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Chironji

A Potential Dry Fruit for Dry Lands

- Sanjay Singh
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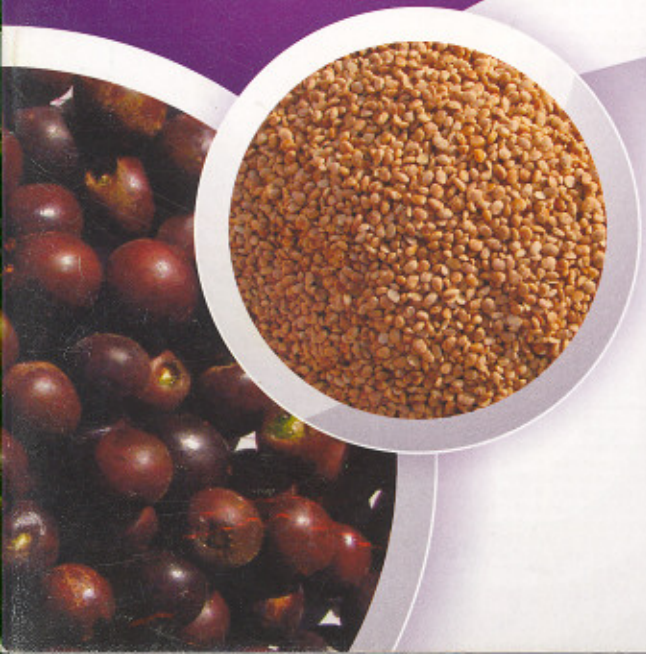
- T. A. More



Central Horticultural Experiment Station
Vejalpur, Panchmahals, (Godhra) 389340, Gujarat

Regional Station of
Central Institute for Arid Horticulture, Bikaner
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FOREWORD

Dr. T. A. More
Director

Chironji or Charoli (*Buchanania lanzan* Spreng.) is excellent tree of agro forestry and social forestry. In the wasteland development and dry land horticulture, it assumes great significance due to its multifarious uses and capacity to withstand adverse climatic conditions. At present, it is growing under forest condition as an under exploited fruit and gives monitory reward to the tribal community of the country and seems to be boon for them. It is valuable species found in dry deciduous forest through out the country excluding eastern Himalayan forests. The flesh of ripe fruit is very palatable and the oily kernels are the most important part and are used in preparation of sweets. Kernel also yields sweet oil, which can be used to substitute olive and almond oil. It provides quality timber wood for various uses.

A wide range of variability occurs with regard to flowering and fruit quality owing to its sexual propagation, which needs to be conserved and exploited. India is emerging as major stakeholder in global horticulture scenario accounting for 10 per cent of world production of fruits. This has been made possible due to the concerted efforts of scientists and progressive farming community.

In recent years, there is considerable awareness about the nutritional security and food safety. More emphasis is given to underutilized fruits due to their high nutritive and medicinal value in addition to being resistant/tolerant to many biotic / abiotic stresses. The demand of this crop is gradually increasing owing to tremendous potential for commercial exploitation aimed at improving the economic status of the poor and marginal farmers.

An area, which needs immediate attention, is the collection, documentation, conservation and utilization for their sustained production and popularization. This bulletin deals with the package of practices for chironji cultivation. It is hoped that, it will be helpful to growers, traders, students, scientists and teachers in playing their role for the chironji production in India.

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(Dr. T. A. More)
Director

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Cover Photographs:
Chironji Tree, Flowering, Fruit Setting, Fruits and Kernals

Introduction

Chironji or Charoli (*Buchanania lanzan* Spreng.) is excellent tree of agro forestry and social forestry. In the wasteland development and dryland horticulture, it assumes great significance due to its multifarious uses and capacity to withstand adverse climatic conditions. At present, it is growing under forest condition as an under exploited fruit and gives monitory reward to the tribal community of the country and seems to be boon for them. It is valuable species found in dry deciduous forest through out the country excluding eastern Himalayan forests (Singh, 1982 and Singh *et al.*,2006). The flesh of ripe fruit is very palatable and is largely eaten raw or roasted and the oily kernels are the most important part and are used in preparation of puddings (Singh, 1982). Mesocarp of fruit is edible and cherished by children (Munde *et al.*, 2003). Very good juice may be prepared from the pulp of chironji fruits. The kernel is highly nutritious and rich in protein (25.0-30.0%) and yields sweet oil, which can be used to substitute olive and almond oil. Kernel contains 33.50 % oil, 1.90 % of which is unsaponifiable. The saponifiable part contained 20.00 % of linoleic acid. Chironji oil is non-repellant and non-toxic and is suitable for human consumption (Banerjee and Jain, 1988). Hemawathy and Prabhakar (1988) reported that total kernel lipid extracted from chironji was 65.60 % of dry kernel and consisted of 90.40 % neutral lipids, 3.4 % glycolipids and 6.2 % phospholipids. The kernels are reported to be used by tribals of Gujarat as brain tonic. An ointment made out of the kernels is used to cure itch of the skin and to remove blemishes from the face. It is also used in diarrhoea and intercostal pains. The bark furnishes a natural varnish and is used in tanning in Kerala. The leaves are reported to be valued for their tonic and cardiotonic properties and their powder is a common medicine for wounds. Chironji provides quality timber wood for various uses.

Present status in India

Information regarding area and production of this fruit in India is not available because it is not grown on plantation scale. They can be seen growing in forest areas. The production in India is mainly concentrated in the drier states and the produce is collected by the villagers and sold in the local market. Kernels are very rich in protein and as such it is being used as a dry fruit for preparation of various food products. Looking in to the importance of the plant, it has tremendous potential for dry land horticulture. Its cultivation may spread to arid and semi- arid areas, resource-poor areas and wastelands.

Origin and distribution

A tree of the dry region is found in north, west and central India. Plants may be seen in forest area of Uttar Pradesh, Madhya Pradesh, Chattishgarh, Maharashtra, Bihar, Jharkhand, Orissa, Andhra Pradesh and Gujarat.

Soil and climate

Chironji is very hardy plant and thrives well on rocky and gravelly red soils. Though it is a very

hardy tree but plants do not survive under waterlogged conditions. It can grow even in pockets of soil between crevices of barren rock. Trees are grown on degraded rocky area including salt-affected soils. However, for its better growth and productivity, well-drained deep loam soil is ideal. It prefers tropical and subtropical climate and can withstand drought admirably.

Botany

Chironji or Charoli (*Buchanania lanzan* Spreng.) belongs to the family anacardiaceae. It is highly heterozygous, cross-pollinated crop and as such seedlings exhibit a wide range of variations. It is a dicot woody plant of deciduous nature. Flowers are typical of family anacardiaceae. Flowering starts in the month of January-February on the well-developed panicles, which have hermaphrodite flowers and they are located on the annular prominent disc and fruit is drupe. Fruits become ready for harvest during the month of April and May. Some of the species of genus *Buchanania* are described below.

Experimental block

Buchanania lanzan

The tree is having 13-18 meter height with straight trunk, young branches clothed with silky hairs. Leaves thickly coriaceous, broadly oblong, obtuse, sometimes emarginate, glabrescent above, more or less villous beneath, reticulately veined, the nerves and veins impressed on the upper surface, base rounded, main nerves 10-20 pairs, petioles long (about 1.2cm). Flowers small, sessile, greenish white, in terminal and axillary pyramidal ferrugineo-pilose panicles which are shorter than the leaves, bracts small, caducous. Calyx lobes short, broadly ovate, ciliate. Petals long, ovate-oblong, subacute, disk fleshy. Stamens 10, a little shorter than the petals, filaments flattened, anthers about as long as the filaments. Ovaries 1 perfect, conical, villous, the other 4 reduced to cylindrical filaments. Drupes obliquely lentiform in the long diameter, black, stone hard, 2 valved.

Buchanania angustifolia

It is a glabrous tree. Leaves thinly coriaceous, linear-oblong, elliptic or elliptic-lanceolate, obtuse or rounded, very often emarginated, quite glabrous, reticulately veined, the nerves and veins slightly prominent on the upper surface, base rounded or acute, main nerves 12-15 pairs, petioles oblong, slender. Flowers in glabrous branched, panicles about equaling the leaves. Calyx-lobes semiorbicular. Petals long, oblong. Fertile ovary pilose. Drupes obliquely globose, slightly compressed.

Methodology for survey and collection of different genotypes of chironji

Diversity rich area of chironji in Panchamahals, Dahod and Vadodara districts of Gujarat were surveyed to select elite genotypes among its population. After conducting survey, promising genotypes were earmarked and multiplied through vegetative propagation and planted at our experimental field. They are being further evaluated for different horticultural traits.

Flowering Behaviour

Reproductive biology

Reproductive biology of the crop was studied at Central Horticultural Experiment Station, Vejalpur, Gujarat. It was observed that peak period of panicle emergence and flowering were recorded in the month of January and February respectively. The peak period of fruit set was recorded in the month of February in majority of genotypes. Highest panicle length (35.11cm) and fruit set per panicle (36.20) were noted in CPT 1. Time taken for complete development of flower ranged from 16-20 days. Peak period of anthesis was recorded between 6-11 am in all the genotypes. None of the genotypes showed anthesis before 4 am and after 2 pm. Anther dehiscence commenced after opening of flowers i.e. at 7 am and continued till 3 pm. Peak period of dehiscence was recorded between 8 am -12 noon in all genotypes. The flower diameter varied from 5.12-6.30 mm. The stamen and carpel length varied from 1.97–2.12 mm and 1.22–1.38 mm respectively. Pollen viability ranged from 54.55-70.38 %. Pollen germination ranged from 20.00 – 35.00 %. Maximum stigma receptivity was recorded in on the day of anthesis. Fruit set / panicle was found to be positively and significantly associated with panicle length and it may be observed while selecting elite genotypes.

Fruit Setting

Genetic diversity

No standard cultivars of chironji are available since a little work has been done to exploit the genetic resources of chironji in India. This crop is facing severe genetic erosion as a result of activities related to deforestation. A number of seedling strains with lot of variation in respect of fruit weight,

total soluble solids, acidity, protein and earliness particularly in Bihar, Uttar Pradesh, Gujarat and Maharashtra provide a good scope for selection of better varieties. A survey was undertaken in Uttar Pradesh to investigate the nature and extent of variability present in chironji seedling progenies for morphological characters of tree and high degree of variability was observed with regard to fruit yield, seed size and chemical composition of the fruit (Rai, 1982). Singh and Chaturvedi, 1983 and Chadhar and Sharma, 1997 surveyed the chironji growing area and recorded significant differences in morphomatrics and yield attributes. An extensive survey and exploration were carried out in Gujarat by Singh *et al.*, 2006. They earmarked thirty promising genotypes and reported that earliest flowering (first week of February) took place in 'CPT 1', 'CPT 5', 'CPT 10', 'CPT 15', 'CPT 17', 'CPT 19' and 'CPT 22', while the latest (4th week of February) occurred in 'CPT 13'. Maximum panicle length (35.11 cm) was found in 'CPT 1', while 'CPT 18' recorded least panicle length (14.20 cm). Ripening time varied from third week of April to second week of May in different genotypes. The highest fruit yield per plant was found in 'CPT 7' (28.00 kg/ plant). With respect to all horticultural traits studied the genotypes, 'CPT 1', 'CPT 2', 'CPT 5', 'CPT 6', 'CPT 7', 'CPT 8', 'CPT 12' and 'CPT 30' were found to be promising. Vegetatively propagated promising genotypes have been planted in the field for their further evaluation.


Diversity rich area of chironji in Chhota Udaipur forest

Floral traits of different chironji genotypes

Genotypes	Panicle length (cm)	Bud diameter at flower opening (mm)	Flower diameter (mm)	Sepal Length (mm)	Sepal breadth (mm)	Petal length (mm)	Petal breadth (mm)	Filament length (mm)
CPT 1	35.11	3.00	6.12	1.25	0.75	2.60	1.11	1.30
CPT 2	25.24	2.13	5.12	1.10	0.78	2.40	1.00	1.20
CPT 3	15.34	3.30	6.16	1.16	0.89	2.70	1.15	1.26
CPT 4	20.12	3.12	6.00	1.19	0.86	2.50	1.00	1.33
CPT 5	25.13	3.16	6.10	1.28	0.90	2.63	1.10	1.30
CPT 6	26.00	2.50	5.13	1.29	0.73	2.49	1.06	1.32

CPT 7	27.10	2.80	5.18	1.10	0.75	2.46	1.16	1.26
CPT 8	26.00	3.60	6.30	1.30	0.83	2.71	1.14	1.24
CPT 9	18.13	2.50	5.13	1.31	0.84	2.51	1.10	1.23
CPT 10	17.34	2.80	5.50	1.15	0.89	2.60	1.00	1.25
CPT 11	20.11	2.86	5.14	1.10	0.79	2.63	1.12	1.26
CPT 12	32.10	2.69	5.40	1.19	0.80	2.61	1.06	1.29
CPT 13	20.00	2.63	5.30	1.26	0.81	2.59	1.08	1.32
CPT 14	17.10	2.90	5.40	1.23	0.83	2.51	1.09	1.24
CPT 15	22.00	3.11	5.41	1.29	0.82	2.52	1.10	1.23
CD (P= 0.05)	2.22	0.18	0.20	0.06	NS	0.09	NS	0.04

Floral traits and pollen characters in different chironji genotypes

Genotypes	Anther length (mm)	Anther breadth (mm)	Stamen length (mm)	Carpel length (mm)	Pollen viability (%)	Pollen germination (%)	Pollen diameter (Micron)
CPT 1	0.75	0.42	2.05	1.25	56.20	26.80	49.10
CPT 2	0.85	0.45	2.05	1.30	55.00	26.20	50.30
CPT 3	0.83	0.43	2.09	1.35	65.20	32.00	50.00
CPT 4	0.72	0.40	2.05	1.22	68.00	32.20	52.02
CPT 5	0.68	0.39	1.97	1.23	70.38	35.00	56.10
CPT 6	0.78	0.38	2.10	1.26	62.10	28.00	59.19
CPT 7	0.73	0.43	1.99	1.28	65.10	30.20	56.00
CPT 8	0.85	0.42	2.09	1.30	58.10	24.29	58.00
CPT 9	0.81	0.43	2.04	1.36	54.55	20.00	59.20
CPT 10	0.83	0.44	2.08	1.32	66.00	27.13	62.10
CPT 11	0.83	0.43	2.10	1.36	67.13	26.00	63.18
CPT 12	0.86	0.46	1.98	1.37	62.10	24.10	61.39
CPT 13	0.82	0.39	2.12	1.38	65.00	24.90	60.00
CPT 14	0.83	0.38	2.08	1.26	66.20	25.50	59.13
CPT 15	0.82	0.37	2.05	1.29	63.00	22.10	62.00
CD (P= 0.05)	NS	NS	0.03	0.05	1.05	1.21	1.24

Fruit quality attributes of different chironji genotypes (Singh *et al.*, 2006)

Genotypes	Source of collection	Fruit weight (g)	Pulp percent	TSS (%)	Vitamin C (mg/100g)
CPT 1	Lunawada Road, Near Panchmahal Dairy, Godhra	1.35	48.88	22.20	51.50
CPT 2	Lunawada Road, Near Panchmahal Dairy, Godhra	1.31	58.02	21.21	46.50
CPT 3	Lunawada Road, Near Panchmahal Dairy, Godhra	1.33	55.63	20.21	58.00
CPT 4	Lunawada Road, Near Panchmahal Dairy, Godhra	1.33	50.37	20.58	57.94
CPT 5	Jambugoda, Kada Dam, Panchamahals	1.25	54.40	19.31	60.50
CPT 6	Jambugoda, Kada Dam, Panchamahals	1.12	61.60	21.84	42.21
CPT 7	Jambugoda, Kada Dam, Panchamahals	1.04	60.57	23.50	46.35
CPT 8	Jambugoda, Kada Dam, Panchamahals	0.98	61.22	23.00	47.00
CPT 9	Jambugoda, Kada Dam, Panchamahals	0.98	50.00	21.00	47.51
CPT 10	Jambugoda, Kada Dam, Panchamahals	0.97	49.48	19.00	55.35
CPT 11	Jambugoda, Kada Dam, Panchamahals	1.09	44.04	21.00	61.31
CPT 12	Jambugoda, Kada Dam, Panchamahals	1.10	53.64	21.10	55.20
CPT 13	Jambugoda, Kada Dam, Panchamahals	1.20	48.33	20.00	57.00
CPT 14	Jambugoda, Kada Dam, Panchamahals	1.30	48.46	20.00	56.00
CPT 15	Jambugoda, Kada Dam, Panchamahals	1.07	53.27	19.50	64.00
CPT 16	Ratan Mahal, Pipergota, Dahod	1.30	58.46	22.00	45.30
CPT 17	Ratan Mahal, Pipergota, Dahod	1.34	61.19	20.00	47.20
CPT 18	Ratan Mahal, Pipergota, Dahod	1.32	61.36	19.80	49.35
CPT 19	Ratan Mahal, Pipergota, Dahod	1.20	61.66	19.90	42.26
CPT 20	Ratan Mahal, Pipergota, Dahod	1.18	55.08	22.10	49.00
CPT 21	Ratan Mahal, Pipergota, Dahod	1.19	57.14	21.00	56.35
CPT 22	Ratan Mahal, Pipergota, Dahod	1.22	60.65	21.20	57.94
CPT 23	Ratan Mahal, Pipergota, Dahod	0.98	62.24	21.50	52.32
CPT 24	Ratan Mahal, Pipergota, Dahod	0.99	54.54	21.30	54.61
CPT 25	Ratan Mahal, Pipergota, Dahod	1.13	62.83	21.40	58.37
CPT 26	Ratan Mahal, Pipergota, Dahod	1.18	62.71	19.40	60.31
CPT 27	Ratan Mahal, Pipergota, Dahod	1.18	56.77	19.80	52.62
CPT 28	Ratan Mahal, Pipergota, Dahod	1.22	59.01	20.10	42.95
CPT 29	Ratan Mahal, Pipergota, Dahod	1.24	57.25	22.12	42.36
CPT 30	Ratan Mahal, Pipergota, Dahod	1.28	58.59	21.50	42.87
CD (P= 0.05)	--------	0.08	1.28	0.74	1.30

Stone and kernel quality of different chironji genotypes (Singh *et al.*, 2006)

Genotypes	Source of collection	Stone weight (g)	Kernel weight (g)	Kernel Percent	Kernel protein (%)
CPT 1	Lunawada Road, Near Panchmahal Dairy, Godhra	0.69	0.14	20.28	28.50
CPT 2	Lunawada Road, Near Panchmahal Dairy, Godhra	0.55	0.13	23.63	30.70
CPT 3	Lunawada Road, Near Panchmahal Dairy, Godhra	0.59	0.12	20.33	29.53
CPT 4	Lunawada Road, Near Panchmahal Dairy, Godhra	0.66	0.10	15.15	26.34
CPT 5	Jambugoda, Kada Dam, Panchamahals	0.57	0.13	22.80	26.00
CPT 6	Jambugoda, Kada Dam, Panchamahals	0.43	0.12	27.90	28.14
CPT 7	Jambugoda, Kada Dam, Panchamahals	0.41	0.09	21.95	30.00
CPT 8	Jambugoda, Kada Dam, Panchamahals	0.38	0.09	23.68	26.77
CPT 9	Jambugoda, Kada Dam, Panchamahals	0.49	0.09	18.36	24.87
CPT 10	Jambugoda, Kada Dam, Panchamahals	0.49	0.11	22.44	27.00
CPT 11	Jambugoda, Kada Dam, Panchamahals	0.61	0.09	14.75	25.10
CPT 12	Jambugoda, Kada Dam, Panchamahals	0.51	0.08	15.68	24.00
CPT 13	Jambugoda, Kada Dam, Panchamahals	0.62	0.10	16.12	23.53
CPT 14	Jambugoda, Kada Dam, Panchamahals	0.67	0.12	17.91	25.90
CPT 15	Jambugoda, Kada Dam, Panchamahals	0.50	0.08	16.00	26.90
CPT 16	Ratan Mahal, Pipergota, Dahod	0.54	0.13	24.07	26.32
CPT 17	Ratan Mahal, Pipergota, Dahod	0.52	0.08	15.38	26.94
CPT 18	Ratan Mahal, Pipergota, Dahod	0.51	0.10	19.61	28.31
CPT 19	Ratan Mahal, Pipergota, Dahod	0.46	0.10	21.73	30.33
CPT 20	Ratan Mahal, Pipergota, Dahod	0.53	0.11	20.75	30.28
CPT 21	Ratan Mahal, Pipergota, Dahod	0.51	0.12	23.52	29.21
CPT 22	Ratan Mahal, Pipergota, Dahod	0.48	0.11	22.91	28.37
CPT 23	Ratan Mahal, Pipergota, Dahod	0.37	0.11	29.73	25.00

CPT 24	Ratan Mahal, Pipergota, Dahod	0.45	0.11	24.44	24.94
CPT 25	Ratan Mahal, Pipergota, Dahod	0.42	0.12	28.57	24.54
CPT 26	Ratan Mahal, Pipergota, Dahod	0.44	0.13	29.55	25.24
CPT 27	Ratan Mahal, Pipergota, Dahod	0.51	0.12	23.52	28.28
CPT 28	Ratan Mahal, Pipergota, Dahod	0.50	0.10	20.00	29.29
CPT 29	Ratan Mahal, Pipergota, Dahod	0.53	0.10	18.86	28.28
CPT 30	Ratan Mahal, Pipergota, Dahod	0.53	0.11	20.75	24.94
CD (P= 0.05)	--------	0.02	0.03	0.26	0.21

Brief characteristics of the important genotypes

CPT-1

This was collected from Lunawada Road, Godhra, Gujarat. The tree has upright growing habit. It is regular bearer and flowers in the first week of February. Peak period of fruit set is third week of February. It ripens in first week of May.

CPT-1

Fruit weight 1.35g, total soluble solids 22.20 %, total sugar 15.14 %, vitamin C 51.50 mg/ 100g, stone weight 0.69 g, kernel weight 0.14 g and kernel protein 28.50%.

CPT-2

CPT-2

This was collected from Lunawada Road Godhra, Gujarat. The tree has spreading growth habit. It is regular bearer and flowers in the second week of February. Peak period of fruit set is fourth week of February. It ripens in second week of May. Fruit weight 1.31g, total soluble solids 21.21 %, total sugar 14.40 %, vitamin C 46.50 mg/ 100g, stone weight 0.55 g, kernel weight 0.13 g and kernel protein 30.70%.

CPT-7

This was collected from Jambugoda, Panchamhals, Gujarat. The tree has spreading growth habit. It is regular bearer and flowers in the second week of February. Peak period of fruit set is fourth

week of February. It ripens in third week of April. Total soluble solids 23.50 %, total sugar 15.61 %, vitamin C 46.35 mg/ 100g, stone weight 0.41 g, kernel weight 0.09 g and kernel protein 30.00 %.

CPT-7

CPT-32

This was collected from Chhota Udaipur, Vadodara, Gujarat. The tree has spreading growth habit. It is regular bearer and flowers in the first week of February. It ripens in fourth week of April. Total soluble solids 22.50 %, total sugar 14.00 %, vitamin C 48.00 mg/ 100g, stone weight 0.40 g and kernel protein 28.00 %.

CPT-32

CPT-33

CPT -33

This was collected from Chhota Udaipur, Vadodara, Gujarat. The tree has spreading growth habit. It is regular bearer and flowers in the second week of February. It ripens in first week of May. Total soluble solids 23.50 %, total sugar 14.50 %, vitamin C 46.54 mg/ 100g, stone weight 0.41 g and kernel protein 29.50 %.

CPT -40

This was collected from Chhota Udaipur, Vadodara, Gujarat. The tree has spreading growth habit. It is regular bearer and flowers in the first week of February. It ripens in second week of May. Total soluble solids 23.00 %, total sugar 15.00 %, vitamin C 50.00 mg/ 100g, stone weight 0.42 g and kernel protein 30.10 %.

CPT-40

Plant propagation

Seed propagation and Raising of seedlings

Chironji plants are generally propagated by seed giving a long gestation period (10-15 years) and large variability. Percent germination in freshly extracted seeds is poor because of hard seed coat on the kernels. Seed germination of 83.00 % within 18 days could be achieved with satisfactory seedling growth by mechanically damaging the stony endocarp before sowing in the month of June, plant survival of 93-96 % with satisfactory plant growth was obtained when one year old seedlings were planted in 60x60x60 cm pit filled with red soil and 10 kg of well rotten farmyard manure coupled with proper mulching around the plants during winter and summer season and with or without thatching (Shukla and Solanki, 2000). Seed treatment with sulphuric acid (5-7 %) was also found very suitable for promotion of seed germination in chironji. The seeds are extracted from tree-ripened fruits during April- May. They can be sown on raised beds at 2-3 cm depth or in polythene bags during June-July and it germinates within 25-35 days. Seedlings are transplanted to 15x 25 cm size, 200- gauge thick perforated polythene bags at 3-5-leaf stage. The polythene bag filling mixture are prepared by mixing with soil and FYM (2:1). The seedlings become ready for grafting after one year from the date of sowing.

Raising of chironji rootstocks

Vegetative propagation

Soft wood grafting

When one-year-old seedlings raised for rootstock commence putting on new growth and the leaves are of light green colour, these are ready for soft wood grafting. Shoots of 3-4 months, which have prominent apical bud, are taken as the scion material. Defoliation of such shoots is done 8-12 days before detaching them from the parent tree for grafting operation. At the time of removal of these shoots, the apical buds should remain intact. The top of the new growth of the stock is cut and the scion is fitted by cleft grafting. The union is

Soft wood grafting

tied with 200-gauge polythene strip. If the selection of scion and rootstock is proper, 60-70 % success may be obtained during the month of July-August.

soft wood grafting

Soft wood grafting *in-situ*

This method was proved to be better for establishing *in-situ* Chironji orchard in gravelly soils and drier tracts where mortality of nursery raised grafts was very high. Freshly extracted seeds are sown in the polythene bags for germination. After attaining height of 5-10 cm, it should be directly planted in the field at the desired distance. These vigorous seedlings, attaining pencil thickness after one year are soft wood grafted with scion sticks of the suitable genotypes. Singh *et al.*, 2007 advocated that about one year old rootstocks should be planted in the field in the month of June for *in-situ* grafting under semi-arid ecosystem of western India. Such plants grow very fast and attain a stature in few years. Main advantages of this method are better plant growth and no mortality.

Standardization of time of softwood grafting in chironji (*Buchanania lanzan* Spreng.) under semi-arid environment of western India

An experiment was conducted to standardize time of softwood grafting in chironji under semi-arid environment of western India during consecutive years of 2005-2006 and 2006-2007 at this station. The grafting was carried out at monthly interval commencing from July 2005 to June 2007. Grafted plants sprouted earliest in July (24.66 days). Highest percentage of graft success was also noted in July (66.66 %) followed by August (40.33) and June (39.00), where as it was recorded least in the month of February (3.33 %). After 150 days of grafting, highest sprout length (35.00 cm) was recorded in the month of March, it was closely followed by July and August. Soft wood grafting in the month of June, July and August may be followed for multiplication of chironji plants under semi arid environment of Western India.

Effect of time of soft wood grafting on bud sprouting, time taken for bud sprout and success per cent.

Treatments	Time taken for bud sprout (Days)	Bud sprout (%)	Success (%)
July	24.66	71.00 (57.42)	66.66 (54.70)
August	25.67	64.00 (53.13)	40.33 (39.41)
September	29.33	26.33 (30.85)	24.00 (29.33)
October	31.67	19.00 (25.84)	17.00 (24.35)
November	0.00	0.00 (0.17)	0.00 (0.17)

December	0.00	0.00 (0.17)	0.00 (0.17)
January	0.00	0.00 (0.17)	0.00 (0.17)
February	30.00	4.33 (11.97)	3.33 (10.47)
March	25.00	40.00 (39.23)	34.33 (35.85)
April	25.00	35.00 (36.27)	29.00 (32.58)
May	27.33	17.67 (24.80)	16.33 (23.81)
June	26.67	44.33 (41.73)	39.00 (38.65)
CD (P=0.05)	1.29	2.24	1.51

Figures in parentheses are transformed values

Effect of time of soft wood grafting on length of sprout and number of leaves per graft.

Treatments	Length of sprout (cm)			Number of leaves per graft		
	90 days	120 days	150 days	90 days	120 days	150 days
July	22.67	26.33	32.00	5.67	11.33	14.33
August	21.67	24.33	30.33	5.00	10.33	14.33
September	17.33	21.67	24.33	4.33	8.67	12.33
October	15.33	20.67	25.33	3.33	8.00	11.33
November	0.00	0.00	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00
February	23.33	26.67	33.00	6.67	11.67	15.67
March	24.33	27.33	35.00	7.67	13.00	16.33
April	23.33	25.67	34.00	7.00	11.67	15.67
May	19.00	23.67	29.33	6.33	11.00	15.67
June	21.67	24.67	27.67	5.67	11.33	14.33
CD (P=0.05)	1.35	0.97	1.40	0.78	0.92	0.75

Effect of time of soft wood grafting on number of sprout per graft and diameter of sprout (cm)

Treatments	Number of sprout per graft			Diameter of sprout (cm)		
	90 days	120 days	150 days	90 days	120 days	150 days
July	1	1.33	1.67	0.90	1.00	1.30
August	1	1	1	0.80	1.00	1.20
September	1	1	1	0.70	0.90	1.10
October	1	1	1	0.60	0.80	1.00
November	0.00	0.00	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00
February	1	1	1	0.60	0.80	1.00

March	1	1.33	1.67	0.91	1.00	1.20
April	1	1.33	1.67	0.90	1.00	1.20
May	1	1	1	0.80	0.90	1.00
June	1	1	1	0.80	0.90	1.00
CD (P=0.05)	NS	0.14	0.12	0.11	0.11	0.10

NS = Non Significant

Wedge grafting *in-situ*

Optimization of period for *in-situ* wedge grafting was attempted. Highest percentage of graft success is recorded when grafting is done in the month of July- August. Better graft success is recorded in the month of July- August because of fast establishment of vascular connection with rootstock and scion. July- August may be the ideal months for multiplication of elite chironji genotypes under semi-arid environment of western India.

***In-situ* wedge grafting**

Root cutting

Experimentally, this method has been tried with varying degree of success. Due to poor viability of seeds and slow growth of seedlings, the *Buchanania* species has not so for been raised in plantations despite the high price of the kernels in the market. Rooting in root cuttings is very difficult, however with the use of auxins, appreciable success may be obtained. Two- year old root cuttings having thickness of 3.6-5.5 cm, treated with IAA 1600 ppm recorded 67.66 % rooting (Singh *et al*., 2002). Root cuttings are found successful, but the method has limited use as it results in serious injury to the mother trees when large number of root cuttings is taken. Moreover, taproot is also absent in the plants that affect the longevity of the plants particularly in degraded lands.

Rootstocks and use of polycontainers

Rootstock selection for vegetative propagation of Chironji is important as it controls the vigour and equilibrium between yield and quality.

Raising of rootstock in nursery beds and lifting budded plants with earth ball in highly sandy soils is practically not feasible. Transportation of plants from long distance may also cause high mortality particularly under semi-arid and arid environment. To reduce the time for raising rootstock and to avoid damage during handling and transportation, polyethylene bags may be used on commercial scale. Generally polyethylene bags (25cm x 15cm) with small holes in bottom filled with porous rooting medium are used for raising the rootstocks. Generally 1-2 seeds are sown in each polythene bags and then placed in trench bed, so that it can be irrigated easily.

Planting:

The seedling plants should be planted 10 m apart, whereas grafted ones 8 m apart. The pits of 1m x 1m x 1m size are dug and filled with a mixture of top soil + 25 kg farmyard manure up to a level of 30

CPT-2

CPT-10

Growth pattern of Chironji genotypes

cm from the ground level. After onset of monsoon, soils are settled and planting is done in the center of the pit during July- August. Drenching of pits with insecticides are required if there is problem of termites.

Training and pruning

Training is very essential to develop the framework of chironji plants. Experimental block at our station was established after following proper canopy management practices. Plants are allowed to grow straight with the help of stakes. The framework should be developed by encouraging the growth of 4-6 well-spaced branches on the trunk at a height of 60-90 cm. from the ground level. Pruning is not performed in chironji plants except removal of dead, diseased and crossing branches.

Manuring and fertilization

A dose of 100g N, 50g P and 75g K/plant should be given to one-year-old plant. It should be increased every year in the same proportion up to the age of 10 years. In addition, 5 kg FYM should be added to 1 year plant, it should be increased @ 5 kg up to 10 years.Thus fully-grown up trees require 50 kg farmyard manure, 1 kg N, 0.5kg P and 0.75 kg K. Farmyard manure should be applied during July-August. Half dose of N and full dose of P and K should be applied in the month of July and remaining dose of N may be applied by the end of August under rainfed conditions. The manure and mixture of fertilizer should be spread under the canopy of plants and be incorporated in the soil. Above dose of fertilizer and manure may be recommended for semi arid regions of western India.

Weed management

Productivity of Indian orchards can be increased only when all the aspects of production technology including weed management are given due consideration. Weeds injure crops very slowly in a subtle way. Most weeds complete their life cycle in a shorter time compared to the fruit trees and compete for light, water and mineral nutrients and reduce yields. In new and old orchard, hoeing, hand weeding and ploughing the land 2-3 times a year is done to suppress weed growth. Intercropping and mulching may also be followed to control weeds.

Intercropping

Intercropping is intended to maximize land and space use efficiency to generate supplemental income particularly during the initial unproductive phase of the orchard to protect the inter space from losses through weeds, erosion, impact of radiation, temperature, wind and water and enriching it by nitrogen fixing legume crops. Compatible crop combination is necessary with regard to species, cultivars, planting method and sequence. Peas, gram, lentil, black gram, cowpea, cluster been may be grown as inter crops in the orchard. However, it needs to be standardized.

Irrigation

Plant can survive under rain fed conditions. If the irrigation facilities are available, basin system of irrigation should be used for young plantations. Irrigation should be given during summer season at the interval of 15 days. Proper moisture after fruit set is important for retention and development of fruits.

Flowering and fruit set

In chironji, flowers appear in the month of January- February in different agro climatic zones of the country. The time taken for complete development of flower varies from 16-20 days. New plantation of grafted plants start flowering after 4th year. The cause of poor fruit set may be due to

Flowering in elite genotype

pollination problem or self-incompatibility. Seedling trees of higher age have better fruit set than the tree of lower age group.

Fruit growth, maturity, harvesting and yield

Singh *et al.*, 2006 studied developmental pattern in chironji genotypes and it was observed that the fruit growth was faster initially and slowed down while reaching towards maturity and followed sigmoid growth curve. Deep purple colour appeared on fruit surface of different genotypes during peak period of ripening. The specific gravity showed increasing trend (more than one) in all the

Fruits after harvest

Chironji Kernels

genotypes during development. Total soluble solids, total sugar, reducing sugar and kernel protein increased as the fruits reached towards the maturity. Titratable acidity showed declining trend during development. Vitamin C increased during development and remained constant till the harvest period. TSS and titratable acidity ranged from 19.50-22.00 and 1.42- 1.50 per cent respectively during ripening. The TSS/ acid ratio was recorded 15.71, 14.68, 13.47, 13.99, 13.73 and 14.69 in CPT 1, CPT 2, CPT 3, CPT 4, CPT 5 and CPT 6 respectively during ripening. On the basis of physio - biochemical attributes, it may be concluded that fruits of CPT 1, CPT 4 and CPT 5 may be harvested by the first week of May and that of CPT 2, CPT 3 and CPT 6 by second week of May under semi- arid ecosystem of western India.

Singh and Singh, 2006 reported that ripening time varied from third week of April to second week of May in different genotypes and highest fruit yield per plant was found in 'CPT 7' (28.00 kg/ plant).

Changes during development of Chironji fruits: CPT-1

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.87	1.10	1.10	G	1.00	---
7/4	1.12	1.12	1.13	G	1.00	---
14/4	1.20	1.16	1.17	L P	1.00	---
21/4	1.30	1.19	1.20	L P	1.00	10.07
28/4	1.34	1.20	1.24	LP	1.00	11.76
5/5	1.37	1.21	1.26	P	1.02	15.04
12/5	1.38	1.21	1.26	P	1.04	15.71
CD (P=0.05)	0.03	0.03	0.02	---	---	0.59

G= Green, LP= Light Purple, P= Purple

Changes during development of Chironji fruits: CPT-2

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.80	1.04	1.06	G	1.00	---
7/4	1.10	1.11	1.12	G	1.00	----
14/4	1.18	1.13	1.15	L P	1.00	---
21/4	1.24	1.17	1.19	LP	1.00	---
28/4	1.30	1.18	1.22	L P	1.00	9.34
5/5	1.32	1.19	1.23	L P	1.01	11.76
12/5	1.34	1.20	1.24	P	1.02	14.42
CD (P=0.05)	0.02	0.02	0.03	---	---	0.62

G= Green, LP= Light Purple, P= Purple

Changes during development of Chironji fruits: CPT-3

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.85	1.10	1.10	G	1.00	---
7/4	1.11	1.11	1.12	G	1.00	---
14/4	1.19	1.15	1.16	L P	1.00	---
21/4	1.28	1.18	1.19	L P	1.00	---
28/4	1.33	1.19	1.23	L P	1.00	9.26
5/5	1.35	1.20	1.25	L P	1.01	10.89
12/5	1.37	1.20	1.25	P	1.03	13.33
CD (P=0.05)	0.02	0.01	0.02	---	---	0.81

G= Green, LP= Light Purple, P= Purple

Changes during development of Chironji fruits: CPT-4

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.90	1.12	1.12	G	1.00	---
7/4	1.15	1.13	1.13	G	1.00	---
14/4	1.23	1.17	1.17	L P	1.00	---
21/4	1.32	1.19	1.19	L P	1.00	9.32
28/4	1.36	1.12	1.21	L P	1.00	12.08
5/5	1.39	1.22	1.22	P	1.02	13.97
12/5	1.39	1.22	1.22	P	1.02	13.99
CD (P=0.05)	0.02	0.03	0.03	---	---	0.75

G= Green, LP= Light Purple, P= Purple

Changes during development of Chironji fruits: CPT-5

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.76	1.00	1.05	G	1.00	---
7/4	1.00	1.08	1.11	G	1.00	----
14/4	1.12	1.10	1.13	L P	1.00	----
21/4	1.20	1.11	1.15	L P	1.00	8.96
28/4	1.25	1.12	1.17	L P	1.00	10.19
5/5	1.30	1.13	1.18	P	1.02	13.40
12/5	1.30	1.13	1.18	P	1.03	13.73
CD (P=0.05)	0.02	0.03	0.02	----	---	0.86

G= Green, LP= Light Purple, P= Purple

Changes during development of Chironji fruits: CPT-6

Sampling dates	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Skin colour	Specific gravity	TSS/Acid ratio
1/4	0.70	0.99	1.00	G	1.00	---
7/4	0.96	1.03	1.08	G	1.00	--
14/4	1.00	1.08	1.10	L P	1.00	---
21/4	1.10	1.10	1.11	L P	1.00	---
28/4	1.14	1.11	1.12	L P	1.00	9.58
5/5	1.18	1.12	1.13	L P	1.01	11.87

12/5	1.20	1.12	1.14	P	1.03	14.49
19/5	1.20	1.12	1.14	P	1.03	14.69
CD (P=0.05)	0.03	0.02	0.02	---	---	0.67

G= Green, LP= Light Purple, P= Purple

Processing and value addition

After completion of ripening, seeds are separated by rubbing in the water and dried. After that, kernels are taken out by breaking of the hard seed coat mechanically and packed either in glass jars or polyethylene bags.

There is tremendous scope for preparing beverages from ripened fruits of chironji. Kernals are being used for preparation of different kinds of sweets. The products like squash, R.T.S and nectar may be prepared from the pulp of the fruit. However, it needs to be standardized.

Marketing

About 75% of the farmers sell their produce at the farm level to the village merchants, retailers, big producers or to the pre harvest contractors. They can not afford to transport their produce to distant markets on account of the non availability of transport facilities, expensive transport, mal practices in the market. Information regarding demand, supply, price, market outlook, knowledge of the consumer's preference, marketing channels are important for marketing of produce.

Plant protection:

Pest management:

Hopper (Sucking pest)

This is the most damaging insect during the flowering season. Both adults and the nymphs damage the crop. They suck the sap from tender shoots and panicles. The panicles wither away and the fruit set is adversely affected. They excrete honeydew, which develops a sooty mould on the leaves and panicles. It can be controlled by spraying with dimethoate (0.03%) or phosphomidon (0.05%) once at the time of panicle emergence and then again at the fruit set stage.

Mealy bug

These insects are characterized by a waxy coating over their bodies. Mealy bugs are found in large number on ventral surface of leaflets, base of leaf petioles, tender shoots and even fruits, and suck cell sap from different parts. The leaflets become chlorotic and fall down and in case of severe infestation, there may also be premature fruit fall. Spraying with 0.03 % dimethoate or phosphomidon (0.05%) is effective to control the pest.

Bark eating caterpillar (*Inderbela* spp.)

Larvae of this moth feed on bark of stem, interrupting translocation of sap and thus the tree becomes weak and unproductive. The caterpillars are 50-60 mm long has pale brown body spins brown silken web on the tree, which consists of their excreta and chewed wood particles. Pest is very active from February to March. It can be controlled by maintaining sanitary situation in the orchard and petrol or dichlorovos (0.1%) should be injected in the hole and be plugged. Foliar sprays with Dimethoate (0.05 %) at tri weekly interval control the pest effectively.

Disease management:

Gummosis

It is found associated with *Fusarium* species. The fungus affects the bark and can penetrate in a limited way in to the wood. In advanced stages, the bark cracks, shreds in lengthwise strips as it dries and gum starts exuding. In case, the disease is detected before the bark covering more than half of the circumference of a stem is damaged, scraping of the affected portions with a little extra healthy tissue without injuring the wood and application of Bordeux paste on the scraped as well as healthy portion around the infected zone, may help in combating the disease and recovery of the plant.

Powdery mildew

During flowering season, in the beginning the appearance of grayish whitish powder on the flower buds, fruitlets and rachis of the panicles denotes the attack of the fungus. In severe cases, the whole panicle appears scorched. Within a few days of first visible symptom, all the panicles get affected. In order to have effective control, 2 sprays of wettable sulphur (2.5 g/litre water) first one at the time of panicle emergence, second after flowering at 15 days intervals is suggested.

Future thrust

There is considerable potential for the expansion of chironji cultivation in India. Therefore, some suggestions for future research priorities are given below.

1. The plant genetic resource (PGR) research needs to be undertaken on the classification of the genetic diversity through use of the morphological, biochemical and molecular techniques. Efforts may be made in using the molecular techniques for understanding the genetic structure of the crop. Promising genotypes having tolerance to the biotic and a biotic stress should be selected.
2. Model nurseries for the local supply of quality plant material should also be established.
3. Information should be made available on chironji based cropping system for different normal and problematic soils.
4. Agro techniques like integrated nutrient management, diversified farming system, high density planting system, weed management, canopy management and irrigation management should be standardized under different ecosystems of the country.

5. Maturity, harvesting, grading, packaging and storage system should also be standardized.
6. There is need to develop new products from chironji kernels and popularize them not only in domestic market but also in international market.
7. Research information on integrated pest management should also be made available.

References

Banerjee, A. and Jain, M. 1988. Investigations on *Buchanania lanzan* Spreng. seed oil. *Fitoterapia*, 59: 406.

Chadhar, S.K. and Sharma, M.C. 1997. Trends in fruit production in *Buchanania lanzan* trees. *Vaniki Sandesh*, 21: 1-3.

Hemawathy, J. and Prabhakar, J.V. 1988. Lipid composition of chironji (*Buchanania lanzan* Spreng.) kernel. *Journal of Food Composition Analysis*, 1: 366-370.

Munde, V.M., Shinde, G.S., Sajindranath, A.K., Prabu, T. and Machewad, P.M. 2003. Correlation and path analysis studies in charoli (*Buchanania lanzan* Spreng.). *South Indian Horticulture*, 50: 517-521.

Rai, Y.C. 1982. *Buchanania lanzan* Spreng. Studies on methods of propagation and estimation of fruit yield. *Indian Forester*, 108: 501-511.93-96.

Shukla, S.K. and Solanki, K.R.2000. Studies on seed germination, plant survival and growth of Chironji (*Buchanania lanzan* Spreng.). *Journal of Tropical Forestry*, 6: 44-49.

Singh, Jagdish, Banerjee, S.K. and Francis, A. 2002. Vegetative propagation of *Buchanania lanzan* Spreng. root cuttings. *Indian Forester*, 128: 700-704.

Singh, R.P. and Chaturvedi, O.P. 1983. Primary production of deciduous forest at Varanasi. *Indian Forester*, 109: 255-260.

Singh, R.V. 1982. Fodder trees of India. Oxford and IBH Publication, New Delhi. PP-663.

Singh, Sanjay, Singh, A.K. and Apparao, V V. 2006. Genetic diversity in Chironji (*Buchanania lanzan* Spreng.) under semi arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences* 76:695-698.

Singh Sanjay, Singh A.K., VV Apparao, Bagle, B.G. and Dhandar, D.G. 2006. Phsio- biochemical changes during fruit development in chironji (*Buchanania lanzan* Spreng.). National symposium on under utilized horticultural crops 8th & 9th June, 2006 at IIHR, Bangalore. pp 78.

Singh Sanjay, Singh A.K. and Bagle, B.G. 2006. Chironji (*Buchanania lanzan* Spreng.).A boon for tribals. *Intensive Agriculture*. March-April, pp35-36.

Singh, Sanjay, Singh, A K and B G Bagle 2007. Propagating chironji by in-situ soft wood grafting. *Indian Horticulture*, May-June, 35-36.

Tewari R K and Bajpai, C K 2001. Propagation of chironji by chip budding. *Agroforestry News Letter*, 13: 1-2.

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