CHAPTER 43

SWEET TAMARIND

(*Pithecellobium dulce* (Roxb.) Benth.)

Narayan Lal and Vishal Nath

CONTENTS

1. INTRODUCTION

It is basically a forest species which can be grown as border plant or wind break around the orchard. It produces edible fruits and therefore, is also planted in the back yards. It is called by many names like Manila tamarind, Mitiambli, Madras thorn, Korkalikka is the local Tamil name, Jungle jilebi. Blackbead, Camachile, Thai-Sweet Tamarind, Monkey Pod, Seema Chintakayalu (Foreign Tamarind), Kona Puliyankai (Twisted Tamarind) It is also known as Ape's earring, Bread-and-cheese tree. The plant growing naturally on the waste land or being planted at community lands are main source of edible fruits. It is mainly grown as a hardy roadside tree or hedge plant. Its potential as a fruit has not been utilized (Verheij and Coronel, 1991). Leaves are browsed by horses, cattle, goats and sheeps. The plants are multipurpose and are often planted as live fence or thorny hedge which is eventually thick and impenetrable. Plants when attain full size, braches become potential source of lac cultivation.

1.1. Nutrition Value

The fruits of sweet tamarind are very rich in various nutrient and anti-oxidant properties and various useful compounds have been extracted from different parts of manila tamarind which includes wax, hexacosanol, L-proline, L-leucine and asparagines from fruits, leucorobinetinidin, leucofisetinidin and melacacidin from wood; catechol, pectin, various yellow colour dyes from bark. Nutritive value of the fruits has been presented in the Table 1.

Table 1: Nutritive value per 100 g of pulp (Verheij and Coronel, 1991)

Moisture	75.8-77.8 g
Protein	2-3.3 g
Fat	0.4-0.5 g
Carbohydrate	18.2-19.6 g
Fibre	1.1-1.2 g
Ca	13 mg
P	42 mg
Fe	0.5 mg
Vitamin A	25 IU
Thiamine	0.24 mg
Riboflavin	0.1 mg
Niacin	0.6 mg
Ascorbic acid	13.8mg
Calories	78.8 K
Ash	0.6 %
Sodium	19 mg

1.2. Uses

Pithecellobium dulce is most often cultivated as an ornamental, shade or street tree planted on roadsides, and in backyards and hedges (Streets, 1962). In Indonesia, it is often pruned to be a shapely avenue tree, and occasionally used for more elaborate topiary. It is however, best known as a good hedging plant and is widely used as such in southern India, especially in Tamil Nadu. With regular trimming it produces a hedge which quickly forms a dense spiny barrier that is impenetrable to livestock if well maintained. It can withstand any amount of clipping. As a hardy, drought and heat tolerant, nitrogen-fixing tree it is more often planted because it tolerates harsh sites and heavy cutting than because of the products which it produces, none of which are of particularly high quality or significant commercial value.

The wood is used locally for construction, panelling, boxes, crates, agricultural implements, and cart wheels. Irregular growth habit and branchiness prohibit use as a sawn timber and the wood has never been used commercially, except in some areas for fuel. However, as a fuel wood it is not of very high quality, having only low to moderate calorific value, being thorny and burning with a very smoky flame (Brewbaker, 1992). Nevertheless, the wood is used as a domestic fuel in many areas where firewood is in short supply and as fuel for brick kilns in India.

1.3. Medicinal uses

In Haiti root and bark decoctions are taken orally against diarrhoea; fruit pulp is taken orally to stop blood flow in case of heamoptysis. The seed juice is inhaled into the nostrils against chest congestion and pulverised seeds are ingested for internal ulcers. The leaves, when applied as a plaster, can allay pain of venereal sores and taken with salt can cure

indigestion, but can also produce abortion. The root bark may be used to cure dysentery. The bark is used medicinally as a ferbrifuge.

2. ORIGIN AND DISTRIBUTION

Pithecellobium dulce (Roxb.) Benth. is native to Mexico, South America, and Central America. It is introduced in Indonesia and Philippines by Portuguese and Spaniards, respectively. It is common in India, Malaysia and Thailand (Verheij and Coronel, 1991; Hocking, 1993). The related species, which are grown for fruit are *P. Bubalinum*(Jack) Benth. (in Malaysia) and *P. Jiringa* (Jack) Prain (in Myanmar to western Malaysia). Holm *et al.,* (1979) reported that it is introduced in Hawaii as invasive crop species, not planted by people.

3. AREA OF CULTIVATION

Sweet tamarind has large but unaccounted area as forest species. It is very common as roadside and fence plant in tropical and subtropical region. Since, it has never been counted under fruit species, systematic plantation as orchard has not been attempted so far. The fruits marketed and utilized for various purposes are mainly collected from the groves and roadside/waste land plantations. The *Pithecellobium* species is distributed over tropical Africa including coastal Africa, Latin America, Mexico, East Indies and South East Asia. Guyana, Venezuela, Brazil, Peru, Jamaica, Puerto Rico, Cuba, St. Croix, Philippines and India are the major countries where manila tamarind or sweet tamarind is commonly grown. In India, it is distributed throughout the country; however the plantations have been made in northern states as forest species and in Andaman Island as food tree (Pareek and Nath, 2006). Mahapatra (2008) has mentioned its presence in forests of Orissa also. The ancient history reveals the evidence of presence of manila tamarind pod in Peruvian graves of Ancen and Paracas. Little and Wadsworth (1964) reported that *Pithecellobium* is widely planted and naturalized throughout tropical region including the old world. It has been listed as weed species in Hawaii.

4. GENETICS

Pithecellobium is a member of family Fabaceae sub family Mimosoideae and somatic chromosome number of *P. dulce* is 26 (Brewbaker *et al.,*1983). The genus *Pithecellobium* contains 100-200 species distributed mainly in tropical America and Asia (Allen and Allen, 1981). *Pithecellobium unguis-cati* (L.)Benth. is a comparatively small tree with a native range that extends from southern Florida to northern South America (Little and Wadsworth, 1964). Botanical synonyms of *P. dulce* include *Pithecelobium dulce* Benth. (Gamble, 1922), *Mimosa dulcis* Roxb., and *Inga dulcis* Willd. (McVaugh, 1983; Troup, 1921). The generic name is derived from the Greek for “ape’s earring” referring to the coiled pods of some species; the Latin species name, meaning “sweet”, describes the edible seed pulp (Little, 1983).

5. BOTANICAL DESCRIPTION

It is a very hardy and thorny tree and is small to medium sized semi-evergreen tree which can be grown up to 20 m height. The crown is spreading but irregular and trunk is short (about 1 m height) with crooked branches and somewhat shiny branchlets. Bark is grey and smooth in young trees, turning to slightly rough and furrowed in old trees. Bark exudes reddish-brown gum when injured. Leaves are bipinnately compound with a pair of pinnae, each with two leaflets that are kidney shaped and dark green in colour. Spines are present in pairs at the base of the leaf. New leaf growth and shedding of old leaves occur almost simultaneously, giving the tree an evergreen appearance.

5.1. Flowering

Flowers are borne on short-stalked, whitish, racemelike or spiciform panicles 10 to 20 cm in length and 1 to 1.5 cm in diameter, often in one year old twig on terminal compound inflorescence. Each branch has around 15-20 white flower in round heads. Each flower is 0.3 to 0.5 cm long with hairy corolla and calyx. Fruit is a pod, 10 to 15 cm long, 1 to 1.5 cm wide, curled up tightly and reddish-brown in colour. Each pod has five to ten shiny black coloured seeds, which are surrounded by thick, spongy, dry pulp and 9,000-26,000 seeds/kg (Parrotta, 1991; Stewart *et al.,* 1992).

Sweet tamarind may first produce flowers when trees are 2 years of age (Crane *et al*., 1984). Some workers suggested that seedling plant starts bearing six year after planting. Flowering generally occurs between December and May and fruits can be obtained on tree from February to August depending on the climatic condition (Little and Wadsworth, 1964; McVaugh, 1983). In Puerto Rico, fruiting has been observed throughout the year. Mahapatra (2008) reported that fruits of *P. dulce* mature by April-June in Orissa and most of the northern states. Pollination is mainly done by insect and honey bee rearing which increases pollination. Fruits are ready to harvest approximately 3 to 4 months after flowering. Fruits are available in the market from summer to early monsoon season.

6. CLIMATE AND SOIL

In its native range, the climate is dry to semi arid sub tropical and tropical with mean rainfall ranging from 500 to 1000 mm. It can tolerate shade and drought conditions but susceptible to severe frost. It has been successfully planted in areas with a mean annual rainfall as low as 400 mm and with a maximum dry season of 4 to 5 months (Little, 1983; Relwani *et al*.,1988). Sweet tamarind reportedly grows well in semiarid region of India characterized by mean monthly temperature ranging from 7 to 8^0C in January and 40 to 42^0C in May and June (Relwani *et al.,* 1988).

Sweet tamarind is a drought hardy plant which can be grown in waste land. It tolerates a wide range of soil types including clays, rocky limestone soils, nutrient poor sand and soils with high, brackish water table (Crane *et al*., 1984 and Little, 1983). In

India, the tree is reported to grow well on saline sites (Chaturvedi, 1985) and on severely eroded, Montana wastelands (Relwani*et al.,* 1988).

7. PROPAGATION AND ROOTSTOCK

7.1. Propagation by seed

It is commonly propagated by seed (Pareek and Vishal Nath, 2006). Seed are sown in polythene bag containing FYM, sand and Clay in equal proportion. Seed do not require scarification or other treatments for germination. Freshly harvested seed germinate easily in 1 to 2 days after sowing (N.A.S., 1980) while dried seeds take 30-35 days for germination. Seed remain viable in storage for approximately 6 months (Chaturvedi, 1985 and N.A.S., 1980). Seedlings raised on nursery are used for replanting after 4-6 months. Seedlings may be pricked out from the germination beds to transplant beds or polythene bags after 6 months and young plants need the shelter from dry and hot winds.

7.2. Propagation by vegetative method

Pareek and Vishal Nath (2006) reported that it can be propagated through hardwood cuttings. The best time for taking cutting is in July-August and treatment with 1000 ppm IBA improves rooting. Budding, grafting and layering are also successful at limited scale.

7.3. Micropropagation

Goyal *et al.,* (2012) developed an efficient and reproducible protocol for in vitro propagation of *Pithecellobium dulce* (Roxb.) from field grown nodal segments (axillary bud). Plant material of fresh and mature branches with 10–15 nodes were collected from field grown trees (15 yrs old). After excision of leaflets and thorns branches were cut into smaller segments (4–5 nodes long) and rinsed in 20 % (v/v) 'Extran' (liquid detergent; Merck, India) for 10 min then treated with 0.5 % (w/v) bavistin (carnbandazin powder), a broad spectrum fungicide for 8–10 min and finally washed in running tap water for 30 min. These segments were then aseptically surface sterilized with 0.1 % mercuric chloride (w/v) for 3 min followed by 4–5 rinses with sterile distilled water. Since the use of sodium hypochlorite did not prevent contamination, mercuric chloride was used as sterilizing agent throughout the experiment. Segments having 4–5 nodes were recut into segments of about 1 cm having single node in each explant and cultured aseptically in vertical position in the culture flask (100 ml, Borosil) containing nutrient medium. Shoot bud induction occurred from nodal explants on Murashige and Skoog (MS) basal medium supplemented with 4.4 ìM 6-benzyladenine (BA) and multiplication was achieved on MS medium supplemented with 4.4 ìM BA + 0.73 ìM phenylacetic acid (PAA) i.e. up to 7 shoot buds in the period of 5–6 weeks. Addition of adenine sulphate (AdS) to this medium further enhanced the number of shoot buds up to 10. Proliferating shoot cultures were established by repeatedly

sub-culturing primary culture on fresh medium (MS + 4.4 ìM BA + 0.73 ìM PAA) after every 25 days. In vitro rooting was achieved on MS medium supplemented with 2.46 ìM Indole-3-butyric acid (IBA) + 41.63 ìM activated charcoal (AC). The micro-propagated shoots with well-developed roots were acclimatized in green house in pots containing sand, soil and manure (1:1:1).

8. VARIETY

No systematic work has been carried out to identify germplasm of manila tamarind and therefore recognized varieties of sweet tamarind are presently lacking. However, mainly two types of sweet tamarind i.e. Red aril and creamy aril types are common in most parts of the country.

8.1. Crop improvements

A large genetic pool of *Pithecellobium* is available in the various regions. Owing to seedling origin of most of the plants, they inhibit variation with respect to tree and fruit characters. Visualizing the nutritive value and adaptability of plants to adverse conditions, Pareek and Nath (2006) emphasized the importance of varietal selection in sweet or manila tamarind and mentioned that in Southern parts of our country attempts are being made to identify and select the promising genotypes on the basis of bearing potential, fruit colour and pulp content.

9. CULTIVATION

9.1. Planting

It is multipurpose tree species. Its method of planting and after care differs with use. For hedge, seed are sown in 2-3 rows at 15 cm distance which develops an impenetrable fence after regular training and pruning. To develop a shelter belt, seedlings are transplanted at 3-4 m spacing around the orchard. For fruit production seedlings of Inga are planted in square system at 8 x 8 m spacing (Pareek and Nath, 2006). Vegetative multiplied plants are planted at 6 x 6 m spacing. July-August is the best time for planting when the saplings are planted in the well prepared and filled pits of 60 x 60 x 60 cm. In problematic soil, pits size can be enhanced as per need.

9.2. Training and pruning

Training is essential at initial stage to provide better frame work. As avenue plant, the tree trunk is kept clean up to 3-4 m height and then branches are allowed in all directions. It does not require regular pruning to produce fruits. *Pithecellobium* tree has fast growth rate and vigorous coppicing capacity and therefore can withstand any amount of pruning, lopping or browsing by animals. For hedge regular pruning is necessary.

9.3. Irrigation

It is hardy tree and grows very well even without irrigation. At initial stage, irrigation is required to establish the young plant. Once established, irrigation is not mandatory to produce fruits. Irrigation during summer improves fruit size and yield.

9.4. Orchard management

Intercultural operation can be introduced at initial stage to control weeds and for better soil management. One or two weeding can be done as per needs.

9.5. Mulching

Sweet or manilla tamarind is hardy and drought tolerant plants, however, paddy straw, dry banana leaf etc. can be used as mulch beneath the tree canopy. Black polythene mulch is very effective to conserve soil moisture.

9.6. Intercropping

Inter crops such as coffee, tea, cacao, cardamom can be taken under humid tropical conditions ((Parrek and Vishal Nath, 2006) and other seasonal inter crops like cow pea, brinjal, can be grown at initial stage of manila tamarind.

9.7. Mineral nutrition

The systemic information on nutritional requirement of manila tamarind is not available since the existing plantations are mainly in shelter belts and road side plantations where nutrients are generally not applied. However, application of 50 kg FYM during monsoon improves fruit set, fruit size and yield in a bearing tree (Pareek and Vishal Nath, 2006). Application of 40-50 kg FYM and 500 g phosphatic fertilizer per tree has been found beneficial. Fertilizers should be applied during February-March and July-August and light irrigation should be given after application of fertilizers.

9.8. Insect pests

Manilla tamarind generally remains free from pests and diseases. However a number of defoliating and boring insect pests have been reported. Shoot hole borer cause damage by making holes in the trunk which can be controlled by plugging cotton swabs soaked in petrol/kerosene. It is favourite host for thorn bug (N.A.S. 1980). It has also been reported to be a host for lac insects. Browne (1968) mentioned various insects on *pithecellobium*, which includes Coleopterus- *Celosterna scabrator*, *Sternoceras termicornis;* Hemipterus- *Kerria lacca, Nipaecoccus vastator and* Lepidopterus- *Cryptophlebia illeptida, Eucosma stereoma, Euproctis scintillans, Hypanartia hecabe*

and Macroplectra nararia. Root knot nematode species *Meloidogyne spp.* has been reported as pest of manila tamarind in Florida.

In Hawaii, the fruit and seeds are reportedly susceptible to attack by the larvae of *Subpandesma anysa* Gn. (USDA, 1977). In Puerto Rico, the hemipteran *Umbonia crassicornis* Amyot and Serville has been reported as a pest of manila tamarind (Martorell and Garcia-Tuduri, 1973). The bark boring larvae of *Indarbela* spp. have been reported to attack the tree in India (Verma and Khurana, 1974). The lepidopteran *Polydesmaum bricola* is considered a serious pest of the species of the Island of Reunion in the Indian Ocean (Etienne and Viette, 1973). These can be controlled by spraying of insecticides.

9.9. Diseases

Plants are severely affected by leaf spot diseases. Fungi such as *Bitzea ingae, Catacauma ingae, Fusarium semitechim var. majus, Perisporium truncatum, Peziotrichum sacchardinum, Phyllostica ingae-edulis, Ravenelia ingae, Rhizoctonia spp., Colletrotrichum spp., Uredo ingae and Corticum salmonicolor* have been found on the manila tamarind. These can be managed by spray of fungicides. Trees are also affected by mosaic virus witches broom. The twig blight (*Phomopsis spp.*), leaf spot (*Phyllostica pithecolubis*) in Texas and Puerto Rico; *Physalospora fusca* and *Physalospora rhodina* in Florida; wood rot (*Polyporus gilvus*) in Hawaii are the major disease of this crop.

10. HARVESTING, YIELD, POST-HARVEST MANAGEMENT AND STORAGE

Ripe fruits are manually harvested when peel colour turns from green to pink or when pulp becomes pinkish in colour. However climbing on the tree is a risk because tree has thorny stem and branches. To harvest the fruits from a tall (10-15 m) tree, thin and long bamboo poles having a sharp pruning knife (skeel) fixed at the top of it, is used for harvesting. Harvested pods are separated from the twigs and packed in bamboo baskets and wooden basket for marketing. Fruit can be stored for a few days at room temperature. The pulp is extracted from the pods by removing the peel and seeds. Fresh fruits are eaten. The fruits do not store for long and must be eaten within a few days.

11. UTILIZATION/PROCESSING/VALUE ADDITION

P. dulce is perhaps best-known for its sweet edible aril, which is eaten fresh, as an infusion, or macerated in water to make a lemonade-like beverage (Brewbaker, 1992). The species name ‘dulce’ derives from this use. The aril is small, fleshy, sweet, but often rather astringent, and has been the focus of selection in the Philippines to produce superior clones with sweeter, redder arils. The pods are often harvested for local consumption, but in some areas, such as the Philippines, Thailand, Cuba and Mexico (McVaugh, 1987), pods are harvested in larger quantities and sold in local markets. These can also be used for making paste, mixed fruit jam, beverage, etc. Coloured varieties are well suited for making

jam and squashes. The seeds themselves are also edible (Parrotta, 1991), eaten in curries in India. They also contain 17% oil, light-coloured, as thick as castor oil, which is extracted in some areas, and the resulting pressed seed cake residue is rich in protein (30%) and can be used as a seed meal for stock feed. The pods are also relished by livestock and chickens (Hocking, 1993). The leaves contain 29% crude protein (Luna, 1996) and the young shoots are used for livestock fodder in some areas (Kundu *et al.,* 1983), either browsed directly or by lopping branches and allowing the leaflets to dry and drop off. Hedge trimmings are often used in this way as fodder for goats in parts of India (Hocking, 1993). However, it is rarely considered an important fodder and there has been only limited evaluation no fits nutritive value. The flowers of *P. dulce* are a high quality nectar and pollen source producing excellent quality honey (Crane *et al.,* 1984). Tannin, used to soften leather, can be extracted from the bark, seeds and leaves. The tree also produces a reddish-brown, water-soluble exudates gum similar to commercial gum arabic from *Acacia senegal. P. dulce* has numerous minor medicinal uses (Standley, 1922; Standley and Steyermark, 1946; Timyan, 1996).

12. SPECIAL PROBLEM OF FRUIT PRODUCTION

Fruit cracking or splitting is a major problem. Though splitting indicates the maturity of pos by showing pinkish pulp and brown seed colour. When pods splitting take place, individual pulp segment starts to drop on the ground and this dropping of segment become serious at the time of attack of birds and parrots on the tree. Sudden rainfall facilitates pathogen (fungus and bacteria) to attack on splitted pods.

13. ECONOMICS OF CULTIVATION, TRADE AND MARKETING

There is no commercial plantation of manila or sweet tamarind. It is commonly collected from forest and roadside plantation and sales for livelihood security. In Mexico and India, the fruits are commonly sold in country market for the sweet, acidic, edible aril which are consumed raw or roasted or are used in a beverage resembling lemonade

14. FUTURE RESEARCH THRUST

Manila or sweet tamarind is a hardy underutilized fruit crop which has not been exploited commercially. Owing to its high nutritive value, antioxidant properties and multipurpose nature of the tree, this crop species need special research attention. The full potential of the species can only be exploited after:

1. Development of high yielding, dwarf statured, probably thorn less variety with high quality and palatability of fruits.
2. Development of commercial protocol for production of quality and true-to-type planting materials.

3. Standardization of complete agronomical practices for fruit production under various ecological regions.
4. Development of various value added product and diversification of its present use pattern.
5. Popularization of this fruit from neglected fruits to health food in the society.

References

Allen, J.B. and Allen, E.K. 1981. The Leguminosae: a sourcebook of characteristics, uses and nodulation. Madison, WS: University of Wisconsin Press, pp-812.

Brewbaker, J.L. 1992. *Pithecellobiumdulc*e - sweet and thorny. NFT Highlights, No. 92-01:2 pp.; 5 ref.

Brewbaker, J.L., Halliday, J. and Lyman, J. 1983. Economically important nitrogen fixing tree species. *Nitrogen Fixing Tree Research Report,* **1**: 35-40.

Browne, F.G. 1968. Pest and disease of forest plantations tree. Clarendom Press, Oxford.

Chaturvedi, A.N. 1985. Firewood farming on degraded lands in the Gangetic plains. UP. Forest Bulletin No. 50. Lucknow, India: Uttar Pradesh Forest Department, pp-52.

Crane E, Walker P and Day R.1984.Directory of important world honey sources.International Bee Research Organization (IBRA).pp. 384.

Etienne, J. and Viette, P. 1973. *Polydesmaum bricola* (Lep.Noctuidae). Identification and biology. *Bulletin de la Societe Entomologue de France*. **78**: 98-107.

Gamble, J.S. 1922. A manual of Indian timbers. Londan: Sampson Low, Marston and Co. Pp-866.

Goyal, P, Kachhwaha, S and Kothari, S.L. 2012. Micro-propagation of *Pithecellobium dulce* (Roxb.) -a multipurpose leguminous tree and assessment of genetic fidelity of micropropagated plants using molecular markers. *Physiol. Mol. Biol. Plants*, **18**(2): 169–176.

Hocking, D. 1993. Trees for dry land.Oxford and IBH Publishing co. Pvt. Ltd. New Delhi, Bombay and Culcutta, 370 pp.

Holm L.G, PanchoJ.V., Herberger J.P. and Plucknett, D.L.1979. A Geographical Atlas of World Weeds. New York, USA: Wiley.

Kundu, H., Panda, N.C. andSahu,B.K.(1983).Leaves of *Inga dulcis* (Manila tamarind; *Pithecellobium dulce*) as a fodder for goats. *Indian Journal of Animal Sciences,* **53**(6):669-671.

Little, E.L., Jr. 1983. Common fuelwood crops: a handbook for their identification. Morgantown, WV: Communi-Tech Associates, pp- 354.

Little, E.L., Jr. and Wadsworth, F.H. 1964. Common tree of Puerto Rico and the virgin Islands. Agricultural Handbook 249, USDA, Washington, DC.

Luna, R.K. 1996. Plantation trees. Delhi, India: International Book Distributors.

Mahopatra, A.K. 2008. Wild edible fruits, nuts and berries-Conservation Programme, RPRC, Bhubaneshwar.

Martorell, L.F. and Garcia-Tuduri, J.C. 1973. Notes on the accidental introduction of *Umboniacrassicornis*(Amyot&Serville)- (Hemiptera: Membracidae) into Puerto Rico and its control. Journal of Agriculture of the University of Puerto Rico. 57 (4): 307-313.

McVaugh, R. 1983. Flora Novo-Galiciana: a descriptive account of the University of Michigan Press. 5:786.

McVaugh R, 1987. Flora Novo-Galiciana: a descriptive account of the vascular plants of western Mexico. Volume 5. Leguminosae. General Editor Anderson, W.R. Michigan, USA: University of Michigan Press.

National Academic of Sciences.1980. Firewood crops, Shrubs and tree species for energy production. National Academy of Sciences, Washington, DC, pp-237.

Pareek, O.P. and Vishal Nath 2006. Arid and minor fruits. In: Text of Horticulture (Eds. K.L.Chadha et al.), MPH, New Delhi.

Parrotta,J.A.1991. *Pithecellobiumdulce* (Roxb.) Benth. Guamúchil, Madras Thorn. Leguminosae (Mimosoideae). Legume family. USDA Forest Service. Southern Forest Experiment Station. New Orleans, Louisiana: Institute of Tropical Forestry.

Relwani, L.L.,Lahane, B.N. and Gandhe, A.M. 1988. Performance of nitrogen fixing MPTS on mountainous wastelands in low rainfall areas. In: Withingotn, D.; MacDicken, K.G.; Sastry, C.B.; Adams, N.R., eds. Multipurpose tree species for small farm use: proceeding of workshop; 1987 November 2-5; Pattaya, Thailands. Morrilton, AR: Winrock International Institute for Agricultural Development Research Centre of Canada: pp.105-113.

Standley, P.C.1922. Trees and Shrubs of Mexico. Gliricidia. *Contributions from the U.S. National Herbarium*, **23**(2):482-483.

Standley, P.C. and Steyermark, J.A.1946. Flora of Guatemala.Fieldiana (Botany), **24**(5).

Stewart,J.L., Dunsdon, A.J. Hellin, J.J. and Hughes, C.E.1992. Wood biomass estimation of Central American dry zone trees. Tropical Forestry Papers 26. Oxford, UK: Oxford Forestry Institute.

Streets, R.J. 1962. Exotic forest trees in the British Commonwealth. Oxford, UK: Clarendon Press.

Timyan J, 1996. Bwayo: important trees of Haiti. Bwayo: important trees of Haiti, i418: 14.

Troup, R.S. 1921. The silviculture of India trees. Oxford, England: Clarendon Press. 3: 1195

United States Department of Agriculture.1977. Hawaii pest report. *Cooperative Plants pest report*., **2** (29): 548.

Verheij, E.W.M. and Coronel, R.E. (eds) 1991. Plant resources of south East Asia No. 2. Edible fruits and Nuts. Pudoc.Wageningen.The Netharland, 447 pp.

Verma, A.N. and Khurana, A.D. 1974. Further new host records of *Indarbela spp* (Lepidoptera: Metarbelidae). *Haryana Agricultural University Journal of Research*, **4** (3): 253-254.