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# Conservation and Seed Quality enhancement of *Buchanania lanzan* Spreng: an endangered NWFP species of Madhya Pradesh

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**ABSTRACT: *Buchanania lanzan* Spreng. is an important underutilized fruit tree species. At present, it is grouped as non-nationalized minor forest produce, so it is free for collection. Indiscriminate harvesting, climate change, large-scale urbanization, and developmental activities, pose a very severe threat to its extinction. This species has a scattered distribution in forest areas. Local people are doing unscientific harvesting of this species, such as cutting the whole trees, and heavy lopping of branches for the collection of seeds from trees. Long gestation period (15-20 years) and large variability, low germination of seeds due to hard seed coats, recalcitrant in nature, and fungal contamination associated with the storage of seeds are the other major problems associated with this species. It require special treatments, for overcoming dormancy with better vegetative growth. The application and effectiveness of pre-treatment such as scarification (physical and chemical using acid) in this species have been reported in many studies. But the chances to damaging delicate embryos and the harmful ecological and biological impacts of mechanical and acid treatment push us to find new alternatives. Seed enhancement technologies (SETs), such as pre-sowing, pre-storage, and mid-storage treatments, are widely practiced in present-day seed science and technology in the agriculture sector but have found very little application in forest tree seed improvements. As a result, there is a lot of room for these technologies to be used to improve this potentially profitable economic species. Thus in order to augment its sustainable production, and livelihood security, and fullest utilization of species : need to awareness among the people for conservation of trees, proper research support on the application of many new SETs is the need of the hour for conservation and up-gradation of seed quality of this vulnerable NWFP species. This review aims to present an overview of the currently available SETs along with the present status of research and development in this potential economic but vulnerable NWFP species of Madhya Pradesh.**

**Keywords:** Seed quality enhancement (SQE), Seed Enhancement Technologies (SETs), Non-Wood Forest Products (NWFP), Seed Priming, *Buchanania lanzan*, conservation.

## INTRODUCTION

*Buchanania lanzan* Spreng. (Chironji) is a socio-economically important underutilized fruit tree species, locally known as 'Char' by the tribal people of Madhya Pradesh. It is an excellent fruit tree of agro-forestry and social forestry. It is growing under forest conditions at present as an underexploited fruit crop and gives monetary reward to the tribal community of the count yard, which seems to be a boon for them. Fresh fruit is eaten rawand hasa pleasant flavor. Kernels havean almond-like flavor, eaten in raw or roasted form or as dry fruit in sweets (kheer) in India. About seven species of *Buchanania* have been reported in India, of which *Buchanania lanzan* and *Buchanania axillaries* (Syn. *Angustifolia*) produce edible fruits. *Buchanania lanceolata*, an endangered species, is found in the evergreen forests of Kerala while *Buchanania platyneura* is found in the Andaman Islands. Other species of the genus are *Buchanania lucida*, *Buchanania glabra*,and *Buchanania accuminata*. It seems to have originated in the Indian sub-continent. Besides India, the plant is found distributed in other tropical Asian countries, Australia, and Pacific islands also. Recently, *Buchanania lanzan* var. palodensis, a new variety is described and illustrated from Kerala (India). It differs from the typical variety by the smooth or slightly fissured bark, obovate to narrowly obovate leaves, faintly visible secondary and tertiary nerves, pedicellate flowers, broadly ovate bracts, suborbicular bracteoles and the depressed globose pinkish fruits at maturity (Santhosh *et al.,* 2020). This species has a high socio-economic value for providing livelihood to the tribal population of the area besides possessing enormous potential as commercial horticultural species. The seeds/kernels of the plant yield fatty oil, which is a substitute for olive and almond oils and is widely used in confectionary as well as in Indigenenous Medicine System (IMS) (Prasad, 2020).

Awasthi and Nisha (2020) discuss the cultivation, uses, chemical constituents, and therapeutic activities of *Buchanania lanzan* Spreng and emphasize the need for and importance of pharmacognostic study. At present,peoples destroy the branches/whole trees during the collection of its fruits without bothering about new plantations. Unfortunately, due to over-exploitation, indiscriminate harvesting (lopping and cutting), climate change, large scale urbanization, and developmental activities are undertaken in the tribal inhabited areas of states holding a natural population of this species, causing a considerable reduction in the population of *Buchanania lanzan* has been recorded in the recent past, leading to a very severe threat to its extinction, which calls for urgent conservation efforts at all levels. As per the literature survey, rare improvement work has been carried out on this species in central and eastern India. Research on the conservation program for this species is also lacking. Chironji is rapidly disappearing from its natural habitat, *i.e.,* natural forest area, due to unsustainable seed harvesting, poor seed germination due to hard seed coat, dropped seed eaten by rodents and squirrels, and abiotic factors influencing the growth and regeneration of this tree. Due to indiscriminate branch cutting and lopping, this tree is subjected to fungal and insect pest attack. Other biotic variables such as grazing, hacking, and repetitive fire in a given region are also responsible for the faster decline of its population (Meshram and Soni 2014). *B. lanzan* is used for preparation of colour range from selected dye sources (Deshmukh and Ganeshani 2013). No systematic study has been conducted to identify good cultivars or selection of elite clones in this important minor fruit throughout the country especially in the state of Madhya Pradesh. So far, Thar Priya is the only variety, released by the Central Institute for Arid Horticulture, Bikaner, in 2014. Proper research support is an urgent requirement for addressing problems related to scientific tapping, harvesting, collection, processing (drying, grading, handling/storage), value addition, and seed quality upgrading in order to increase their sustainable production, conservation, livelihood security, and fullest utilisation.

## CONSTRAINTS IN PROPAGATION AND CONSERVATION OF CHIRONJI

Chironji plants are usually propagated via seed, which results in a long gestation period (15-20 years) and a lot of variation. Because of the strong seed coat on the kernels, germination percentages in freshly extracted seeds are low. Chip budding and softwood grafting are two examples of vegetative growth procedures that are standardised and recorded in Chironji. However, due to a lack of rootstock availability and a reliance on seasonal conditions, these are less effective. Furthermore, root cutting propagation is a time-consuming process (Singh *et al.,* 2002). Singh *et al.* (2022) developed a protocol for organogenesis and in vitro multiplication of chironji using young leaf and nodal segments. Maximum 41 callus were induced in MS containing 2.5mg/l 2,4-D after 3 weeks of inoculations of leaf explants. However, limited success reported after hardening. While a technically knowledge is available on the in vitro culture of plants, there are limited literature related to plant conservation. The low proportion of seed germination in Chironji reforestation or domestication is attributed to stiff seed coats that are refractory in character, as well as fungal contamination associated with seed storage. The tree is grown from seeds that are protected by a hard shell. The difficult process before sowing is delicately cracking the shell, as the fruit within is typically quite sensitive and tender. Moreover, the fungal attack by *Fusarium* sp. (wilting disease) is common after sowing the seeds in the soil. The seedlings are also attacked by *Fusarium monililforme* var. *subglutinans* Wr. and Rg., *F. semitectum* Berk & Rav. present in the soil. Other which occur most frequently include *Alternaria alternate* (Pr.) Kessler, *Aspergillus flavus* Link, *A. ochraceus* Wilhelm., *A. niger* Van Tiegh., *A. aculeatus* Lizuka, *A. funiculus* Smith, *Cladosporium* Link ex Fr., *Chaetomium globosum* Kunze and Schm., *Curvularia lunata* (Wakker) Boedijn, *Macrophomina phaseolina* Ashby, *Mucorvarians* Povah, *Penicillium citrinum* Thom., *Trichothecium roseum* Link., *Rhizopus arrhizus* and *Verticillium* species (Sharma *et al*., 1998). Humidity and high temperatures are also conducive to fungal contamination. The seeds exposed to sunlight fail to germinate and soon lose their viability (Shende and Rai 2005). Neeta Sharma *et al.* (1998) reported four mycotoxigenic fungi, *viz., Aspergillus j/avus*group, *A. ochraceus, Fusarium moniliforme,* and *Penicillium citrinum,* the main producers of aflatoxin, ochratoxin, zearalenone, and citrinin, respectively, were of common occurrence in stored fruits of chironji. A higher percentage of mycotoxin contamination in the host mainly appears to be due to inadequate storage conditions, high atmospheric temperatures coupled with warm humid conditions conducive to the growth of fungi, and mycotoxin elaboration by toxigenic fungi. The growth is also very poor in comparison to other tropical species. Therefore, the selection of suitable germplasm is also needed which must have a larger seed size , more seed kernel ratio, fast growth, and less gestation period. As a result, there is a pressing need to develop a method that allows Chironji to be easily multiplied, regenerated, and conserved. In Chironji, exceptional selections must also be identified and characterised in order to promote this extremely promising indigenous horticultural fruit crop.

## SEED PROCESSING AND PRETREATMENT

Currently, the Chironji nut is processed manually and occasionally by a machine created locally. This traditional method entails soaking well-matured fruits in water for 24 hours, then removing the skin by hand rubbing and drying. Physical dormancy is common in Anacardiaceae seeds, which is aided by an impermeable endocarp, as described by Li *et al.* (1999). Due to seed dormancy, Chironji seeds have a low germination percentage even when exposed to ideal germination circumstances. It could be the result of morphological features like hard seed, thick testa, or improper storage or handling (secondary dormancy). As a result of this circumstance, chironji seedlings' vegetative growth and biomass are lower. As a result, special treatments like stratification, scarification, soaking in water, growth regulators, and others may be required to overcome dormancy and improve vegetative development. At present, scarification, either mechanical or chemical is most commonly practiced. The dried nut is broken by rubbing between a pair of stone-slabs or hammers followed by separation of the kernel from the hull. In some areas, local artisansdeveloped motorized machines for breaking and separating, but the machines were not specifically designed. So, they are again manually separated (Prasad, 2020). Shukla and Solanki (2000) found that artificially breaking the seed coat with a hammer before spreading seed resulted in good seed germination and seedling growth. The seed of BuchnaniaLanzan handled mechanically by a hammer offered higher germination and seedling growth, according to the Centre of Forest Research and Human Resource Development, Chhindwara (Annual Report, 2005-06). Similar observations were also observed by Kamal Naryan *et al.* (2014). Chemical scarification by conc. $H_2SO_4$ (5%) treatment also resulted in an increased germination percentage. (Kamal Naryan *et al.* 2014; Anand *et al.,* 2014; Chauhan *et al.,* 2020).

The most efficient approach to improve seed germination in chironji through physical and chemical treatments by Thounaojam and Dhaduk (2021), is to increase the rate of imbibition and induce cracking on the hard seed coat by alternate wetting and drying of seed and seed dipping in water. The seed germination and vegetative growth of chironji are improved by pre-sowing treatment with chemicals such as $GA_3$, $KNO_3$, and thiourea (Rajamanickam *et al.,* 2002). Joshi *et al.,* (2017) showed that pre-sowing treatments such as $GA_3$ 200 ppm and mechanical scarification had similar effects on Chironji seedling growth and biomass characteristics. Application of $GA_3$ 200 ppm solution for 24 hours prior to sowing showed better performance for all seed germination parameters *viz.,* days required for germination, germination percentage and seed vigour and with respect to seedling growth parameters *viz.,* seedling height, number of leaves per plant, stem diameter, leaf area and final percent survival. Based on the B-C ratio, it was determined that mechanical scarification (breaking hard seed coat by hammering) was a beneficial and cost-effective treatment for commercial seed germination of Charoli (Vishal *et al.,* 2019). Therefore, an attempt has been made toward the automation of the charoli decortication process. The decorticator performance was evaluated at three levels of disc speeds, disc clearances, and different moisture levels of charoli seed, *viz.,* 197, 246, and 286 rpm; 6, 7, and 8 mm; and 7.83, 8.57; and 9.04% wb, respectively. The optimum value of disc speed, disc clearance, and seed moisture content was found to be 197 rpm, 7 mm, and 9.04% (wb), respectively (Nishad *et al.,* 2022). Treatments with 200ppm GA3 and 4% $H_2SO_4$ were effective in breaking the dormancy of the seeds, resulting in 90% and 61% germination, respectively.In cold water treatment, only 56% of seeds germinated; in control only 25% seeds germinated in the untreated seeds; and germination was not observed in the intact seeds with the impermeable seed coat. Results are indicative of positive responses to treatments, while impermeable seed coats may be responsible for prolonged dormancy in intact control seeds (Ajith *et al.,* 2018). However, almost all researchers emphasized that due to delicate embryos, manual or mechanical extraction of seeds causes a heavy waste of valuable germplasm. Chances to damage delicate embryos and harmful ecological/ biological impacts of acid treatment push us to find new alternatives for the promotion of seed-based restoration of this vulnerable NWFP species of Madhya Pradesh.

## SEED ENHANCEMENT TECHNOLOGIES (SETS)

Due to a variety of edaphic and biotic challenges, seed-based restoration is frequently unsuccessful. Seed enhancement technologies (SETs) are a unique way to reduce these constraints and increase restoration success (Pedrini *et al.,* 2020). But it has received little attention in ecological restoration for a variety of reasons, including the extensive research and development required to adapt existing crop seed technologies to complex and diverse native seed types, the high initial cost of equipment, and scaling challenges. Yet, because the benefits of such technologies far outweigh the costs, they are a typical feature in crop and horticultural seed supply chains (Pedrini *et al.,* 2017). Traditional approaches to seed augmentation, including as pre-sowing, pre-storage, and mid-storage treatments, are widely used in today's seed research and technology (Sharma *et al.,* 2015).

Scarification, stratification, seed pelleting, seed priming, seed coating, and seed protection treatments for the removal of harmful microbes are all used as pre-sowing treatments to break dormancy, increase germination, and for precision sowing of seeds. Pre-storage and mid-storage treatments are generally applied to enhance or maintain the viability and vigour of seeds during storage (Fig. 1).

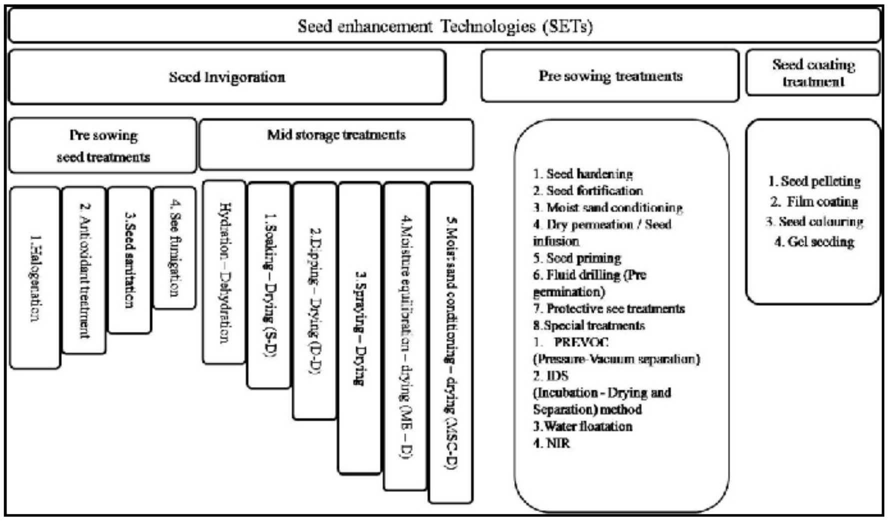


**Fig. 1.** Seed enhancement Technologies (SETs).

Seed priming is one of the several SETs that have been effectively used to improve seed and seedling performance of agricultural plants as well as some native plants. It is the regulated hydration of seeds to a level that allows pre-germinative metabolic activity to continue while preventing the radical's actual appearance. When compared to non-primed seeds from the same seed batch, primed seeds usually produce more uniform and faster seedling emergence from the soil. Two phases are involved in the priming treatments: (a) seed hydration and (b) seed dehydration. During hydration, significant advancements in the germination process occur, including mobilisation of reserves, DNA, RNA, cell membranes, organelles, and other processes (Bray, 1995). During storage, seeds preserve these modifications. Priming leads to a reduction in the duration of the II$^{nd}$ phase of seed germination. Consequently, primed seeds germinate fast and synchronically.

Depending on the type of media used, seed priming can be achieved in a variety of ways. Several priming techniques have been shown to have beneficial effects, including salt solution (halopriming), beneficial microbe solutions (biopriming), osmotic solutions (osmopriming), plant hormone solutions (hormonal priming), the presence of a magnetic field (magneto-priming), and solutions mixed with a solid carrier (matriconditioning) (Fig. 2). Several recent studies have demonstrated effectiveness in overcoming embryo and seed coat dormancy and boosting germination in agricultural crop species utilising nano-priming employing nanoparticles as an unique and efficient seed priming and growth enhancer agent (Mahakham *et al*., 2017). The capacity of NPs to pass through both the cell wall and the seed coat has been suggested as a possible mechanism for higher germination rates (Haghighi & Silva 2014; Liu *et al*., 2009).


**Fig. 2.** Types of seed priming.

These SETs treatments should not be used haphazardly for the sake of novelty or innovation, but rather should have a demonstrated benefit with deployment capable of targeting specific ecological or logistical limitations and giving every seed the best chance for germination, emergence, and successful establishment (Pedrini *et al*, 2020).

## STATUS OF GERMPLASM CONSERVATION IN CHIRONJI

*Buchanania lanzan* was added to the International Union for Conservation of Nature and Natural Resources' Red Data Book in 2009. As a result, the conservation and sustainable use of this type of species is critical for environmentally sustainable development, food security, and the development of the nation's socioeconomically disadvantaged communities. Chironji seeds are recalcitrant, and even after 3 months of harvesting, they lose vitality quickly. In order to preserve the genetic variety of Chironji, both in-situ and ex-situ techniques should be adopted. In the current situation, the best strategy for Chironji germplasm conservation is to combine immediate ex situ conservation (*i.e.* field genebanking and cryobanking) with in-situ conservation (*i.e.* on-farm conservation and protected places like National Parks). Ex-situ field genebanks are currently being constructed at the Indian Council of Agricultural Research's horticulture research facilities in Godhra, Gujarat, and Lucknow, Uttar Pradesh, for conservation and the development of enhanced propagation methods. Collected germplasm has been cryostored in the National Cryogene Bank at NBPGR, New Delhi, as a base collection reflecting significant diversity in the form of 127 accessions for posterity and future use (Malik *et al.,* 2012). As far as the public knowledge pool is concerned, no research on storability enhancement for the conservation of this species has been conducted. In the agriculture sector, several SETs, such as pre-storage and mid-storage treatments, are commonly used to improve or preserve the viability and vigour of seeds during storage (Fig. 1). For the sake of conservation, these technologies must also be tested on this species.

## CONCLUSION AND FUTURE SCOPE

Among the minor forest produce chironji is important multipurpose forest species and source of livelihoods for forest fringe villagers. For such a valuable species, there is urgent need to conserved it and bringing more land under Chironji plantation with improved planting material.Popularization of this crop, particularly in rain-fed areas, and the provision of sufficient high-quality chironji seedling planting supplies are inadequate. In this context, the SETs discussed may be useful in improving seed viability, vigour, and conservation of these important species. Also help in meeting a quality planting material demands. Although still in its infancy in ecological restoration, SETs are expected to bring significant advances in plantation establishment, similar to what agricultural crop species have achieved. As a result, there is a compelling need to identify a suitable 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 appropriate times.

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**Conflict of Interest.** None.

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