R.R. Thaman (eds.). 1993. *Agroforestry in the Pacific Islands: Systems for Sustainability*. United Nations University Press, New York.
- Elevitch, C.R., and K.M. Wilkinson. 2003. Propagation protocol for production of container *Cordia subcordata* Lam. plants. Permanent Agriculture Resources, Holualoa, Hawai'i. In: Native Plant Network. University of Idaho, Moscow, Idaho. <<http://www.nativeplantnetwork.org>>.
- Elevitch, C.R., and K.M. Wilkinson (eds.). 2000. *Agroforestry Guides for Pacific Islands*. Permanent Agriculture Resources, Holualoa, Hawai'i.
- Grace, J.K., D.M. Ewart, and C.H.M. Tome. 1996. Termite resistance of wood species grown in Hawaii. *Forest Products Journal* 46(10): 57–61.
- Handy, E.S.C., and E.G. Handy, and M.K. Pukui. 1991. *Native Planters in Old Hawaii: Their Life, Lore, and Environment*. Revised Edition. Bishop Museum Press, Honolulu.
- Hawaiian Electric Company. 2001. *The Right Tree In The Right Place—Arbor Day in Hawaii 2001*. Honolulu.
- Hollyer, J. (ed.). 2002. *Growing Plants for Hawaiian Lei*. College of Tropical Agriculture and Human Resources, University of Hawai'i, Honolulu.
- Krauss, B.H. 1993. *Plants in Hawaiian Culture*. University of Hawai'i Press, Honolulu.
- Lamb, S.H. 1981. *Native Trees and Shrubs of the Hawaiian Islands*. Sunstone Press, Santa Fe, New Mexico.
- Lamberton, A.R.H. 1955. *The anatomy of some woods utilized by the ancient Hawaiians*. Master's thesis. University of Hawai'i, Honolulu.
- Lemmens, R.H.M.J., I. Soerianegara, and W.C. Wong (eds.). 1995. *Timber trees: Minor commercial timbers*. Plant Resources of South-East Asia No. 5(2). Backhuys Publishers, Leiden, Netherlands.
- ☛ Little, E.L., Jr., and R.G. Skolmen. 1989. *Common Forest Trees of Hawaii (Native and Introduced)*. Agricultural Handbook No. 679. USDA Forest Service, Washington, DC.
- Mueller-Dombois, D., and F.R. Fosberg. 1998. *Vegetation of the Tropical Pacific Islands*. Springer, New York.
- National Tropical Botanical Garden. 1996. *Ten native Hawaiian trees for urban landscapes*. Lāwa'i, Hawai'i.
- ☛ Neal, M.C. 1965. *In Gardens of Hawaii*. Bishop Museum Press, Honolulu.
- Rock, J. 1974. *The Indigenous Trees of the Hawaiian Islands*. Charles E. Tuttle Co., Inc., Tokyo.
- Shigo, A.L. 1989. *Tree Pruning: A Worldwide Photo Guide*. Shigo and Trees, Associates, Durham, New Hampshire.
- Skolmen, R.G. 1974. *Some Woods of Hawaii: Properties and Uses of 16 Commercial Species*. Technical Report PSW

- 8/1974. Pacific Southwest Forest and Range Experiment Station, United States Department of Agriculture, Forest Service, Berkeley, California.
- South Pacific Regional Initiative on Genetics (SPRIG) Country Reports. 1999. Scientific Australian Tree Seed Center, CSIRO Forestry and Forest Products. Canberra, Australia. <<http://www.ffp.csiro.au/tigr/atscmain/whatwedo/projects/sprigCommonwealth>>.
- Swezey, O.H. 1943. The Kou Moth, *Ethmia colonella* Walsm., in Hawaii. Proceedings of the Hawaiian Entomological Society 12(1): 133.
- Thomson, L., and A. Uwamariya. 2000. *Cordia subcordata*. In: Forestry Compendium Global Module, CAB International, Oxon, UK.
- Uphof, J.C.Th. 1968. Dictionary of Economic Plants. Verlag von J. Cramer, Lehre, Germany.
- Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the Flowering Plants of Hawai'i. Revised Edition. University of Hawai'i Press and Bishop Museum Press, Honolulu.
- White, L.D. 1994. Canoe Plants of Ancient Hawaii. <<http://www.canoeplants.com>>.
- Yates, J.R., J.K. Grace, and M. Tamashiro. 1999. New technology for managing the Formosan subterranean termite. Household and Structural Pests 3. College of Tropical Agriculture and Human Resources, University of Hawai'i, Honolulu. <<http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/HSP-3.pdf>>.
- Zimmerman, E.C. 1978. Genus *Ethmia*. In: Insects of Hawaii, vol. 9. University of Hawai'i Press, Honolulu.



Species Profiles for Pacific Island Agroforestry (www.traditionaltree.org)

Cordia subcordata (kou)

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