

Recommended Fruit Trees for Borana Lowlands/Midlands and their Production Techniques

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1. Introduction

Fruits are very important farm products for earning cash as well as an important source of nutrients in rural areas. Depending on soil and climatic conditions and availability of irrigation, several types of fruits can be grown in arid and semi arid areas. What makes fruit trees uniquely important for rural development? There are several reasons among which are (1) fruit tree growing can start from small scale (even only a tree in a homestead!) while other crops require certain size of land, (2) there is usually established market for the products, (3) fruit trees are more tolerant to drought than other farm crops, (4) once established these plants do not require intensive work, (5) fruits trees can be combined with other crops in agroforestry schemes, and (6) fruits trees can be used as ornamental or shade in house compounds.

Where to grow fruit trees?

Existing free grazing system, wildlife and the arid and hot climates in most parts of Borana does not seem to allow growing fruit trees in the field. The right place to grow fruit trees is in homesteads. What looks practical under the existing situation is growing a few number of fruit trees (1-5) in homesteads with intensive management and by applying simple and effective technologies such as porous pot irrigation and microcatchments.

How to grow fruit trees: Innovative dryland tree planting

Recent developments in dryland agriculture have made it possible to grow trees in deserts and drylands. It has become a common practice to grow fruit trees using such techniques as porous pot irrigation or Negarim microcatchments. Use of either of these techniques is recommended for growing fruit trees.

Use of porous clay pots irrigation for fruit tree production

This is a method of irrigation in which water is stored in clay pots buried in the ground, from where it is slowly released to the plants. This method is good for fruit trees. Such use of soil-embedded porous jars is one of the oldest continuous irrigation methods that probably originated in the Far East and North Africa.

The method consists of:

- ◆ Clay pots that are placed in shallow pits dug for this purpose;
- ◆ Soil is then packed around the neck of the pots so that necks protrude a few centimeters above the surface;
- ◆ Water is poured into the pots, either by hand or by means of a flexible hose connected to a water source.

The pots are made of locally available clay with optimum properties of strength (to resist crushing), permeability (to exude water into the soil at an approximately steady rate), and size (to hold enough water for at least one day's supply).

The technology of clay-pot irrigation has not been fully utilized in Ethiopia, even though the technology is suitable for small-scale farmers. There are some recent experiences in Northern Ethiopia.

Further information is referred to Arba Minch Water Technology Institute Perhaps appropriate trainers could also be found from the same.

Competition for Water

From the outset, local communities should be clearly told about the risks associated with growing fruit trees under irrigation scheme. There could be a serious competition for water between fruit tree production and other domestic uses, especially during droughts. Therefore, the participating farmers and the local communities should first agree on the possibility of using the water for growing fruit trees (from Ellas, for instance).

As I mentioned above, the use of porous pot technology installed at the backyards or any form of supplementary irrigation is a precondition for growing fruit trees in Borana because the rainfall is very small and erratic.

2. Carica papaya (Papaya)

Carica papaya grows in Kola (hot lowlands) and Weina Dega (midlands) agroecological zones of Ethiopia under rainfed condition or with irrigation. Papaya is a fast maturing fruit tree. It grows well in areas with a temperature of 25 to 40°C. The tree is sensitive to frost. Currently, papaya is grown in homesteads and commercial farms.

Papaya is rich in vitamins particularly vitamin A, thus contributing to the nutrition of rural people. It is also rich in calcium. The fruit can be processed into juice either alone or in combination with other fruits, or marmalade. The leaves and fruits have traditional uses but is not recommended without professional advise. Papaya is a plant with a weak stem, large leaves and with fruits weighing between 0.5 to 2 kg within which there are several seeds.

Reproduction

Papaya is reproduced with seeds. There are two types of papaya. The first is the one with two sexes. This is widely grown in Ethiopia. Only the female trees produce fruit. But the female tree requires a male tree in the nearby areas in order to give fruit and fertile seeds. It is recommended to leave only one male

tree to 15 female trees on a farm for good yield. Wind and some insects pollinate papaya. The fruits are large, oval or circular in shape.

Another type of papaya is the one containing both sexes on one tree. All trees in a farm will produce fruits. The fruit size is smaller but are suited to storage and packaging.

Seedling Production

Planting just a tree in a certain place will have a probability of 50% of being either of the sexes. By increasing the number of plants grown in an area, it is possible to get the required sex combination in a farm.

Seedlings can preferably be grown directly into plastic bags, the size of which should be long and wide to hold enough soil. Seedlings require great care in terms of supplying water, fertilizers, and weeding while in the nursery.

Planting

To plant papaya seedling, dig a depth and width of 50 cm hole in the planting site with a spacing of 2 or 3 meters. The top soil should be mixed with 2 buckets of manure and if available half a kilo of DAP and half a kilo of Urea and returned to the pit and left for 1 to 2 months. In order to locate the planting spots marking can be used. If water is available planting can be done any time but it is always good to plant seedlings at the start of the main rainy season.

Hardening off by reducing frequency of watering in the nursery is advised 2 weeks before planting out. During planting out the thickness of the seedling should be about the size of a pencil and the height should reach 20 cm. The seedlings should not be buried below the level of their root collars. The soil around the planted seedling should be firmly fixed and if the soil moisture is not satisfactory watering should be made.

Male and female trees

It is impossible to identify sexes of papaya plants before flowering. Female flowers are identified by their bigger size and location at the junction of a leaf and stem while male flowers are smaller and are found in clumps on long branchlets. It is necessary to wait until the plants flower to selectively remove them. It is recommended that among 16 plants retained in the farm one should on average be a male tree.

Fertilizer application

Fertile lands may not need additional fertilizer application. But for soils that are inherently not fertile, as is the case of Borana sandy soils, addition of manure,

ash and any decomposed material will be necessary. It is not possible to recommend a fixed quantity of organic manure for all soil types. However, at the start of planting application of manure as prescribed above will help the plant produce sufficient fruit and if conditions allow manure application can be done at an interval of a year just at the beginning of the rains around each tree.

Irrigation

Where sufficient rainfall is available papaya grows under rainfed condition. But if rain is not reliable and small in amount, papaya can be grown with the support of irrigation. The amount and frequency differs from site to site. But the frequency of application should be high during young ages and the amount can be increased as the tree grows while decreasing the frequency. Local expert advise should be sought.

Disease

The biggest threat to papaya production in the Rift Valley is a fungal disease called Anthracnose. It affects the fruit and when serious kills the plant. The infected trees must be burned or buried.

Another problem is powdery mildew, and applying a Karathane with a normal of 225 gram in 800 liter is advised for controlling the disease. The plant is also affected by phytophthora (stem-rot)and drainage and relay cropping helps in preventing the disease. If the disease is serious, applying Bordox mixture will help.

Collecting fruit before it ripens helps to reduce the impact of birds and insects.

Weeding

Hand weeding and mulching around the plant may be sufficient to control weeds. If there arises a need to apply herbicides, one has to seek advice from experts.

Wind and Storm

Papaya is naturally weak, and it carries heavy load of fruits. Therefore, if there is strong wind, windbreak should be established at right angle to the prevailing wind direction.

It is not advisable to grow papaya in storm and hail prone areas.

Mixed cropping

The farm space cannot be occupied fully by papaya plants, and thus growing annual crops in combination with papaya is possible. Further more, as papaya plants cannot naturally stay more than 4 years in a field it is possible to grow them in mango or citrus fields.

Harvesting

Well managed papaya farm can produce up to 300 quintals of fruits. Harvesting may depend on market availability. As soon as market is available, harvest fruits is a rule. Harvesting must be carefully conducted; it is a good practice to use ladder to collect fruits.

Production period

Good and healthy fruits can be harvested from papaya plants for 4-6 years after which it should be replaced with new plants.

Variety selection and seed source

Currently, there is no selected papaya variety in Ethiopia. What is usually done to select the variety is to assess market needs and taste of already growing papaya plants as seed source.

For further information on fruit trees (seed or propagation material), contact:

Melkassa Agricultural Research Center, Manager,

Tel: 02 114624

Or

Dr. Seifu Gebremariam

Head, Horticulture Division

Tel: 02 112186/114625

2. Mangifera indica (Mango)

Mango performs well in high rainfall areas, but can grow in areas with 650-1000mm rainfall. But dry period is essential at flowering and fruiting. In case of very dry conditions, as is the case in some areas in Borana Zone, supplementary irrigation may be required at least during the first 2-3 years. Porous pot or local modification using available materials such as Jarikans could be installed for irrigation. Optimum temperature is 24-27°C. Mango is limited to lower altitude areas under 1500m amsl. Soils should be rich and well drained with a pH of 5.5 -7.5.

Reproduction/Propagation

Mango can be propagated by either seeds or vegetatively by grafting. Grafting is the union of two separate structures, the upper portion is called a scion and the

lower portion is called a rootstock. The two parts are joined precisely and tied together. Of course, this is a specialized work and requires expertise.

When seeds are used the husk should be removed and should be sown as soon as possible.

Seedling Production

Seedlings can preferably be grown directly into plastic bags, the size of which should be long and wide to hold enough soil. Seedlings require great care in terms of supplying water, fertilizers, and weeding while in the nursery. Seedlings will take four months for out planting.

Planting and field maintenance

To plant mango seedlings dig a depth and width of 60 cm hole in the planting site with a spacing of 10.5m by 10.5 m. The top soil will be mixed with 2 buckets of manure and if available half a kilo of DAP and half a kilo of Urea and returned to the pit and left for 1 to 2 months. In order to locate the planting spots marking can be used. Hardening off by reducing frequency of watering in the nursery is advised 2 weeks before planting out. If water is available planting can be done any time but it is always good to plant seedlings at the start of the main rainy season. The soil around the planted seedling should be firmly fixed and if the soil moisture is not satisfactory watering should be made. Young plants should be mulched and shaded and weed free circle maintained around each. Capping seedlings at a height of 0.9 meter helps to produce a spreading framework. Prevent excessive growth of undergrowth vegetation. Pruning to remove dead wood and hanging branches and to open up the tree is vital. In the second year leave 4-5 well spaced branches which will be the future main ones.

Fertilizer application

If available, apply fertilizers (CAN) when trees are bearing a heavy crop of fruit in order to stimulate the vegetative growth necessary for the next crop; year 1, 50g of CAN, year 2, 100g of Can and year 3, 150 g CAN. Otherwise, addition of manure, ash and any decomposed material will be necessary. It is not possible to recommend a fixed quantity of organic manure for all soil types. However, at the start of planting application of manure as prescribed above will help the plant produce sufficient fruit and if conditions allow manure application can be done at an interval of one year just at the beginning of the rains around each tree.

Irrigation

Where sufficient rainfall is available mango grows under rainfed condition (1000mm). But if rain is not reliable and small in amount, it can be grown with the

support of irrigation. The amount and frequency differs from site to site. But the frequency of application should be high during young ages and the amount can be increased as the tree grows while decreasing the frequency. Local expert advice should be sought.

Disease

Anthracnose (*Collectrotrichum gloeosporiodes*), are black spots on the fruits. It can be controlled by spraying Captan or copper fungicide. The other threat is powdery mildew mainly on flowers. Spray Dinocap fortnightly from flower sets to fruit sets.

Another problem is powdery mildew, and applying Karathane with a normal of 225 gram in 800 liter is advised for controlling the disease. The plant is also affected by *Phytophthora* and drainage and relay cropping helps in preventing the disease. If the disease is serious, applying Bordox mixture will help.

Pests

Mango weevil (*Sternochetus mangiferae*): small larvae enter the fruits and attack the seeds. There may be a hard white area in the flesh and fruits may fall early or rot in the storage. Removing fallen fruits and sanitation helps control the problem.

Mango scale: small flat whitish circular scales which excrete honeydew and sooty mold. Spray Diazino and white oil or Malathion and white oil.

Fruit fly: causes premature coloring of fruits. The flesh in the affected area becomes liquid. Shiny white maggots may be seen in the fruits. Spray Fenthion (Levayad, Baytex) and collect and bury affected fruits.

Mixed cropping

The farm space cannot be occupied fully by mango plants and thus growing annual crops in combination is possible.

Variety selection and seed source

Currently, selection of Mango variety is still on progress at Melkassa Agricultural Research center, and no variety has been released yet. Therefore, it is advised to make contact to the Center for seed and material collection a year before planting (i.e., Contact in April 2004 to make planting material ready for next March 2005).

4. *Persea americana* (Avocado):

Avocado grows well at altitudes of 1500 to 2100m asl in areas with a well distributed rainfall of more than 1000mm under rainfed condition. Soil should be deep and free draining.

Propagation

Select egg-shaped seeds and plant them in boxes or seedbeds. Immediately after germination, transplant the seedlings into pots or polyethylene tubes. Where grafting is to be used, it should be carried out when the seedling reaches a pencil size. This is a specialty work and requires an expert. The wedge grafting method is the most successful. Grafting should be done at the point where the rootstock is soft. The scion should be dormant at the time of grafting and should match the size of the stock. Wrap the grafting point thoroughly to exclude water from the union.

Field establishment

Planting holes should be 60cm deep by 60cm wide , keeping the top soil sub soil separate. Mix the top soil with 20 kg of well decomposed manure and 120 g of double superphosphatate (DSP). Remove the plant from its pot, keeping the root and soil structure to fill up the hole. The subsoil may be used to make a basin around the tree. Water the plants immediately after planting. Shade the plants with banana leaves or similar material if they are putting up new shoots.

Field maintenance

Pruning: initial pruning may be done to give the tree a good shape. Otherwise, pruning is limited to the removal of dead wood.

Windbreak: a windbreak may be appropriate under certain conditions, to protect the plants from leaning to one side and to help prevent shedding and fruit drop and bruising.

Manuring and fertilizer application: an application of manure and fertilizer is desirable at the onset of long and short rains. Use the following rough prescription:

Age	CAN	DSP	Muriate of Potash	Manure
1-3	120g	220g	---	15kg
4-5	220g	450g	---	15kg
6-7	450g	650g	220g	30kg
8-9	650g	650g	450g	30kg
10-14	900g	1kg	650g	---
15+	1.3kg	1.2kg	650g	---

Pests

There are no major pests of Avocado.

Purple scale (*Chrysomphalus aonidum*): this may be controlled by spraying one of the following. Diazinon, Fenitrothion + white oil or Malathion + white oil.

Diseases

Root rot: (*Phytophthora cinnamoni*): the fungus attacks the feeder roots preventing the uptake of moisture from the soil. Leaves of the plant turn yellow, wilt and shed off giving the tree a sparse appearance. The branches die back. As prevention means, seeds for planting should be brought from the tree, not from the fallen seeds from the ground. Newly infected trees can be drenched with Ridolin at a rate of 15-20g/m² every three weeks. Rogue all severely infected trees and take precautions to prevent movement of soil and irrigation water from the diseased to non-infected trees.

Other diseases of Avocado are

Scab (*Sphaceloma perseae*): brown spots on fruit from which copper based fungicides can be used to control;

Cercospora purpurea: Spots on leaves, surrounded by yellow holes. Copper based fungicides or Benomyl can be used to control;

Anthraxnose: fruit lesions start as circular, slightly sunken brown to black spots, Good control of Anthracnose depends on the control of Scab and *Cercospora*.

5. Other fruits

Bananas

Bananas require high temperature (20-25 °C). They can grow from 0-2100m asl. Under rainfed condition, they require about 1500-2000mm rain. In semiarid areas bananas are often planted at riverside, water spring lines, drains, bottom of deep pits or under irrigation. Require deep well drained soil. They are weak against wind, so require wind break. *Musa sapientinum* (dessert banana) and *Musa cavendishi* (dwarf banana) can be grown in Borana area.

Bananas are propagated by vegetatively by root suckers. The following planting material can be used.

Sword suckers: suckers that are formed from bud low on the crown and bear narrow sword leaves, plucked from the plant when they are 0.6-1.2 m in height and about 15cm thick.

Broadleaf maiden suckers: well developed suckers which have broad leaves but have not yet shot off a bunch and are 6-8 months old.

Bull heads: obtained from the corn of the plant which has borne a bunch.
Tall varieties can be planted at a spacing of 3.6m by 3.6 m while short varieties can be planted at 2.7m by 2.7m.

Citrus fruits

Citrus performs well in low altitude areas up to 1800m. *Citrus* plants require at least 900mm of rain under rainfed conditions. They require deep light loamy well drained soil. They are propagated by vegetative means, the most widely used one is budding. Planting holes should be 60cm deep by 60 cm wide. About 20 kg of manure and top soil should be thoroughly mixed. Trees should be spaced 6m apart.

Major pests of the citrus plants are citrus aphid and red scale that can be controlled by spraying Diazinon, or Malathion. Also, Mediterranean fruit fly, false codling moth, mites, orange dog attack orange plants.

Citrus sinensis (Orange), *Citrus limon* (Lemon), *Citrus aurantifolia* (lime) can be grown in the Borana area.

6. *Opuntia ficus-indica* (Mill.)

Cactaceae

Opuntia is a good fruit species but with a potential invasiveness, and any attempt for introduction should make sure that it would not get out of control and escape into natural habitats. In Tigrai adaptation trials have been made to different places, and the species demonstrated that it is weedy and highly invasive. Experts warn that it should not be introduced outside its natural habitats. Thus, it is strongly advised to try it at a pilot level under controlled conditions, if it is necessary at all, before widespread adoption by the Borana people.

Botanical Distribution

Opuntia ficus-indica is a shrub or tree up to 5 m tall, forming sturdy trunk with age. Joints flattened, narrowly elliptic to ovate, varying in size, 30-60 cm long and 6-12 cm broad, attenuate below, often acute above, fairly thick, glaucous-green; areoles small to large, raised and woolly, with 3-6 radiating, unequally long, greyish white spines up to 3 (-10) cm long, straight or occasionally slightly curved, or spineless (in older plants and some cultivars).

Leaves, if developed, are minute, subulate and early deciduous.

Flowers about 7 cm long; hypanthium broadly cylindrical, contracted below, with numerous raised areoles spirally arranged, densely wooly and filled with glochidia, occasionally also bearing small spines and minute leaves; petaloid segments yellow or orange.

Fruits ellipsoid, about 7 cm long, reddish, succulent, edible.

Seeds about 5 mm long.

There is a distinction between the spiny naturalized pears, which are invasive weeds and the cultivated, spine-less ones. The latter exists in several cultivars eg. *O. ficus-indica* forma *inermis* *O. ficus-indica* forma *amyclaea* and *O. ficus-indica* forma *elongata*.

Ecology and Distribution

Natural habitat

Prickly pears are generally not confined to deserts. Many grow in grasslands, woodlands and some in moist tropical forests. *O. ficus-indica* in particular is native to sub-tropical uplands. The development of *O. ficus-indica* is restricted in the Mediterranean basin by the winter cold temperatures. The spiny, naturalized pear is recorded as a pest in part of South Africa and Australia.

History of Cultivation

The species is native to Mexico. It was introduced into southern Europe, Africa and India very long ago and is used for defensive hedge, as support for cochineal production of dyes (carmanic acid), fodder and edible fruit, generally in plantations at low plant densities. It is the most common and widespread species in South Africa. It was introduced to Spain at the end of 15th century.

Biophysical limits

Altitude: 0-2 600 m.

Mean annual temperature: -18-26 deg C.

Mean annual rainfall: 150-600 mm

Soil type: Drainage is an important ecological factor: *O. ficus-indica* like most cacti, is very sensitive to lack of oxygen in the root zone and therefore cannot withstand any prolonged waterlogging. It thus tends to avoid clay soils which may be temporarily saturated, poorly drained or waterlogged. It generally prefers deep sandy soils.

Propagation and Management

Propagation Methods

It is easily cultivated through vegetative propagation from segments. Before propagation, the segments should be exposed to diffuse sunlight for 7-15 days, to partially wither them. This process improves rooting. The segments are then planted in rows. They require slight watering and occasional hoeing, during dry weather.

Tree Management

Plantations are established at different levels according to the utilization and local conditions. In traditional fruit production operations, plants are established quite densely, with some 5 000 or more individual plants/ha. Fodder planting is governed by the conditions under which the exploitation, harvesting and transportation is done: 3 000-5 000 plants/ha is common. Modern plantations, under mechanized cultivation, harvesting and transportation to the site of consumption by tractor and trailer, are planted at a density of 1 000-2 000 plants/ha, with a spacing of 5-7 m between the rows and 1-2 m along the rows.

Maintenance and weeding are done by 2-4 shallow disk plowings per year in the fall and spring, with or without the inclusion of manure.

Plantations are exploitable after 4-5 years and fully grown after 7-10 years; when well managed, some are known to have remained productive for more than 50 years. Irrigation calls for some precautions, direct contact of the aerial parts of the plants with water must be avoided in order to prevent cryptogamic and bacterial diseases.

By pruning and grazing, the plants are encouraged to develop trunks up to 3 m high and are then left to branch freely, in time forming a dense canopy 4-5 m high.

Uses

Products

Food: The prickly pear fruit ranges in flavour from sour to very sweet. The fruit, known as tuna in Spanish and sabra in Arabic, is eaten throughout Latin America, the Mediterranean and the Middle East. There is commercial tuna production in Italy, Spain, Sicily, Tunisia, Mexico and South America, especially Chile. The tender young pads (Nopalitos) are eaten as a vegetable particularly during the lent season.

Fodder: With decline in demand for the tender young pads at the end of the lent, they are alternatively used as dairy cattle fodder. Local dairymen maintain

that cactus pads are essential for good lactation, imparts a better flavour and quality to the milk and enhances better quality for butter. The most extensive use of cactus occurs in Brazil where *O. ficus-indica* has been grown as a fodder for more than 80 years.

Services

Erosion control: Cactus hedges play a major role in erosion control and land-slope partitioning particularly when established along contours. The hedge is a physical obstacle to runoff, favoring temporary local runoff accumulation and silting, thus preventing regressive erosion. In arid lands subject to wind erosion, cactus hedges are an easy, cheap and efficient way of prevention and control of top soil loss and accumulation of wind-borne deposits.

Reclamation: Planting shrubs and particularly cacti is one of the easiest to rehabilitate degraded landscapes. Cacti, because of their easy establishment by vegetative propagation, are amenable to the rehabilitation of lands that could not be reclaimed through conventional agricultural methods because of their steep slope and other physical factor limitations. In Tunisia and Algeria for instance, stony and rocky slope have been rehabilitated by planting cacti on contours.

Soil improver: Cacti help in maintaining soil fertility via their geobiogene and trace element cycling activities, enriching the top soil in organic matter and improving its structure and the stability of its aggregates, hence permeability and water uptake balance.

Boundary or barrier or support: The thorny varieties of *O. ficus-indica* such as forma *amyclaea* and forma *elongata* are often used as defensive hedges for the protection of gardens, orchards and olive groves through out North America and in parts of Italy and Spain. These hedges demarcate boundaries as well.

Other services: The cactus hedges when established in double rows, play an important part in landscape organization, and in the local socio-economy, as evidence of land rights and land ownership in countries or regions where no land registry exists.

Pest and Diseases

In the Mediterranean basin cacti have no serious enemies, such as the prickly pear moth (*Cactoblastis caatorum*), prickly pear cochineal insect (*Dactylopius opuntiae*) and the prickly pear weevil (*Metamasius opuntiae*). These have been used in some countries for biological control of cactus invasions. These insects, although present in the basin, have had no serious impact.

Other occasional pests of the prickly pear include fruit fly, which may be a limiting factor in fruit production, of greater impact may be the bacterial rot, the snails, and occasionally slugs in the humid and sub-humid zones.

7. Zizyphus spina-christi L Willd.

Rhamnaceae

Botanical description

Zizyphus spina-christi is a shrub, sometimes a tall tree, reaching a height of 20 m and a diameter of 60 cm; bark light-grey, very cracked, scaly; trunk twisted; very branched, crown thick; shoots whitish, flexible, drooping; thorns in pairs, one straight, the other curved.

Leaves glabrous on upper surface, finely pubescent below, ovate-lanceolate or ellipsoid, apex acute or obtuse, margins almost entire, lateral veins conspicuous.

Flowers in cymes, subsessile, peduncle 1-3 mm.

Fruit about 1 cm in diameter.

There are 2 varieties: var. *spina-christi* is a tree with white branches, leaves larger, ovate-lanceolate with an acute or obtuse apex, 2.5-8.5 cm long and 1-3.5 cm wide, margins slightly crenate, 3 strong veins from the base, lateral veins inconspicuous; flowers many per cyme, peduncle up to 1.5 cm; fruit 2 cm in diameter; var. *microphylla* Hochst ex A. Rich. is a very bushy shrub, leaves are widely ellipsoid or ovate-ellipsoid, rounded at the tip, 1-3 cm long and just as wide, margins almost entire, basal veins not reaching the apex, 1-2 strong lateral veins on each side of the central vein; branches brown-reddish; fruits up to 1 cm in diameter.

The name 'Zizyphus' is often erroneously written as *Zizyphus*. The generic name is derived from the latinized version of the Arabic vernacular name 'zizouf' for *Z. jujuba*. The specific name is derived from its common name Christ thorn.

Ecology and Distribution

Natural habitat

Z. spina-christi is native to a vast area of Africa stretching from Mauritania through the Sahara and Sahelian zones of west Africa to the Red Sea. It is drought hardy, very resistant to heat and can be found in desert areas with even 100 mm rainfall annually. It prefers edges of ponds, river and wadi banks where

groundwater is available. The tree is frost tender, can withstand water logging for up to 2 months and 8-10 months of dry season. It is an aggressive colonizer, forming spiny, impenetrable thickets.

Biophysical Limits

Altitude: 0-2 000 m

Mean annual temperature: 19-28 deg C

Mean annual rainfall: 100-500 mm

Soil type: *Z. spina-christi* prefers alluvial plains with deep soils but it can also grow on clay where water is available and saline soils.

History of Cultivation

Some attempts have been made to plant Christ thorn as part of range improvement programs e.g. in Djibouti. In various countries, including Abu Dhabi, the species has been planted for windbreaks, sand dune fixation and reforestation of drylands. Agroforestry systems combining Christ thorn and various cereals also exist in the Sudan.

Propagation and Management

Seed storage

There are 15 000 seeds/kg. Seed storage behaviour is orthodox. Viability is maintained in hermetic air-dry storage and cool temperatures. The hard, woody shells of the seeds should be cracked with a hammer and the shelled seeds soaked overnight in lukewarm water or scarified in concentrated sulphuric acid for 2 hours then cold stratified before planting.

Propagation Methods

Propagation is by bare-rooted seedlings and cuttings. 60-80 % germination is realized, seedlings growth rate is medium reaching plantable size in 4-5 months in the nursery.

The tree develops an extremely deep taproot and has extraordinary regenerative power. It is an aggressive colonizer, coppices well and is long lived, forming spiny, impenetrable thickets.

Tree management

The tree develops an extremely deep taproot and has extraordinary regenerative power. It is an aggressive colonizer, coppices well and is long lived, forming spiny, impenetrable thickets.

Uses

Products

Food: The fruit is edible and occasionally sweet, but the flavour and texture are inferior to other *Ziziphus* spp. which have been domesticated in Africa and especially in northern India. Average size is about 50 g, with a single large seed. The fruits contain 14.16% sugar and about 1.6% vitamin C.

Fodder: The leaves provide valuable animal forage and fodder under open grazing conditions, but the nutritional value is apparently not high for most domestic livestock.

The fruits are eaten by sheep and goats and the foliage by camels.

Fuel: Its wood yields an excellent charcoal, but given the current status of the species, and its slow growth rate, this usage is certainly to be discouraged.

Timber: The termite resistant red or dark brown wood is hard and heavy, used for spear shafts, posts, roofing beams, utensils and cabinet making.

Alcohol: An alcoholic drink is made from the fruits.

Medicine: The leaves contain various alkaloids, including ziziphine, jubanine and amphibine, alpha terpinol, linalol and diverse saponins. In the Sahel region, the roots are used to treat headaches, while the spines or ashes of this species are applied to snake bites. Boiled leaves are applied to various surface wounds, and also have antihelminthic and anti-diarrhetic properties. In Egypt and the southern Sahara, a narcotic beverage is made from the fruits and which is considered to be a tranquilliser and sedative. In Morocco, the fruits are used as an emollient and astringent agent. It also is reputed to reduce abscesses and boils while a cataplasm of young leaves is also used to reduce eye inflammations.

Poison: It has been reported that applying Christ thorn bark in larger doses reduces nematode activity in cereal fields and leads to significant increase in the yield of sunflowers (Ismail, 1998).

Services

Erosion control: Because it develops a very deep taproot and spreading lateral roots, it is used for stabilizing sand dunes and other unstable soils.

Shade or shelter: Christ thorn is planted around towns and villages for shade. It makes useful windbreaks and shelterbelts.

Soil improver: The tree improves soil quality by increasing available Phosphorus.

Boundary or barrier or support: The thorny branches are used for fencing. It can also be grown to form a stock-proof living fence.

Intercropping: *Z. spina-christi* is intercropped with millet in West Africa.

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