

Cinchona pubescens

Vahl

Rubiaceae

LOCAL NAMES

Dutch (kinaboom); English (red cinchona); French (quinquina jaune, quinquina); Indonesian (kina); Malay (kuinin); Portuguese (quinquina); Spanish (quino)

BOTANIC DESCRIPTION

Cinchona pubescens is a small to medium-sized tree to 30 m tall. The bark is spongy with a slight odour and strongly bitter.

Leaves broadly elliptic-ovate or sometimes sub-orbicular, 24-50 cm long, 17-40 cm wide, upper surface puberulent, sometimes primarily along veins, or glabrate, lateral veins usually 9-11 pairs, margins entire, apex rounded, base broadly to narrowly cuneate, petioles 1.5-4.5 cm long, stipules ovate, caducous.

Flowers numerous in panicles up to 20 cm long or slightly longer; calyx about 1 mm long, densely appressed pubescent, the teeth deltate; corolla pink or red, appressed pubescent, the tube 10-12 mm long, the lobes ca. 4-5 mm long, villous within.

Fruit a lanceoloid to oblong capsules containing 40-50 seeds, 1-4 cm long, dehiscent from base to apex.

Seeds 4-5 mm long by 1 mm, with a broad ciliate wing.

The genus *Cinchona* contains about forty species of trees. All cinchonas are indigenous to the eastern slopes of the Amazonian area of the Andes on either side of the equator (from Colombia to Bolivia). They can also be found in the northern part of the Andes (on the eastern slopes of the central and western ranges). They are now widely cultivated in many tropical countries for their commercial value, although they are not indigenous to those areas.

BIOLOGY

C. pubescens start flowering in 3-4 years. The sweetly scented, tube-shaped flowers are pollinated mainly by bees and butterflies. Fruits mature about 7-8 months after flowering. Seeds are surrounded by a papery wing, facilitating wind pollination



The fragrant flowers in panicles. Picture taken at Santa Cruz Island, Galápagos, Ecuador. (Jaeger H.)



Small sapling at Makawao Forest Reserve, Maui, Hawaii (Forest & Kim Starr)



Fruits at Makawao Forest Reserve, Maui, Hawaii (Forest & Kim Starr)

ECOLOGY

Cinchona thrives best on steep mountain slopes of tropical forests. Seedlings are capable of germinating in fairly dense understorey vegetation in both disturbed alien forests as well as in relatively rich native moist to mesic forests.

Rapid spread, fast growth and growth habit (tree with dense canopy) result in fast invasion and replacement of native vegetation in naturally treeless environments. Shrub and herb layers experience dramatic loss of species diversity, with very few species able to grow below canopy. In the Pacific, it is very invasive in the Galapagos Islands and Hawai'i. This species has been nominated as among 100 of the world's worst invaders.

BIOPHYSICAL LIMITS

Altitude: 300-3900 m

Mean annual temperature: 10-23°C

Mean annual rainfall: 1020-3800 mm

Soil type: Red deep sandy sub-soils, slightly acidic, volcanic in origin, rich in organic matter with a capacity to retain water. Optimum PH range is 5.0- 6.5

DOCUMENTED SPECIES DISTRIBUTION

Native: Bolivia, Colombia, Costa Rica, Ecuador, Guatemala, Panama, Peru, Venezuela

Exotic: Australia, Burundi, Cameroon, Guinea, India, Indonesia, Kenya, Myanmar, Papua New Guinea, Philippines



The map above shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species can not be planted in other countries than those depicted. Since some tree species are invasive, you need to follow biosafety procedures that apply to your planting site.

PRODUCTS

Food: Nearly half of the harvested bark is directed to the food industry for the production of quinine water, tonic water, and as an FDA-approved bitter food additive.

Medicine: Over half the harvested bark is utilized in the manufacture of the quinine prescription drug. In Brazilian herbal medicine quinine bark is considered tonic, stomachic, and febrifuge. It is used for anemia, indigestion, gastrointestinal disorders, general fatigue, fevers, malaria and as an appetite stimulant. Other folk remedies in South America cite quinine bark as a natural remedy for cancer (breast, glands, liver, mesentery, spleen), amoebiasis, carditis, colds, diarrhea, dysentery, dyspepsia, fevers, flu, hangover, lumbago, malaria, neuralgia, pneumonia, sciatica, typhoid, and varicose veins. In European herbal medicine the bark is considered antiprotozoal, antispasmodic, antimalarial, a bitter tonic, and febrifuge. There it is used as an appetite stimulant, for hair loss, alcoholism, liver, spleen, and gallbladder disorders; and to treat arrhythmia, anemia, leg cramps and fevers of all kinds.

Although all cinchona species are good sources of quinine, *C. succirubra* and *C. ledgeriana* are the species containing the highest amount of quinine alkaloids.

SERVICES

Erosion control: It is used to prevent soil erosion in rainforest.

Intercropping: It is intercropped with food crops such as beans in Central Africa. Also it is interplanted with other leguminous plants to prevent soil erosion.

TREE MANAGEMENT

C. pubescens is a rapidly growing broad-leaved tree (about 1-2 m height increment/year) with a dense canopy, achieving harvestable bark within 6 years. The tree trunks are beaten and the peeling bark is removed (at least 40 cm up from the soil level). The bark partially regenerates on the tree and, after a few years and several cycles of bark removal, the trees are uprooted and new ones are planted. The commercial quinine market today is difficult to calculate. It is thought that 300-500 metric tons of quinine alkaloids are extracted annually from 5000-10000 metric tons of harvested bark. The bark of wild species may yield a quinine content of as high as 7%, whereas cultivated crops yield contents up to 15%.

Before planting, the plants are pruned back about one-third, or defoliated by 50%. Legumes cover crops such as *Desmodium*, *Crotalaria*, *Leucaena* spp. etc may be planted in rows to prevent soil erosion.

A short-term, intensive, high-production system with a relatively short production cycle of about 10 years from planting to harvesting is practiced in Congo at stocking rates of 10000-12000 stems/ha. Weeding is mostly by hand for the first three years. Thinning and pruning continue until the tenth year when a stocking rate of 3000 stems/ha is achieved.

In Indonesia and Guatemala, a long-term extensive, intermediate-production system with longer occupation period is practiced. Planting density is 5000 stems/ha. Weeding is carried out until trees establish while pruning is only carried out to shape the trees. All the trees are coppiced after 7-8 years to a height of 15-20 cm to minimize competition for light. 2-3 shoots per stool are maintained to take over the new cycle. This practice is maintained for several decades and it is suitable under shade of rainforest trees for preventing soil erosion.

GERMPLASM MANAGEMENT

Seed storage behaviour is orthodox.

PESTS AND DISEASES

Seedling under nursery conditions are susceptible to *Pythium* spp, and *Phytophthora* spp

FURTHER READING

Andersson L. 1998. A revision of the genus *Cinchona* (Rubiaceae-Cinchoneae). Mem. New York Bot. Gard. 80: 1–75.

Fosberg, F.R., M.H. Sachet, and R.L. Oliver. 1993. Flora of Micronesia. Part 5. Bignoniaceae-Rubiaceae. Smithsonian Contrib. Bot. 81: 54.

Khoury, H. E. and R. K. Ibrahim 1987. Purification and some properties of five anthraquinone-specific glucosyltransferases from *Cinchona succirubra* cell suspension culture. Phytochemistry. 26(9): 2531-2536.

Missouri Botanical Garden. 2002. W3TROPICOS: Specimen database. Available: http://mobot.mobot.org/cgi_bin/search_vast.

PIER (Pacific Islands Ecosystems at Risk). 2002. Invasive Plant Species: *Cinchona pubescens*. Available: <http://www.hear.org/pier>

Raintree. 2001. Quinine Bark. Raintree Nutrition, Inc., Austin, Texas 78758. Available: <http://www.rain-tree.com/quinine.htm>.

Schmauder, H. P., D. Groeger, et al. 1985. Shikimate pathway activity in shake and fermenter cultures of *Cinchona succirubra*. Plant Cell Reports. 4(5): 233-236.

Sejourne, M., G. Resplandy, et al. 1986. Bioproduction of quinoline alkaloids by *Cinchona succirubra* strains cultured in vitro. Fitoterapia. 57(2): 121-123.

SUGGESTED CITATION

Orwa C, A Mutua, Kindt R, Jamnadass R, S Anthony. 2009 Agroforestry Database: a tree reference and selection guide version 4.0 (<http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp>)