International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

A Review on Tree Improvement through Candidate Plus Tree Selection (CPTs) in Indian Butter Tree (*Madhuca spp*)

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Abstract: ***Tree breeding is the applied branch of biology deal with application principles of genetics, reproductive biology and economics to the genetic improvement and management of forest tree species. The selection of candidate plus tree (CPTs) is considered as an important and foremost stage in tree improvement program in forest species.*** **The** ***tree breeding or tree improvement is a branch of forestry, emerging as an integral part of afforestation and reforestation activities along with commercial production of forest products through the development of genetically improved planting stock for utilization. Tree improvement simply underlines the application of forest genetics principles within a given silvicultural system for the process of improving the genetic quality of the forest, with the goals to improve the genetic value of the population. In general, the tree improvement program comprises the all practices which are designed to produce genetically more desirable trees individuals. Mahua* (*Madhuca longifolia (L.) J. F. Macbr.) is a multipurpose tropical forest tree mainly harvested in the wild in Southern Asia for its edible flowers and oil yielding seeds. The recent modern era evolved biotechnological tools must be utilized for fasten the tree breeding program. The elite germplasm may be screened at seedling stage must be evaluated as rootstock for desirable traits.***

Keywords: Candidate Plus Tree (CPTs), Mahuva, *Madhuca indica*, Progeny selection, Tree Breeding and Tree improvement.

1. Introduction

Diversity is the essence of biological world. Any couple of livingorganism; even maternal twins are not exactly similar to each other at genetic level [16]. Tree improvement through breeding is based on the genetically variable population having high degree of genetic diversity and supported by the method of selecting genetically superior individuals. Essentially, the tree improvement program has a schematic frame work to isolate and evaluate the genetic component of variation in one or more characters which are of interest for improvement. In the simplest procedure, cycles of selection reduce the available population in a particular direction to enhance desirable traits, then breeding from selections to expand the population with improved characteristics. Breeding strategies vary with species and objectives, but all use mating designs to generate information and new material. Choice of a suitable breeding strategy and mating design is a key decision in any breeding program.

Botany of Mahua: Mahua, the Indian Butter Tree (*Madhuca longifolia* (Koenig) J. F. Macribide) is an important tree spreading throughout the tropical and subtropical regions of country, which have vital socio-economic value. Mahua is known to be as a deciduous tree, growing profusely in areas where dry tropical and sub - tropical climatic conditions prevails. Moreover, this species is very hardy and thrives well on rocky, gravely, saline and sodic soils, even in pockets of soil between crevices of barren rock [13]. *Madhuca longifolia* is one of those multipurpose forest tree species that serves as a food, fodder and fuel [11].

Mahua is a medium sized to large deciduous tree, developing the large rounded crown found up to an altitude of 1, 200 meter and of 12 to 15 meter height. In genrea, the bark fouond to be grey to black with cracks, inner bark dark red, milk, trunk short, branches numerous [3]. In normal condition, the tree matures in between eight to fifteen years and fruits lasting up to sixty years of its life span. Mahuva leaves are characteristically thick, leathery, pointed at the tip and generally clustered at the end of branches having property of exudation of a milky sap when broken. The flowers of mahuva are small and fleshy, dull or pale white in colour and in define fascicles near end of branches. Flower consists of a corolla tubular, freshly, pale yellow aromatic and caduceus [19]. Fruits, botanically categorized as 'fleshy berry' are found to be green at maturity and turn pinkish yellow when ripe, which are two to six cm long, ovoid in shape, fleshy and having one to four seeds having characteristics colour of brown to black. Generally, the seed of Mahua contains two kernels, which are highly sensitive to desiccation and freezing, highlighting recalcitrant nature of seed.

The seed of Mahua is also known as *'Tora'*, while the seed oil as *'Mahua butter'*, which is semi solid fat having a characteristics pale yellow colour. The tribal communities use seed oil for cooking. Now a days, the use of Mahua butter in the manufacture of vanaspati ghee, soaps has been reported moreover, it is used as illuminant and hair oil also [14]. The seed oil content of Mahua ranges in between 32 to 57 per cent. It has characteristic properties viz., Refractive index (1.452 - 1.462), Iodine value (55 - 70), Saponification value (187 - 197), Unsaponifiable matter (%) (1 - 3), Stearic Acid C 18: 0 (%) (22.7), Oleic Acid C C18: 0 (%) (37.0), Palmitic C 16: 0 (%) (24.5), Linolic Acid C18: 2 (%) (14.3) which makes it as an important commercial entity in sector

of oil market [14]. Although, the bark, leaves and entire plant parts of *Madhuca species* are useful for medicine or industrial use. But specific to seeds extract, it is found to be an anti - inflammatory, antiulser, hypoglyuacemic and effective to alleviate pain. Seed oil extracted from Mahua has emuluscent property, used in skin disease, rheumatism, headache, laxative, piles and sometimes found to be as galactogogue [14]. *Madhuca indica* J. F. Gmel, *Madhuca latifolia* (Roxb.) J. F. Macbr, *Illipe latifolia* (Roxb.) F. Muell., *Bassia longifolia* L., *Bassia latifolia* Roxb all are synonyms belonging to family sapotaceae. Mahua is sometimes substituted for *Diploknema butyracea* (Roxb.) H. J. Lam, a related species with similar properties that was formerly known as *Madhuca butyracea* (Roxb.) J. F. Macbr. [8]. The trees of *Bassia latifolia* and *B. longifolia* grow up to an altitude of 1, 200 m. The *B. malabarica* grows in Western Ghats from Kanara to Travancore and also in the Himalayas. The trees of *Bassia butyracea* grow in the Himalayan regions up to an altitude of 4, 500 m [5].

The Mahua introduced from India to Australia and Polynesia [1, 15]. The species, *Madhuca longifolia* is distributed in northern, central and south-ern part of peninsular India, and M. latifolia is found in some parts of central and north India. Mahua, a characteristic tree of the dry region, is found in almost all parts of India. It commonly grows in eastern Uttar Pradesh, Madhya Pradesh, Chattisgarh, Maharashtra, Bihar, Jharkhand, Orissa, Andhra Pradesh and Gujarat. In Rajasthan, it is also found growing on the wastelands particularly in southern part of the state. Dense population of Mahua trees can be seen in Dahod, Panchamahals and Vadodara districts of Gujarat.

Concept of Tree Improvement: Tree improvement alternating known to genetic improvement, referring the process of improving the genetic quality of a individual organism mainly the tree species. It is evident that, the present stage of forest trees is still genetically closer to their wild relatives in respect of natural state. However, the present population exhibits the considerable variation for economic traits viz. growth rate, stem form and wood quality between different populations within a species, and also between individual trees within populations. Tree breeding or improvement, in contrast to the selective breeding of livestock, arable crops, and horticultural flowers over the last few centuries, the breeding of trees, with the exception of fruit trees, is a relatively recent occurrence. A typical program for forest tree breeding initiates with selection of superior phenotypes (plus trees) in a natural or managed (planted) forest, generally based on the consideration viz., growth rate, tree form and site adaptation traits, which is responsible for improvement the mean performance of the forest via mass selection. Progeny obtained from selected trees and grown in test plantations designated as the genetic trials which serves as base for selection of the best genotypes among which the parents can be selected. These selected trees are typically multiplied by either sexually (seeds) or asexually (grafting) for establishment of seed orchards. Even recent techniques of *in - vitro* propagation can also be employed. Hence, there is great scope for undertaking breeding activities to improve the silvicultural value of a individual tree species by identifying the best wild seed sources; and also to select individuals within these genetic stocks to develop varieties that are considerably better potential than those of the wild population. In general, following two broad methods of improvement are employed in forest tree species:

The Provenance study–to identify the best wild relatives in populations: the range of tree species commonly found in Indian forests have wide natural ranges which spread over in different habitats and over diverse climatic zones. The specific trees species have adapted to these diverse conditions and as a result they can have very different characteristics depending on the origin of the seed source

The Tree breeding programs – to select and breed from the best individuals within the populations: The wide phenotypic variations in metric traits are found in target tree species such as growth rate, stem form and wood quality that provide tree breeders with the opportunity to develop improved varieties through tree breeding activities. The basic breeding techniques viz., Plus tree selection, controlled crossing, progeny testing, clonal selection etc.,

Plus tree selection: The activity for selection of plus - trees is the essential first stage in the process of improving any forest tree species, it serves similar as exploration activity in general plant improvement program in annual crops. Generally, in the process of plus tree selection, the tree's dominance within the stand, indicated by its superior height and diameter, are the first attributes are assessed. However, the selection strategies may differ in respect of tree species and object of selection.

The objective of any tree breeding program may include the goal viz., to increase productivity, to improve the quality of forest products, to develop insect - pest resistance and to adapt the species to unfavorable climatic conditions. The tree breeding program initiates with the selection of plus trees based on the specific objectives of breeding program. Candidate Plus trees are selected among the base populations consisting of either uneven - aged or even - aged stands. The breeder should make efforts to select even - aged stands, preferably plantations, for making more purposeful selections as per the objectives. A plus tree is selected either by comparing phenotypic values of a candidate tree with those of base population (comparison methods) or evaluating a candidate tree on the basis of its score values (individual tree methods). The comparison methods include comparison tree method, base value method and regression method. In general, under individual tree methods either the sum total of scores or independent culling or selection indices are used to select a plus tree. Comparison tree method has been recorded to be the easy and effective method of plus tree selection. The plants with high oil content with good phenotypic performances regarding fast growth along with good response for selection. Rapid multiplication potential is also adds a value for selected candidate plus tree.

Need of Tree Improvement: Any tree improvement has main focus areas as per the need of specific tree species. Conventionally the morphological characterization distinguishing proof and genetic improvement evaluation is most extreme significant input for field functionaries [17]. In

general, following are the thematic areas for undertaking tree improvement program.

- Improvement of productivity
- Building protection against adverse conditions (biotic and abiotic)
- Incorporation of disease and pest resistance
- Sustainable supply of quality and reliable seed
- Improvement of economically beneficial traits (MFPs etc.,)

These goals can be achieved through following main improvement activities.

a) Genetic Modification for adding value to tree species via., development of ideal ideotype, exploration of superior phenotypes in natural stands and plantation, progeny testing for identification of elite genotypes, development of seed orchids for multiplication of desirable plant types followed by selection and documentation of plus trees.
b) Deploying the plant breeding techniques using vegetative propagation via., establishment of clonal seed orchids, clonal banks, propagation of special breeding material followed by mass production of selected elite material.

Breeding Activities in *Madhuca species*: Madhuca species is identified as to be highly heterozygous, open pollinated fruit tree species securing the status of the multipurpose tree species. At early stage of life cycle i. e. seedlings exhibit a wide range of variations, facilitating in the selection of the superior desirable genotypes at early nursery stage during improvement program. Moreover, due to cross pollination mode and predomination of seed propagation over a long period of time, provides the immense opportunity to locate elite trees having positive morphological traits of desired ideotypes.

The successful adoption of plant based fuels i. e. biofuels is dependable on the feedstock supply from non food plant species having potential of growing on marginal land which are not cultivated under food crops. Fortunately, *Madhuca species* fulfils the criteria of both hence proving the candidature species for contributing significant quantity of fuel feedstock. Moreover, it found to be very promising, profitable and basis for self sustaining small scale entrepreneurship helpful for getting economical self sufficiency of tribal communities.

Breeding Objectives of *Madhuca spp.:* The preference by growers and market oriented need/demand for commercial utilization of any forest tree species is main consideration while deciding the objectives of any breeding program. Mahua is generally preferred designated as multipurpose tree for its utilization for purpose of food, fodder, fruit, flower, timber and fuel wood. These targeted uses of *madhuca species* was help in defining the tree species specific ideotypes i. e. a biological model having perform predictability, leading to greater quantities and qualities of yield under defined environment. This model focus on objectives viz., to develop promising genotypes having high yield potential along with early and regularity in bearing, to develop short stature, precocious (rapid juvenile growth i. e. precocious in bearing) and prolific bearer cultivars having high oil content in kernels and lastly the breeding for resistance against biotic and abiotic stresses may be the objective of Mahua improvement [7].

The specific ideotype specification for *Maduca longifolia* may be as below [4]

- Crown must be large with profuse branches for planting on common land,
- Whereas, narrow and dance canopy for farm and home planting.
- Stem may be single or multiple but with a long straight bole with branches high on the stem
- Root system should deep, strong taproot to resist the high velocity winds.

Limiting factors in breeding of Mahua: The Mahua is cross pollinated tree species and for improvement of this species, it faces big challenge to breeder. Few of them are summarized below

- Mahua is cross pollinated species so leading to heterozygous nature of the population.
- The Improvement of such forest tree species generally require long period as compared to the annual crops. Moreover there is flower and fruit drop is major constrain.
- Range of predators is also associated with Mahua due to its sweet corollas leading to more flowers and fruit drop.
- Mahua is known for its long gestation period generally of 8 to 10 years.
- The genetic variability is declining in Mahua genepool at faster rate due to deforestation
- Being basically cross pollinated species, self and hand pollination gives low fruit set as compared to natural pollinations.
- The seed collection is difficult. The availability of seed is big deal due to birds and animals eat the fleshy fruits. Beside this, seeds of mahuva have an integral position in diet of tribal communities.
- As in case of other forest tree species, there is no commercial cultivar available in this forest species.

Institutes involved in Germplasm Improvement of Mahua: Its breeding work is carried out by National Bureau of Plant Genetic Resources (NBPGR), New Delhi; Central Institute for Subtropical Horticulture (CISH), Lucknow; Central Arid Zone Research Institute (CAZRI), Jodhpur; The National Oilseeds and Vegetable Oils Development (NOVOD) Board, Gurgaon; Central Institute for Arid Horticulture (CIAH), Bikaner; Tropical Forest Research Institute (TFRI), Jabalpur; Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad; Chaudhary Charan Singh Haryana Agricultural University, Hisar etc.,

2. Conclusion

Tree improvement activity is an part of continuous breeding program, progenies of available CPTs has to be evaluated for desirable traits for yield, oil content etc., which will helpful for selection of elite material for further utilization. The tree, *Madhuca Species* can be known to be a good friend of Indian tribal and rural communities being a source of food, fodder and shelter. Available material i. e. genotypes

of Mahuva should be improved by using advanced breeding techniques in collaboration will experts from field of genetics, botany, biotechnology and taxonomy

References

[1] Anonymous.1988. Wealth of India - a dictionary of Indian raw material and industrial products. Vol. VI. L-M. CSIR, New Delhi, pp.207–216.
[2] Ayate Dipika, N. K. Kapse and V. V. Ujjainkar.2014. Trait Relatedness Studies For Stem Volume Production in Teak (*Tectona grandis* L.) *Intl. J Genetic Engineering & Biotech* 5 (3): 103 – 108
[3] Behl, P. N. and G. S. Sriwasrawa 2002. Herbs useful in dermatological therapy, CBS Publishers and Distributors, New Delhi, Edition
[4] Chuntanaparb, L. and R. Ranganathan 1990. Defining tree-breeding objectives for multipurpose tree species in Asia. Report No.10. Multipurpose Tree Species Network Research Series. Forestry/Fuelwood Research and Development Project, Bangkok.
[5] Dhakar M. K., D. K. Sarolia, A. A. Kaushik, K. L. Kumawat, Sanjay Singh and A. K. Singh.2015. Mahua (*Madhuca longifolia* (Koenig) J. F. Macribide) Chapter - 21., 305 - 323
[6] Dipika Ayate and V. V. Ujjainkar.2017. Assessment of Genetic Variability in Elite Clones of Teak., *Journal of Agroecology and Natural Resource Management* 4 (1): 75
[7] Donald, C. M.1968. The breeding of crop ideotypes., *Euphytica*., 17: 385 – 403
[8] Heuze V., G. Tran, H. Archimede, D. Bastianelli and F. Lebas.2017. *Mahua (Madhuca longifolia)., Feedipedia., 13 - 21*
[9] Mena J. and D. Meena.2016. Medicinal and commercial potential of *madhuca indica*: A Review., *International Journal of Medical and Health Research.*, Vol.2 (2): 23 - 26
[10] Nilisha Jibkate, Dipika Ayate and V. V. Ujjainkar.2017. Genetic variability studies in teak (*Tectona grandis* L.) *International Journal of Farm Sciences* 7 (5): 1 - 3
[11] Patel, M., Pradhan, R. C. and Naik, S. N.2011. Physical properties of fresh Mahua. *Int. Agrophys*, 25: 303–306.
[12] Patil, Rahul, Dipika Ayate and V. V. Ujjainkar.2016. Genetic variability studies in clonal population of teak (*Tectona grandis* L) *International Journal of Farm Sciences* 6 (4): 136–139
[13] Singh, I. S.1998. Mahua-An oil-bearing tree. Technical Bulletin, NDUAT, Faizabad (UP): 3–11
[14] Sunita Mishra and Sarojini Pradhan.2013. Madhuca Lonigfolia (Sapotaceae): A Review of Its Traditional Uses and Nutritional Properties, *International Journal of Humanities and Social Science Invention*.2 (5): 30 - 36.
[15] Troup, R. S.1921. The silvicuture of Indian Trees: Vol. II Oxford University Press, Oxford.: 640–646.
[16] Ujjainkar V. V. and M. W. Marawar 2020. Genetic diversity: A tool for assessing potential of genepool., *Remarking An Analisation.*, 4 (11): 38 - 44
[17] Ujjainkar V. V., E. R. Vaidya, M. Y. Ladole and G. G. Kale.2021. Morphological characterization of diverse sesame genotypes., *In E - conference on Agricultural Education, Innovation and Research for Future Livelihood - Indian Scenario in 2050*., NAHEP, Dr. PDKV., AKOLA (MS)
[18] Ujjainkar V. V., S. B. Datke, D. G. Mahurkar and T. H. Rathod.2001. Dispersion study for annual volume production in teak (*Tectona grandis*) growing in natural and managed habitats *Annals Plant Physiology* 15 (1): 80 – 84.
[19] Variers, V. P. S.1995. Indian Medicinal Plants, Orient Longman Publication, New Delhi, Edition 1 Vol. III, 362 - 366
[20] Wani M. S., A. Wani, A. Mughal.2015. Estimation of divergence to genetic variations in half sib families of Madhuca indica GMEL. under greenhouse and open field environmental conditions. Indian J. Agric. Sci.141 (1): 35 – 40