

**Abstract**

The wood apple, *Feronia limonia* (Linn.) Swingle, synonyms *Limonia acidissima* L., *Feronia elephantum correa*, and *Schinus limonia* L., is the species of its genus, in the family Rutaceae. Besides wood apple, it may be called elephant apple, monkey fruit, curd fruit, kath bel, and other dialectal names in India. The plant is a native and common in the wild in dry plains of India and Ceylon. The plants are hardy with deep penetrating root system, which makes them survive harsh soil and climatic condition. In India, the fruit was traditionally a “poor man’s food” until processing techniques were developed in the mid-1950s. The fruit is much used in India as a liver and cardiac tonic and, when unripe, as a means to halt persisting diarrhea and dysentery and effective treatment for hiccup, sore throat, and diseases of the gums. In a Poultrice, the pulp is used to help with bites and stings of venomous insects, as is the powdered rind.

**15.1 Introduction**

The wood apple, *Feronia limonia* (Linn.) Swingle, synonyms *Limonia acidissima* L., *Feronia elephantum correa*, and *Schinus limonia* L., is the species of its genus, in the family Rutaceae. Besides wood apple, it may be called elephant apple, monkey fruit, curd fruit, kath bel, and other dialectal names in India. In Malaya, it is gelinggi or belinggi; in Thailand, Ma-khwit; in Cambodia, Kromsang; and in Laos, Ma-fit. In French, it is pomm-d-elephant, pomm de bois, or citron des mois, with chromosome no.  $2n=18$  (Morton 1987).

**15.2 Origin and Distribution**

The plant is a native and common in the wild in dry plains of India and Ceylon. It is found growing; it is also frequently grown throughout Southeast Asia, in Northern Malaya, and in Penang Island. In India, the fruit was traditionally a “poor man’s food” until processing techniques were developed in the mid-1950s. It occurs wild or cultivated, up to an elevation of 1,500 ft; in Western Himalayas, it is more common in the Deccan and Thane and Chandrapur districts of Maharashtra. It is also reported to occur in parts of Hazaribagh, Palamau, and Chota Nagpur in

Jharkhand. It is often cultivated on borders of fields and as a roadside tree near villages and is sometimes planted in orchards.

### 15.3 Composition

Analysis of the edible part (55–58 %) of the fruit gave (food value per 100 g edible portion) the following value.

Component	Fruit pulp	Seeds
Moisture (%)	64.20	4.00
Protein (%)	7.10	26.18
Fat (%)	3.70	27.10
Carbohydrates (%)	18.10	35.49
Ash (%)	5.00	5.03
Calcium (%)	13.00	1.58
Phosphorus (%)	110.00	1.43
Iron (%)	0.60	0.03
Tannins (%)	1.03	0.08
Ether extract (g)	0.60	–
Mineral matter (g)	1.90	–
Fiber (g)	5.00	–
Riboflavin ( $\mu\text{g}/100\text{ g}$ )	0.17	–
Vitamin C ( $\text{mg}/100\text{ g}$ )	3.00	–
Carotene ( $\mu\text{g}$ )	6.10	–
Thiamin ( $\mu\text{g}$ )	0.04	–
Niacin ( $\mu\text{g}$ )	0.80	–
Energy (k/cal)	134.00	–

Gopalan et al. (1984) and Morton (1987)

### 15.4 Food Uses

The pulp represents 55–56% of the whole fruit. The pectin content of the pulp is 3–5 % (16 % yield on dry weight basis). The seed contains bland, non-bitter oil high in unsaturated fatty acids. The rind must be cracked with a hammer. The scooped-out pulp, though sticky, is eaten raw with or without sugar or is blended with coconut milk and palm-sugar syrup and drunk as a beverage or frozen as an ice cream. It is also used in chutneys and for making jelly and jam. The jelly is purple and much like that made from black currants. A bottled nectar is made by diluting pulp with water, passing through a pulper to remove the seeds and fiber, further diluting,

straining, and pasteurizing. A clear juice for blending with other fruit juices has been obtained by clarifying the nectar. Pulp sweetened with syrup of canes or palm sugar has been canned and sterilized. The pulp can be freeze-dried. A stiff jelly can be made from the wood apple, but the flavor is somewhat harsh, so it is seldom used alone, but more frequently mixed with such fruits as the guava. Anon (1956), however, speaks of the jelly as having an exceeding agreeable flavor. He also reported syrup and chutney as other possible products. He refers to two types of wood apple, one with fruit larger and sweeter than the other, and states that the ripe fruit pulp contains 2.3 % acid and 7.25 % sugars.

#### 15.4.1 Medicinal Value

The fruit is much used in India as a liver and cardiac tonic and, when unripe, as a means to halt persisting diarrhea and dysentery and effective treatment for hiccup, sore throat, and diseases of the gums. In a poultice, the pulp is used to help with bites and stings of venomous insects, as is the powdered rind.

The juice of young leaves is mixed with milk and sugar candy and given as a remedy for biliousness and intestinal troubles of children. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhea in children. Oil derived from the crushed leaves is applied on itch and the leaf decoction is given to children as an aid to digestion. Leaves, bark, roots, and fruit pulp are used against snakebite. The leaves are aromatic, carminative, and astringent.

#### 15.4.2 Other Uses

##### 15.4.2.1 Gum

From the trunk and branches of the tree exudes a gum resembling gum arabic in properties. The exudation is profuse after the rainy season. It is considered to be a good substitute for gum arabic and commercial samples of the latter are utilized as substitutes for, or adulterant of, gum arabic and are also used in making artists' watercolors,

ink, dyes, and varnishes. It consists of 35.5 % arabinose and xylose, 42.7 % D-galactose, and traces of rhamnose and glucuronic acid.

#### 15.4.2.2 Wood

The wood is yellowish gray to grayish white and hard and heavy (sp.gr. -0.83). It is somewhat refractory to season. It is durable both under cover and in exposed situations. It is used for house building, hanes of wheels, and oil crushers. It can be used as wood pattern wood, for shoe lasts, penholders, and similar articles. It is also used for agricultural implements and ornamental carving (Anon 1956).

#### 15.4.2.3 Pectin

The pectin has potential for multiple uses in India, but it is reddish and requires purification. Fruit pulp contains 2.66 % pectin on fruit weight basis (Roy and Majumdar 1988).

#### 15.4.2.4 Rind

The fruit shell is fashioned into snuffboxes and other small containers.

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### 15.5 Area and Production

There are no regular plantations; however, plants are usually found along the border of fields, roads, railway lines, and banks of the river. Normally 20-year-old plants are found to bear 1,000–1,500 fruits per trees. However, the size of the fruit is varying. The fruit weight varies from 175 to 350 g. There is tremendous scope for increasing the area under this crop considering its production potential, which is as high as 1.75–3.50 q per tree per year, and multifarious uses.

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### 15.6 Soil and Climate

The plants are hardy with deep penetrating root system, which makes them survive harsh soil and climatic condition. Wood apple can be grown on saline marginal lands, which are unsuitable for cultivation of other crops or trees. Once established they can withstand salinity and drought in a better way.

Mature plants can tolerant low temperature (0–15 °C) as well as a temperature as high as 47.7 °C (Troup 1921). Wood apple is found to be growing in high as well as low rainfall areas of tropical and subtropical conditions. It can also be grown in semiarid regions of India. The warm season appears conducive for the initiation of floral buds.

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### 15.7 Taxonomy

The slow-growing tree is erect, with a few upward-reaching branches bending outward near the summit where they are subdivided into slender branchlets drooping at the tips. The tree grows up to an elevation of 450 m in the Western Himalayas. The bark is rigid, fissured, and scaly and there are sharp spines: 2–5 cm long on some of the zigzag twigs; Leaves pinnate, 8–10 cm long, The deciduous, petiole and rachis, flat, often narrowly winged, glabrous, entire, alternate Leaves, dark green, leathery, often minutely toothed, blunt or notched at the apex, are dotted with oil glands and slightly lemon-scented when crushed. The leaflets 3–9, opposite, sessile, or short petiolate, obovate with crenate tip and cuneate base and glabrous. Flowers are dull red or greenish, 1.25 cm wide, and are borne in small, loose, terminal, or lateral panicles. They are usually bisexual. The calyx is very small with 5–6 lobes, deciduous; petals 5–6, elliptic-oblong, spreading or bent downward. The fruit is round to oval, 5–12.5 cm wide, with a hard, woody, grayish white, scurfy rind about 6 mm thick. The pulp is brown, mealy, odorous, resinous, astringent, and acid or sweetish, with numerous small, white seeds scattered through it. It grows wild and is considered an indigenous fruit. It is found in gardens, but is not grown systematically.

Warm season appears conducive for the initiation of floral buds. The tree sheds its leaves and branches are bare for a short period during January, and flowering starts in February–March. Flowering is mainly on new shoots; emergence of panicles commences in the middle of February and continues up to the 3rd week of May. Opening of flowers starts in the 2nd week of

March. The flowers are mainly staminate and hermaphrodite. Ovary, style, stigma are in both hermaphrodite and male flower but rudimentary

in the latter. Average fruit weight is 350 g with rind thickness of 0.3–0.6 cm, acidity 1.04–4.50 %, and total sugar 4.08–4.47 %.



### 15.8 Germplasm Conservation and Improvement

Breeding and improvement is not studied so far systematically. The plants growing so far or of seed origin and found to have lot of variability which can be used for making selection of superior types. There are two forms: one with large, sweetish fruits and the other with small, acidic fruits.

### 15.9 Ideotypes of Wood Apple

High yielding (more than 500 fruits on 10-year-old plants)  
 Earliness in bearing  
 Dwarf nature  
 Thin shell (thickness less than 0.3 cm)  
 Less fiber  
 High TSS (more than 15 °Brix)  
 Pulp color dark brown  
 Strong aroma

### 15.10 Evaluation

Twenty germplasm lines collected from different places were evaluated at Central Horticultural Experiment Station, Vejalpur (Gujarat). Seed germination ranged from 15.56 to 62.40 %. Survival percentage ranged from 80.00 to 94.00 %. It is observed that germination percentage was higher in ACC No.-2 followed by ACC No.-4 and percent survival was higher in ACC No.-5 followed ACC No.-6 (Table 15.1).

There was significant variation in various parameters like fruit length, fruit diameter, pulp weight, skin weight, TSS, number of seeds, and seed weight. The following were recorded: fruit weight ranged from 187 to 350.53 g, fruit length 71.50–95.06 mm, fruit diameter 69.84–86.00, pulp weight 83.23–155.69 g, skin weight 82.93–164.48 g, TSS ranged from 10.67 °Brix to 14.33 °Brix, number of seed (239.67–505.00), and seed weight 3.00–15.00 g, indicating that there is lot of variability in the species, which needs to be collected and evaluated for identifying high yielding cultivars for commercial cultivation.

**Table 15.1** Germplasm evaluation of wood apple

ACC. no.	Germination (%)	Survival (%)	Fruit wt. (g)	Fruit length (mm)	Fruit dia. (mm)	Pulp wt. (g)	Skin wt. (g)	TSS °Brix	Seed no.	Seed wt. (g)
1	22.88	87.00	289.83	81.90	80.33	106.72	125.86	12.67	409.67	9.00
2	62.40	90.00	257.16	74.73	82.33	83.23	116.84	12.33	262.00	7.00
3	15.56	80.00	217.83	73.06	79.53	92.47	87.72	14.33	505.00	15.00
4	33.47	83.00	215.16	75.13	77.33	92.03	82.93	11.33	224.00	13.07
5	25.16	94.00	350.53	86.20	84.16	155.69	164.48	14.33	451.33	12.67
6	21.14	91.00	328.67	95.06	86.00	148.15	158.42	10.67	239.67	3.99
7	–	–	187.00	71.50	69.84	86.63	86.30	12.50	247.00	7.33
CD at 5 %	–	–	34.13	3.87	7.90	18.45	16.05	1.79	28.45	1.53

Annon (2003)

### 15.11 Vegetative Growth Characteristics of Wood Apple Germplasm

There were significant differences in respect to all the growth parameters of wood apple during the year except stock diameter. Maximum plant height was recorded in line CHES-10 (7.37 m) and least in CHES-11 (5.5 m). Stock and scion diameter was highest in line CHES-1 and least in CHES-11. Plant spread in both North south and east-west direction was maximum in line CHES-8 (5.56 and 5.30 m) and least in line CHES-10 (3.71 and 3.8 m) (Tables 15.2 and 15.3).

There were significant differences among the various characteristics, viz., yield per plant, fruit retention, fruit weight, skull weight, pulp weight, pulp skull ratio, and pulp seed ratio. The clone CHES-2 retained maximum fruit per plant and highest yield per plant (90.40 kg/plant). However, fruit weight was highest in line CHES-4 (627.33 g) followed by CHES-2. The least fruit retention (46.67) and yield per plant (12.97 kg) were recorded in CHES-10 and least fruit weight in CHES-9 (174 g). The least skull weight and pulp weight in were recorded in line CHES-9 (48.13 g and 55 g, respectively). It was highest in CHES-4 (179.33 and 319 g, respectively). Similarly pulp skull ratio and pulp seed ratio were highest in the selections. Based on fruit retention, fruit weight, yield per plant in CHES-2 and CHES-4, they were found to outperform (Table 15.4).

**Table 15.2** Vegetative growth characteristic of wood apple germplasm

Line no.	Plant height (m)	Stock dia. (cm)	Scion dia. (cm)	Plant spread (m)	
				NS	EW
CHES-1	6.12	29.5	26.46	4.38	4.53
CHES-2	6.44	25.36	21.86	4.12	3.91
CHES-3	6.05	23.36	23.43	4.54	4.10
CHES-4	5.95	23.53	23.66	4.72	4.41
CHES-5	6.12	26.36	22.43	4.18	4.10
CHES-6	6.26	26.43	22.43	5.49	5.18
CHES-7	6.37	26.00	25.23	4.65	4.31
CHES-8	7.16	25.46	23.00	5.56	5.30
CHES-9	6.44	26.23	23.73	5.46	5.13
CHES-10	7.37	24.40	23.43	3.71	3.8
CHES-11	5.5	21.53	21.33	4.32	5.2
CD at 5 %	0.297	NS	1.46	0.185	0.194

Hiwale (2013)

There were significant differences among the various characteristics, viz., seed number per fruit, seed weight per fruit, reducing sugar, total sugar, TSS, pulp skull ratio, and pulp seed ratio. The highest seed number and seed weight per fruit were recorded in line CHES-8 (638.33 and 19.33 g, respectively). The superior type CHES-4 and CHES 2 had medium composition. The least seed number and seed weight per fruit were recorded in line CHES-5 (388.33 and 11.67 g, respectively). Reducing sugar and total sugar were highest in superior clones CHES-4 (1.42 and 3.07 %) followed by CHES-2. The results clearly indicated the superiority of clones CHES-4 and CHES 2 in respect to the above

**Table 15.3** Wood apple yield per plant/fruit retention and physical characters of fruit

Line	Fruit no/ plant	Fruit weight g	Yield kg/ plant	Fruit length mm	Fruit dia. mm	Skull weight g	Pulp wt. g	Pulp skull ratio	Pulp seed ratio
CHES-1	106.67	423.33	43.45	85.00	92.66	116.00	178.33	1.54	10.69
CHES-2	206.67	440.00	90.40	88.33	89.33	107.33	185.67	1.73	12.11
CHES-3	87.00	421.00	35.57	87.66	90.00	150.33	211.33	1.41	11.95
CHES-4	134.00	627.33	85.25	96.66	103.66	179.3	319.00	1.78	27.33
CHES-5	181.00	266.33	48.60	79.33	80.66	88.67	98.33	1.11	8.44
CHES-6	141.00	370.33	52.11	83.00	83.67	124.67	156.00	1.25	12.31
CHES-7	114.67	426.00	60.52	82.33	91.90	149.33	217.00	1.46	15.14
CHES-8	72.67	227.00	20.88	76.33	75.00	95.33	151.67	1.59	7.84
CHES-9	402.00	174.00	67.75	69.00	65.00	48.33	55.00	1.14	3.88
CHES-10	46.67	283.33	12.97	78.17	75.67	74.00	126.67	1.71	7.31
CHES-11	73.33	299.33	21.98	75.33	82.67	98.00	136.33	1.88	11.36
CD5%	23.35	53.33	2.37	3.43	4.35	8.12	7.24	–	–

Hiwale (2013)



**Wood apple tree in bearing**



**Bunch bearing in the selection**



**Fruits of CHES selection**



**wood apple germplasm**

**Table 15.4** Fruit analysis

Line	Seed no./fruit	Seed wt. (g)	TSS ° Brix	Acidity (%)	pH	Reducing sugar (%)	Total sugar (%)
CHES-1	516.33	16.67	7.60	2.31	3.47	1.01	2.59
CHES-2	493.67	17.67	11.60	3.25	3.31	1.39	2.17
CHES-3	488.87	15.33	11.00	2.54	3.62	1.11	1.95
CHES-4	570.67	16.67	9.60	2.08	3.48	1.42	3.07
CHES-5	388.33	11.67	9.60	2.31	3.28	1.12	2.90
CHES-6	450.33	12.67	11.00	2.33	3.70	0.99	2.79
CHES-7	574.00	16.00	9.00	2.62	3.72	0.65	2.06
CHES-8	638.33	19.33	6.00	2.54	3.57	1.01	2.83
CHES-9	490.33	14.33	7.30	4.81	3.28	1.03	1.91
CHES-10	449.33	17.33	11.0	3.08	3.51	0.69	2.21
CHES-11	451.33	12.00	5.30	3.65	3.51	0.65	1.77
CD at 5 %	37.41	1.74	1.27	0.196	0.208	0.22	0.20

**Table 15.5** Nutritional composition of wood apple germplasm

Line	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Protein
CHES-1	5.31	0.074	1.38	0.34	0.53	33.58
CHES-2	3.58	0.048	1.87	0.13	0.58	23.45
CHES-3	3.27	0.071	1.61	0.196	0.64	20.56
CHES-4	4.30	0.071	1.76	0.39	0.71	27.36
CHES-5	3.10	0.017	1.55	0.27	0.49	20.41
CHES-6	3.54	0.030	1.36	0.113	0.35	21.63
CHES-7	3.16	0.059	1.62	0.22	0.38	25.42
CHES-8	3.79	0.049	1.76	0.12	0.52	20.84
CHES-9	4.21	0.034	1.41	0.12	0.45	26.41
CHES-10	3.76	0.053	1.29	0.29	0.45	22.61
CHES-11	3.04	0.044	1.26	0.12	0.57	19.69
CD at 5 %	0.204	0.0073	0.14	0.196	0.063	1.701

characteristics. Maximum TSS was observed in line CHES-2 (11.6° Brix) and least in CHES-8 (6° Brix). Percent acidity was highest in line CHES-9 (4.81 %) and least in CHES-4 (2.08 %). The pH of the juice was maximum in line CHES-3 (3.62) and least in CHES-5 and CHES-9 (3.28) (Table 15.5).

## 15.12 Nutritional Composition of Wood Apple Germplasm

Nutritional composition of wood apple indicated that there were significant differences among the various characteristics, viz., N, P, K, Ca, Mg, and protein content. The maximum P, Ca, and Mg content was recorded in clone CHES-4 (0.071 %, 0.39 %, and 0.71 %, respec-

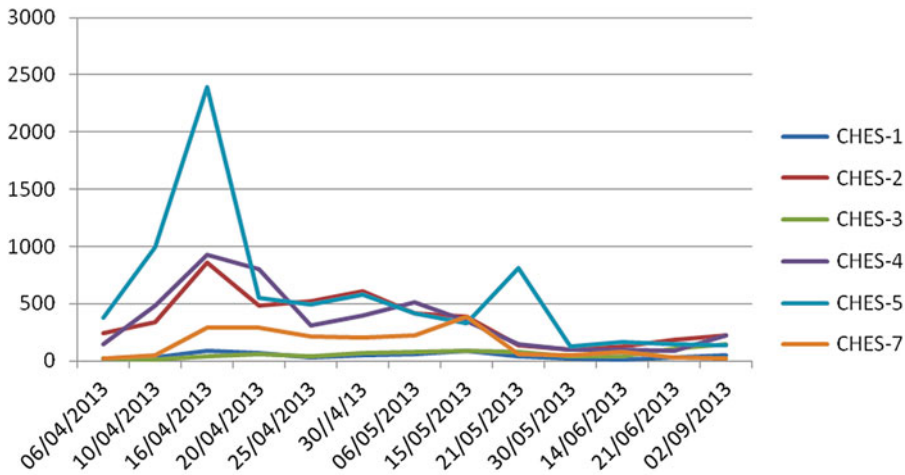
tively). However, the maximum N, K, and protein content was recorded in clone CHES-2 (5.31, 1.87, and 33.58 %). The least N, K, Ca, and protein content was recorded in line CHES-11 (3.04 %, 1.26 %, 0.12, and 19.69 %, respectively), P in line CHES-5 (0.017 %), and Mg in line CHES-6 (0.35 %). The superior clones CHES-4 and CHES 2 had better nutritional composition.

## 15.13 Fruit Drop in Wood Apple

Data on fruit drop at weekly interval showed that heavy fruit drop was recorded in line CHES-5 (no. 7530); least fruit drop was recorded in line CHES-2 which resulted in higher fruit retention and yield per plant followed by CHES-4. The ini-

tiation of fruit drop started immediately after 10 days of fruit set from last week of March. It was at peak during the middle of May and continued

till June. The fruit drop continued due to continuous growth during the hot summer months. Most of the drop occurred at pinhead stage of the fruit.



**Fruit drop in wood apple**

**15.14 Plant Propagation**

Wood apple is mostly propagated from seed, although root cuttings or layers are said to be successful. Multiplication may also be by budding onto self-seedlings to induce dwarfing and precariousness. Recent work done at CHES, Vejalpur, showed that there is scope for softwood grafting for large-scale multiplication of the plants (Table 15.6).

To reduce the gestation period of 12–15 years required for fruiting in wood apple, a successful method of softwood grafting has been standardized. Plants raised from seeds of same species (1 year old) were defoliated 10 days prior to grafting. These scions were grafted (on the 1-year-old) local rootstock seedling. Percent success in

grafting recorded on monthly basis indicated that it was highest when grafting was performed in the months of January and February (48.88 and 53.33 %, respectively) and lowest in December and April (30.24 % and 34.56 %, respectively).

**Table 15.6** Soft wood grafting/budding in wood apple

Time of soft wood grafting	Percent success	
	In grafting	In budding
December	30.24	20.3
January	48.88	27.17
February	53.33	29.83
March	44.28	29.73
April	34.56	24.13
CD at 5 %	13.56	5.21

Hiwale (2008)





**Local root stock**



**Grafted plant**

### 15.14.1 In Situ Softwood Grafting

Wood apple plantation can be established by in situ grafting method. The seeds of local type are collected in October–November and during June are sown in the marked pits in the field (2–3 seeds/pit). The seeds germinate on the onset of monsoon. The growth is slow which takes 8–9

months for the rootstock seedlings to become ready for grafting. The plants are grafted in situ during March when there is leaf fall on the mother tree. The graft starts sprouting after 15 days after grafting. The percent success was as high as 80 %. Thus, the orchard can be established under rainfed condition in semiarid areas (Hiwale 2006).



**In situ softwood grafting**

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## 15.15 Agro-techniques

### 15.15.1 Orchard Establishment

Planting is done during rainy season. Plantation can be done at 8–10 m spacing, which can vary according to soil and climate and growth habit of plant. Alley plantation is possible in wood apple where in it can be cropped with various arable crops to obtain additional income.

### 15.15.2 Irrigation Management

The tree can be grown without any irrigation under rainfed condition. However, irrigating the crop will increase its bearing, fruit size, and ultimately yield. The plants need to be watered in the first year of plantation. After harvesting the fruit in October–November, water should be withheld and plant should be irrigated only after flowering in March. Its water requirement is least.

### 15.15.3 Integrated Nutrient Management

No work so far has been done on this fruit tree species. Leaf analysis done at Central Horticultural Experiment Station, Godhra, revealed that the plant removes substantial quantity of these major nutrients (nitrogen (2.016 %), phosphorus (2.963 ppm), and potassium (2.325 %) content) from soil which needs to be replaced.

### 15.15.4 Canopy Management

The flowering is mainly on new shoots. Old non-bearing trees can be made productive by heading back the branches. As such the shape of the tree is very compact. Infected and dried branches should be regularly removed.

### 15.15.5 Weed Management

Land where the wood apple is to be planted should be free from *Cynodon dactylon* and *Cyperus rotundus*. For controlling these weeds, four spray of glyphosate at 3-month interval should be given. Manual digging and removal of the weed biomass from the field is the best control measure but is expensive. Earthing up of soil at frequent interval will help in controlling other seasonal weeds and also in improving aeration of the soil.

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## 15.16 Harvesting and Yield

Fruit is tested for maturity by dropping it onto a hard surface from a height of 1 ft. Immature fruits bounce, while mature fruits do not. After harvest, the fruit is kept in the sun for 2 weeks to fully ripen. Ripened fruits are known for their typical aroma.

Fruit takes about 210–240 days to mature from flowering. The fruits ripen in 10–15 days after harvesting. Single fruit should be picked. If the fruit is dropped on soil, there is every possibility of fruit cracking and subsequent infection by fungi leading to rotting of fruit during storage. The fruits have very hard skin making it suitable for long storage of 15–20 days without any treatment. It is also easy to handle.

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## 15.17 Marketing and Economics

Mature fruits are harvested and sold in the market as such. The fruits fetch remunerative prices in the market. A 20-year-old seedling plant gives a yield of 500–700 fruits per plant at 10×10 m spacing, there will be 100 plants/ha, which will yield 50,000 fruits and a yield of 12.5 tons per hectare. An income of Rs.25,000–30,000/- can be obtained from the plantation.

There is tremendous export potential for this crop as it can be made into different value-added products and very profitable processing industries could be established.

## 15.18 Value Addition

A good quality stiff jelly of attractive color can be prepared from the pulp. Similarly, wood apple toffee can be prepared by boiling the pulp with sugar. It is also possible to prepare syrup and chutney from wood apple.

### 15.18.1 Wood Apple Syrup

Wood apple syrup can be prepared from pulp. Pulp is extracted from fruit by cracking it and water is mixed with it and is boiled two times. Sugar syrup is added to the extraction to raise the TSS to 13 Brix. The prepared mixture after boiling for 30 min is filled in cans while it is still hot. The cans are sealed and stored at room temperature for about 1.5 years.

### 15.18.2 Jelly

Select fresh, disease-free half ripen fruits and remove the hard cover of the fruit; pulp should be used for making jelly.

Extract juice by adding 1.5 times water to the weight of fruit pulp; use stainless steel and aluminum vessel for storing juice. To preserve juice and its color heat the juice uniformly. Overheating converts pectin into pectic acid; also the color and aroma is lost. Fix the time for which the juice has to be heated. To make jelly transparent, the juice should be extracted by tying in cloth and allowing it to drop on its own. Do not press it by hand. Filter the juice through muslin cloth to maintain the acidity and pectin content. Addition of sugar, acid, and pectin will depend upon the natural sugar, acid, and pectin present in the fruit. For wood apple, 1.5 kg juice, 1.5–1.75 kg sugar is required when it is heated at 104–105 °C. The resultant produce is 1.5–1.75 kg jelly.

Mix the sugar only in boiling juice before adding sugar; prepare its syrup and mix with juice. The juice should be heated till the sugar fully dissolves and acid sugar and pectin blend is achieved.

### 15.18.3 Chutney

Select matured fruits; keep the fruits for 8–10 days so that color of pulp and its aroma develops to its best. Crack them and remove the pulp with seed. To the 1 kg fruit pulp should be mixed with 350 g sugar, 30 g chili powder, 5 g jeera, 5 g pepper, 55 g, 20 g ginger, add pulps with seeds, to the mixture grinder and pack in a well-sterilized bottle or any suitable container. Taste of the chutney develops when storage period increase; its aroma and taste also increases.

### 15.18.4 Plant Protection

In wood apple, there were no serious pests and diseases observed, due to its hardy nature. An infection of the leaves, fruits, twigs, and thorns by *Xanthomonas bilvae* was found, which is also capable in infecting the wood apple (Anon 1956). Other diseases like gummosis caused by aspergillus are also observed but it is not common.

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