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Buchanania lanzan Spreng (Chironji): An endangered socio-economic forest tree species of Central India

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Abstract
Buchanania lanzan Spreng (Chironji), is a member of the family Anacardiaceae. It exhibits an extensive therapeutic profile which has proven to be a socio-economic boon to the tribal community. Plant parts such as leaves, seeds, bark, and kernels have been shown to retain a variety of metabolites with great potential. Presently, *B. lanzan* is grouped as non-nationalized minor forest produce and widely distributed in the forest regions. Indiscriminate and improper harvesting, climate change, large-scale urbanization and developmental activities, lead to a very severe threat of its existence. It has been classified as a red-listed medicinal plant species of Indian origin, necessitating a comprehensive conservation strategy, as reported by many organisations. The major problem in the reforestation or domestication of this species is the low percentage of seed germination due to hard seed coats, recalcitrant in nature, and fungal contamination associated with the storage of seeds. Vegetative propagation has also not proved successful in this species so far. Thus to augment its sustainable production and conservation, proper research support is an urgent requirement for addressing the problems and further multiplication in the forest area. Also, need to promote awareness among various stakeholders regarding the conservation of this valuable species.

Keywords: *Buchanania lanzan*, medicinal plant, conservation, propagation

1. Introduction
India is home to a massive array and principal repository of an enormous number of medicinal and aromatic plants in the globe. Approximately, over 8000 medicinal plants species are present with speckled ecological habitats in 15 diverse agro-climatic zones of India [1]. Nature has endowed India with a significant amount of medicinal plants, as the country is often referred to as the "Medical Garden" or "Botanical Garden" of the world [2]. Our country has a wealthy record of the traditional healing system, and medicinal plants played an important role in the evolution of the ancient Indian system of medicine. Medicinal plants have been used as a source of medicine in all cultures since ancient times. In addition to being an important source of raw materials for traditional health practices (Unani, Ayurveda, Homeopathy, Siddha, Sowa-Rigpa, Naturopathy, and diverse area and community-specific folk medicine) and the pharmaceutical industry, it also provides a livelihood to a large Indian population [3]. Indigenous and traditional medicine systems using plants have shown potential (directly or indirectly as immune boosters) against many dreaded ailments, including the recent global COVID-19 pandemic. Today, medicinal plants have a very significant place in earning foreign exchange through international trade. Non-timber forest products (NTFPs) account for 70% of India's forest product exports and the demand for phytochemicals is predicted to increase in the future as a new frontier for trade.
In the present scenario, more than 90% of medicinal plants species are facing threat because of excessive and unsustainable collection, overexploitation, or un-skilled harvesting [4]. Among several medicinal plants of India, *Buchanania lanzan*, a member of the family Anacardiaceae is currently facing a severe threat of extinction [5]. This plant is locally known as many vernacular names such as Char, Achar, Charoli, Chawar, and Priyal by tribal peoples' of the country. This plant is very useful and has myriad use with medicinal value. Seed, kernel, and leaves are rich in nutrients and phytochemicals with high medicinal value. It is an excellent fruit tree of agro-forestry and social forestry and growing under forest conditions that can withstand unfavorable climatic conditions. It is an under-exploited fruit crop and gives monetary reward to the tribal community of the count yard seems to be a boon for them [6].

2. Origin and distribution

B. lanzan is native to the Indian sub-continent and is also found in Vietnam, Thailand, Laos, Burma, and Yunnan. The tree is almost evergreen and grows naturally in the tropical dry deciduous forests of Northern, Western, and Central India, mainly in the states of Madhya Pradesh, Chhattisgarh, Jharkhand, Uttar Pradesh, Maharashtra, Bihar, Orissa, Jharkhand, Andhra Pradesh, Rajasthan, and Gujarat. The occurrence of Chironji in central India is concentrated largely in Sal and teak growing region comprising, Betul, Mandla, Balaghat, Seoni, Amarkantak, Dindori, Annuppur, Bastar, Reewa, Satana, Dantewada, Kanker, Kondagoan, Raipur and Sarguja. Survey and collection of *B. lanzan* unveiled that natural wild trees are prevailing in small populations of 10–15 trees in the forest and occasionally isolated 1–2 trees were seen in the farmers' field near the marginal forest lands (Figure 1).

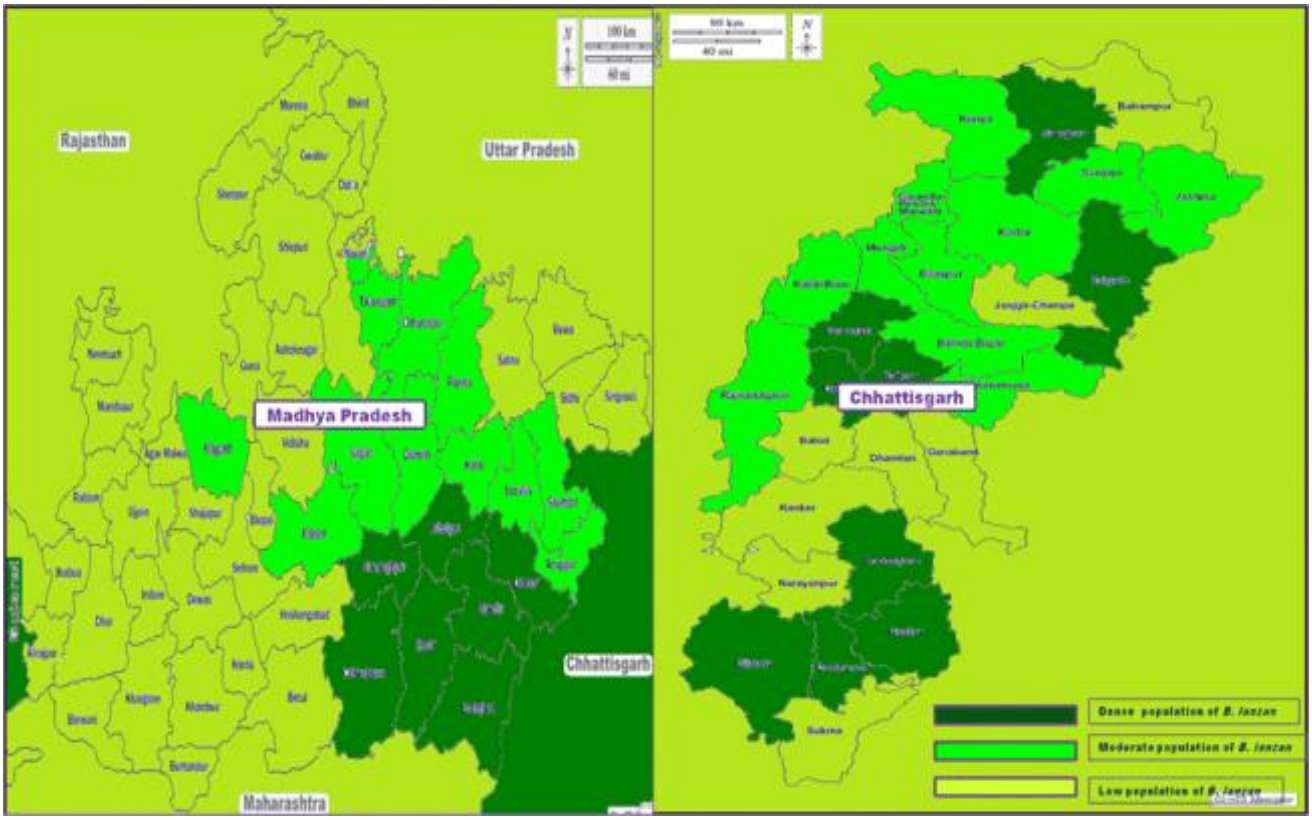

Fig 1: Population status of *Buchanania lanzan* in Central India

Classification, Botany, and taxonomy of *Buchanania lanzan*

Taxonomical classification

Kingdom	:	Plantae
Subkingdom	:	Viridiplantae
Phylum	:	Tracheophyta
Superdivision	:	Embryophyta
Division	:	Tracheophyta
Class	:	Magnoliopsida
Order	:	Sapindales
Family	:	Anacardiaceae
Genus	:	*Buchanania*
Species	:	*Lanzan*

Vernacular Names

Buchanania lanzan is known by several names in different parts of the country.

Common name	:	Calumpng nut, Almondette tree, Cheronjee, Cuddapah almond
Hindi	:	Chironji Piyal, Piar, Char
Kannada	:	Charoli, Kole maavu, Murkali
Tamil	:	Saraiparuppu, Moraetha, Morala, Mudaima, Moraimaram
Telugu	:	Sarapappu, Morli, Sara, Jarumamidi
Oria	:	Char
Sanskrit	:	Priyala
Marathi	:	Charoli
Malayalam	:	Kalamavu, Moongapezhu, Mungapera, Mural, Priyalam, Nooramaram, Padacheru, Nuramaram

3. Taxonomy and botany

B. lanzan is a highly heterozygous, cross-pollinated species and pollination occurs through flies, wasps, butterflies, ants, bees, and beetles as well as by wind. Cross-pollination is occur due to differences in the maturity of sex organs. Plant is highly heterozygous and sown a wide range of agro-morphological and genetic variations [7]. *B. lanzan* is a diploid species and have 2n=22 chromosome. The plant shows an alternate bearing habit of fruit such as pistachionut, mang, olive etc. According to the Catalog of Life, accepted the botanical name of chironji is *Buchanania cochinchinensis* (Lour.) Almeida. The trees are found in the Rocky Mountains, wastelands, farmlands as well as widely scattered in forests, and hence it takes 8-10 years for fruiting. Eight species of *Buchanania* have been reported in India out of which two species viz., *B. axillaries* (Syn. *B. angustifolia*) and *B. lanzan* (Syn. *B. latifolia*) produce edible fruits. It is reported that the fruits of *B. platyneura* are also edible. Apart from these, *B. lanceolata* is another endangered species found in the evergreen forests of Kerala while B. *platyneura* is found in

Andaman only. Other species of the genus are *B. accuminata*, B. *glabra*, and *B. lucida*. The *B. exillaris* are reported to be dwarf in size and produce excellent quality kernels [8].

Plants usually attain a height up to 18m and a circumference of 1.5m. Seedlings and plants show a wide range of variation and have a distinctive dark gray bark with a red blaze on the trunk [5] (Figure-2). It is dicot woody plants constitutes of leaves which are thickly coriaceous, broadly oblong, obtuse, reticulately veined, the nerves and veins impressed on the upper surface, base rounded, main nerves 10-20 pairs, petioles long. The inflorescences are hermaphrodites with well-developed panicles located on the terminal and lateral droop. The flowers are small, sessile, greenish-white in colour, in the terminal and axillary pyramidal ferrugineo-pilose panicles, and bisexual attaining a diameter of 6.11mm. A single panicle bears about 3000-5000 flowers. When buds start growing externally, it takes 18-28 days to anthesis and around 3 percent fruit sets. Flowering starts in January to March on the well-developed panicles and fruits ripe in May–June for harvesting[9]. The fruit is a drupe which is yellowish-red in colour with a weight of 1.15g consisting of 23.90º Brix TSS, 57.6% pulp, and 48.70mg/100mg vitamin C [10]. Single seeded fruits emerge in February and mature in May and June, while fruit collection started in mid-April and ends by mid-June [11].

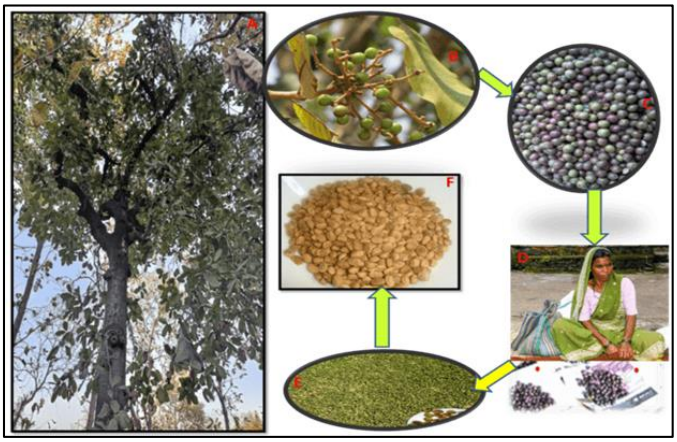

Fig 2: *Buchanania lanzan*: (a) Natural wild population in the forest area of Madhya Pradesh (b) Unripe fruits in a tree branch, (C) Freshly harvested mature fruits, (d) Fruits are ready to sell in the local market, (e) Deplumed stones of chironji being dried for extracting kernels

4. Current status and Socio-economic importance

B. lanzan is a socio-economically and medicinally important underutilized fruit and life support species of tribal populations of central India. Total cultivable area and production of chironji is not known and currently no cultivation practices have been standardized in India. The plant is underexploited, not grown on a plantation scale, and has limitations in forest areas. The production in India is mainly concentrated in the drier states and fruits are directly plucked from the naturally wild-growing trees by the villagers and sold in the local market. Its cultivation may spread to semi-arid areas, resource-poor areas, wastelands and Rocky Mountains. In MP and Chhattisgarh, *B. lanzan* is non-nationalized Non-Wood Forest Produce, and collection and sale are done by MP and CG Minor Forest Produce Federation only. These agencies have a network for the collection of superior quality Non-Nationalized Non-Wood Forest Produce (NWFP). The estimated annual trade of chironji is 100-200 MT per year at the national level (NMPB, GoI, India). Its price varies and depends on its size and quality. The average price of Chironji ranges from Rs. 700 to 1200 per kg [12]. The demand of Betul and Bastar chironji is high in the national market and now it becomes a rare commodity and fetches higher prices more than Rs. 1000 per kg [13]. According to M.P. State Minor Forest Produce (T & D) Co-op. Fed .Ltd. Bhopal ~466 quintals chironji is produced per year by Madhya Pradesh and contributing ~50 percent of national production [14]. Kernels of chironji were also exported to several European and Asian countries and earned foreign exchange.

Now a day's genetic diversity of *B. lanzan* is subjected to severe genetic erosion due to extensive urbanization and underlying developmental activities carried out in tribal populated areas of states possessing this species' natural population [15]. The inhabitants of the region do not prefer to cultivate it in their fields or farmland and prefer to take advantage of the natural wild population for a variety of commercial purposes. Thus, the natural populations found in the forests and marginal lands of chironji face a grave threat of extinction.

Chironji's myriad uses and benefits have grown exponentially in demand, especially among tribal communities of the country. A variety of non-traditional cropping practices, reduce re-introduction, high biotic pressure, and over-exploitation caused it's to run out from forest and non-forest areas which has caused the genus to be on the edge of extinction [5]. From the past couple of years, due to lack of appropriate and effective harvesting techniques and ignorance in the tribes about his unique properties such as nutritional and therapeutic values may lead to an increase in deforestation resulting in the extinction of this important forest produce. Even though these plants grow in wild and have been overlooked. Therefore, the conservation, cultivation, and promotion of this plant species are very crucial for nutritional, medicinal, and economic purposes. This increased overexploitation has landed it in International Union for Conservation of Nature and Natural Resources' Red Data Book. It is one of the 195 red-listed medicinal plant species of Indian origin that must be protected as reported by the Foundation of Revitalization of Local Health Tradition (FRLHT), Environmental Information System (ENVIS)–Centre on Medicinal Plants, Bangalore, Government of India [5]. The low proportion of seed germination caused by the hard seed coat, which is recalcitrant, and fungal contamination associated with seed storage is the main issue in chironji reforestation or domestication.

It is the backbone and source of income for the tribal people of Central India. They often consume and sell very nutritious seeds to sustain themselves and also to earn their livelihood. Fresh fruit is eaten raw and has a nice, sweetish, sub-acid flavor and consumed by tribal's and also sold in the local market. Chironji kernels have an almond-like flavor and are consumed in raw or roasted form. They are used as a culinary spice and dry fruit in desserts, Kheer, Meaty korma in India. All parts of the plant such as roots, leaves, gum, bark, and fruits have various therapeutic applications. Chironji seeds are rich in nutrients and have anti-inflammatory qualities. It is an active source of phenolics, natural antioxidants, fatty acids, and minerals. Its seed oil is used to cure skin diseases and to remove facial spots and blemishes. Ethanolic and methanolic extracts of chironji roots have shown considerable wound healing, anti-diarrheal activity [16].

5. Nutritional and phytochemical composition of chironji

Seeds of *B. lanzan* are rich in fatty oil (34-37%), lipids (59.0%), proteins (19.0-21.6%), carbohydrates (12.1%), fiber (3.8%), calcium (279mg), thiamin (0.69mg), ascorbic acid/vitamin C (5.0 mg) and niacin (1.50mg) [9]. The nutritional and phytochemical composition of chironji is shown in Table 1. The fatty oil obtained is known as 'chironji oil' which is a suitable alternative for olive and almond oil. The oil is also used as an expectorant and in confectionery. The kernels have pistachio and almond taste and are often eaten raw or roasted. Various skin disorders are treated with the oil obtained from the kernels [17]. It is used to relieve itch and prickly heat with an ointment made from the kernel. The fruits have laxative properties and are used to cure thirst, fever, cough, and asthma. The roots are used as an expectorant to treat diarrhea, biliousness, and blood disorders. The methanolic extract of the roots has anti-inflammatory and analgesic effects [18, 9]. The leaf juice consists of 2.64% tannins, tri-terpenoids, saponins, flavonoids, and reducing sugars. As a result, it is used as an aphrodisiac, purgative, blood cleanser, and thirst quencher. It can also be useful in treating a variety of digestive disorders. The bark contains 13.4% tannins and the gum obtained from the cut-bark is water-soluble, making it a useful remedy for intercostal pain and diarrhea when combined with goat milk. It is also used in the refining of tobacco and the adulteration of guggul (*Commiphora wightii*) by the addition of scent. High-quality gum is used in soft drinks and edible coloring. The wood is termite-resistant and cheap, making it ideal for manufacturing furniture, boxes, and agricultural equipment [5].

Table 1: Nutritional and Phytochemical Composition of *B. lanzan*

Nutritional and Phytochemical Composition	Value	Plant Parts	Reference
Nutritional Component			
Calcium (mg/100g)	279.0	Seeds	19
Calories (K cal)	229.99	Seeds	16
Copper(mg/100g)	1.50	Seeds	16
Iron (mg/100g)	8.50	Seeds	19
Magnesium(mg/100g)	275.00	Seeds	16
Manganese(mg/100g)	1.60	Seeds	16
Phosphorus (mg/100g)	528.0	Seeds	19
Total Carbohydrate (%)	12.96	Seeds	16
Total Fat(%)	59.00	Seeds	19
Fibre(%)	18.50	Seeds	3
Zinc(mg/100g)	3.32	Seeds	16
Proteins (%)	63-72	Kernel	20
Starch(%)	12.10	Fresh Flower	20
Fats (%)	59.00	Kernel	20
Niacin(mg/100g) (mg/100g)	1.50	Kernel	19
Vitamin like Thiamine(mg/100g)	0.69	Kernel	19
Oil (%)	34-47	Seeds	19
Riboflavin(mg/100g)	0.53	Kernel	19
Vitamin C (mg/100g)	5.0	Seeds	19
Oil	52.0	Kernel	20
Fatty Acids			
Myristic Acid (%)	0.41	Seeds	16
Palmitic Acid (%)	31.28	Seeds	16
Stearic Acid (%)	5.16	Seeds	16
Arachidic Acid (%)	0.45	Seeds	16
Lignoseric Acid(%)	0.10	Seeds	16
Palmitoleic Acid (C16: 1) (%)	0.76	Seeds	16
Oleic Acid (C18: 1) (%)	55.17	Seeds	16
Cis 11-Eicosanoic Acid (C20:1) (ω-9) (%)	0.16	Seeds	16
Linolenic Acid (C18: 3) (ω-3) (%)	0.26	Seeds	16
Linoleic Acid (C18: 2) (ω-6) (%)	6.24	Seeds	16
Phyto-chemicals			
Tannin	13.4	Bark	17
Polyphenols	-	Leaves	21
Flavonoids,	-	Leaves	22
Alkaloid	-	Leaves	22
Saponins	-	Leaves and Bark	22
Dipalmitoolein (%)	22.7	Seeds	19
Dioleopalmitin (%)	31.0	Seeds	19
Triolein (%)	11.3	Seeds	19
Quercetin-3-Rahmnoglucoside	-	Leaves	22
Kaempferol-7-O'glucosides,	-	Leaves	21
Kaemferol	-	Leaves	21
Myricetin-3'-Rhmnoside-3-Galactoside	-	Leaves	21

6. Medicinal and therapeutic uses of *b. Lanzan*

B. lanzan exhibits an extensive therapeutic profile which has proven to be a financial boon to the tribal community (Table 2). Plant parts such as leaves, seeds, bark, and kernels have

been shown to retain a variety of metabolites with great potential.

Table 2: Medicinal uses of different plant parts of *B. lanzan*

Medicinal Uses	Parts used	Reference
Skin problem	Leaves	19,23
Remove spots from skin and blemishes	Seed oil	18
Anti-snake venom activity	Bark	5,19
Wound healing property	Root	19
Alzheimer's,	Kernel	19
Blood dysentery	Seed oil	18
Reduce mycotoxin	Bark	24, 19
Wound healing property	Root	19
Memory booster	Kernel	25,19
Skin problem	Leaves	23, 19
Depurative	Bark	26
Constipating	Bark	28, 26
Brain tonic	Bark	27
Cardiotonic	Bark	27
Glandular swelling	Bark	27
Intrinsic hemorrhage	leaf decoction	26
Fever and burning sensation.	leaf decoction	26
Blood dysentery	Powder of the bark	29
Antidiabetic	Leaf Extract	29
Wound healing activity	Ethanolic Leaf Extract	29
Adaptogenic activity	Methanolic Extract	29

7. Improvement initiatives in *B. Lanzan*

B. lanzan is a cross-pollinated and highly heterozygous plant, contributes to huge genetic variation. A wide range of variability occurs with regards to flowering and fruit quality owing to its sexual reproduction, which needs to be conserved and exploited. Malik *et al.* surveyed and collected 72 indigenous *B. lanzan* accessions from diversity–rich areas of Madhya Pradesh, Gujarat, Chhattisgarh, and Rajasthan [24]. They characterized 52 accessions for fruit, stone, and kernel characters as well as quantitative characters and showed huge genetic variability. Furthermore, accessions IC-552921, IC-552924, IC-546107, IC-546109, and IC-553215, were found as superior genotypes.

Singh *et al.* compared the performance of *B. lanzan* 30 genotypes grown at Experimental Farm of Central Horticultural Experiment Station (CIAH), Vejalpur, Panchmahals (Godhra), Gujarat, India under rainfed hot semi-arid habitat [7]. Plant height, rootstock girth, plant spread (East-West), and plant spread (North-South) ranged from 5.96-1.63 metres, 23.99-53.38 metres, 1.40-5.10 metres, and 1.50-5.38 metres, respectively. Flowering and fruit set occurred during the first and third weeks of February and the third and second weeks of March, respectively. The longest panicle (35.13 cm) was found in CHESC1, whereas the number of fruits per panicle was found in CHESC7. The highest ripening phase was seen in all genotypes in May. Fruit production, fruit weight, pulp percentage, TSS, acidity, total sugar, and vitamin C levels ranged from 1.00 kg-11.00 kg/plant, 0.94g-1.34g, 43.52-63.06 percent, 19.05-23.900 Brix, 1.00-1.34 percent, 13.01-15.51, and 42.24-64.09 percent, respectively. Stone weight, shell weight, kernel weight, and protein content, respectively, varied from 0.38 to 0.68 g, 0.27 to 0.55 g, 0.08 to 0.15 g, and 23.53 to 31.36 percent. The genotypes CHESC7, CHESC2, CHESC4, and CHESC11 were found to be promising in rainfed hot semi-arid climates in western India based on the horticultural attributes studied. Thar Priya, a genotype CHESC7, was published as a variety.

In Chhattisgarh, Niratker, and Sailaja [30] investigated morpho-physiological variations among 27 wild *B. lanzan* genotypes. They analyzed the variance for six traits *viz*., fruit size, fruit color, seed purity, seed weight, seed moisture content, and germination percentage. The analysis of variance revealed large significant differences, showing that all characters had a lot of morphological variation. Based on morphological and physio-chemical characters along with quality parameters, Changdev and Ahir, assessed the 25 native *B. lanzan* genotypes from Dhadgoan Tehsil in Satpuda hill of MP[31]. The studied genotypes showed wide variability for morphological traits such as foliage (dense and sparse), growth habit (spreading and upright), leaf colour (light green to dark green), leaf morphology (oblong, ovate, and elliptic), stem colour (dark grey to black), early flowering (2nd week of February), fruiting (4th week of February), harvesting (4th week of April) and also flat fruit shape.

8. Conservation strategies used for *B. Lanzan*

In order to preserve the existing diversity and conservation of chironji germplasm, both in-situ and ex-situ techniques must be applied. In the current endangered situation of this species, the best approaches for germplasm conservation is to use of both ex-situ (field gene banks and cryobanking) as well as in-situ conservation (on-farm conservation and protected places like as National Parks). Currently, ex-situ field gene banks are being established at regional Horticulture Research Institute of ICAR-CIAH at Godhra, Gujarat, and Lucknow, Uttar Pradesh, for the development of mass multiplication propagation methods and germplasm conservation. Unique and superior germplasm has been cryogenically stored as a base collection reflecting significant variability in the form of 127 accessions at the National Cryogene Bank at NBPGR, New Delhi, for prosperity and future use [24].

9. Seed propagation and Raising of seedlings

Chironji plants are usually multiplied through seed and which has shown high genetic variation. Presence of strong seed coat on the kernels and less viability of the seed germination percentage is low as compared to other forest plant species. Although, mechanically scraping of seed coat and sowing in the month of June is preferable for getting high percentage of the germination of the seeds. One-year-old chironji seedlings planted in a 60x60x60 cm pits filled with red soil and 10 kg of well rotten FYM, along with proper mulching around the plants during the winter and summer seasons, ~93-96 percent seedlings were survives with satisfactory plant growth [32]. Seed treatment with 5-7 percent sulphuric acid was also shown to be effective in enhancing chironji seed germination. Raised bed nursery or polythene bags are most effective methods for raising the seedlings. During June-July, seed are shown 30 cm in open raised bed nurseries and germination will occurs in 25-35 days. One year raised bed old seedlings are used for grafting purpose. In a study conducted by Shukla *et al*. on enhancing the germination percentage of chironji and found that soaking seeds in ordinary water for 48 hours resulted in 71 percent seed germination while mechanical cracking of the stony endocarp, resulted in 83 percent germination [33]. Mechanical breaking, on the other hand, is time-consuming and has a significant chance of damaging the embryo. Seeds are highly prone to lose their viability but may also be preserved for up to a year in airtight containers. In chironji, Choubey *et al*. found that 1 percent $HgCl_2$ treatment resulted in the best germination [34].

10. Vegetative propagation

Chip budding [35] and softwood grafting [11] are two successfully reported vegetative propagation procedures that has been standardized in Chironji. However, due to lack of round the year rootstock availability and a reliance on seasonal conditions, these methods are less successful. Furthermore, root cutting is another approach for vegetative propagation but require more time and less effective for commercial scale propagation [36].

Various methods like in-situ and ex-situ approaches are used be implemented to conserve the germplasm [37]. The technique of micropropagation has proved to be one of the best methods for conservation because it is faster, efficient, unaffected by weather conditions, produces superior plantation stocks [38]. Tissue culture has been used to generate genetic variability in the crop plants which is employed to improve the state of health of the planted material and to enhance the number of desirable germplasm available. Tissue-culture based propagation approaches are available for many agricultural species, while many crops, particularly cereals and woody plants, still require some improvement [39]. Sharma *et al.* developed a protocol for *B. lanzan* somatic embryogenesis and plantlet regeneration using immature zygotic embryos cultured on Murashige and Skoog (MS) medium supplemented with various combinations of 2,4 dichloro phenoxy acetic acid (2,4-D), 6-benzyl adenine (BA), and/or 1-naphthalene acetic acid (NAA) [37]. Somatic embryo induction was seen at the greatest frequency (60%) in cells inoculated on MS media supplemented with 4.53 µM 2,4-D, 5.32 µM NAA, and 4.48 µM BA. For the maturation and germination of somatic embryos, the medium supplemented with 15 µM abscisic acid (ABA) was the most efficient. Shende and Rai claimed to develop tissue culture technology for fast clonal proliferation of Chironji [38]. They inoculated decoated seeds on MS media supplemented with varying concentration of auxins and cytokinins alone or in combination, and obtained multiple shoot initiation. The highest number of shoots were obtained on Murashige-Skoog (MS) medium supplemented with 22.2 µM BAP and 5.37 µM NAA. Furthermore, MS medium with 23.3 µM kinetin induced rooting in profused shoots. In vitro multiple shoot inductions from shoot tips and nodal segments explants in half-strength MS m supplemented with 1 mg/l BAP and 0.5 mg/l IAA were obtained by Niratker [30]. The meristematic end of plants, such as the stem tip, auxiliary bud tip, and root tip, are most widely used explants tissue in chironji. These tissues have high cell division rates and either concentrate or create growth-regulating chemicals like as auxins and cytokinins [40].

11. Conclusion

This species has a significant socioeconomic importance in terms of providing a source of income for tribal people. Unfortunately due to excessive utilization, casual harvesting (lopping and cutting), climate change, large scale urbanization, developmental activities undertaken in the tribal inhabited areas of states holding a natural population of this species, insect pest and no or very less natural regeneration potential causing considerable reduction in the population of this plant. It is a highly heterozygous plant, which is cross-pollinated contributes to genetic variation. An area, which needs immediate attention, is the collection, documentation, conservation and utilization for their sustainable production and popularization. There is an urgent need to develop a technology that allows for easy multiplication, regeneration, and conservation of the species while also imparting and disseminating proper knowledge and education to the tribal population in order to stop destructive harvesting and raise awareness about the collection of ripe fruits at the appropriate times.

12. Acknowledgements

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13. Conflict of interest: There is no conflict of interest.

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