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Horticultural Approach for *Ex-situ* Conservation of Endangered *Mangifera* species

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Abstract—Mango (*Mangifera indica L.*) is grown as one of the major fruit crops in all the countries of tropical and subtropical Africa, America and Asia pacific. As there is huge export marketing demand for mango the industrial sector depends on few of the commercial cultivars, resulting in narrowing of the genetic base and flourishing pertaining to the loss of wild species by several anthropogenetic ecological impacts. There is record of more than 60 wild *Mangifera* species identified in South East Asia many are now locally rare and are enclosed on the IUCN Red List categorized as *Mangifera andamanica* (near threatened), *Mangifera camptosperma* (near threatened), *Mangifera casturi* (extinct), *Mangifera griffithii* (no entries found), *Mangifera indica* (data deficient), *Mangifera odorata* (data deficient), *Mangifera sylvatica* (least-concern) and *Mangifera zeylanica* (vulnerable), although there are some conservation initiatives the biodiversity of these wild *Mangifera* species continue to descent. The present study was designed to vegetatively propagate *M. andamanica*, *M. camptosperma* and *M. griffithii*, for long-term sustainment in the gene bank. The establishment of these *Mangifera* species through *ex-situ* conservation was successful using current grafting techniques on *Mangifera indica* root stocks (polyembryonic) and ongoing with initiation in DNA characterisation and assessing for the purpose of breeding.

Keywords—Andaman; Conservation; Biodiversity; Extinction; Species; Hotspots.

I. INTRODUCTION

The forest genetic resources are on major decay and their future in several regions around looks to be disrupted [1,2]. The Convention of biological diversity is solely answerable for conserving, sustaining and employing biodiversity [3,4]. Presently, 34 biodiversity hotspots have been recognized all over the world, occurring in tropical forest. In India, valuable documentation of genetic resource and bioprospecting with remarkable population of extensive flora and fauna exhibits some of the world's most diverse regions viz., Indo-Burma, Himalayas, Andamans Islands and Western Ghats. The genus *Mangifera* is one of the 68 genera originated from Indo-Burma region [5], during the Eocene or an earlier period in the Cretac--eous [6], and is usually termed as mango belonging to the family Anacardiaceae. The assessment of conservation rating was undertaken exploiting the International Union for Conservation of Nature (IUCN) released in 1994 at species level [7], were criteria and categories has been evaluated and enhanced numerous times [8]. The Andaman and Nicobar Island of India is a Genetically Diverse Hot Spot (GDHS) dwelling wild mangoes and harbours 25,000 angiosperms, 245 among them are endemic [9]. The native *Mangifera* species in this region are *Mangifera andamanica*, *Mangifera camptosperma*, *Mangifera griffithii*, *Mangifera indica* and *Mangifera nicobarica* [10], enhanced knowledge of the status of such species is necessary for livelihood security and conservation of these valuable species. There is record of more than 60 wild *Mangifera* species identified in South East Asia, many are now locally rare and are categorized on the IUCN Red List as *Mangifera andamanica* (near threatened), *Mangifera camptosperma* (near threatened), *Mangifera casturi* (extinct), *Mangifera griffithii* (no entries found), *Mangifera indica* (data deficient), *Mangifera odorata* (data deficient), *Mangifera sylvatica* (least-concern) and *Mangifera zeylanica* (vulnerable), despite of some conservation projects the biodiversity of these wild *Mangifera* species remain declined. Therefore it is essential to fund collection, *in-situ* and *ex-situ* conservation of these wild species as they are precious resource of biotic and abiotic stress and reinforced 'trait' specific towards crop improvement and assuring against genetic erosion. In this study, we have illustrated the collection and *ex-situ* conservation of *Mangifera* species viz., *Mangifera andamanica*, *Mangifera camptosperma* and *Mangifera griffithii* from Andamans that are locally rare and are included on the IUCN Red List, for further establishment of these species in the gene bank as it is economically important in breeding programmes.

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II. MATERIALS AND METHODS

A. Study Area

The geographical location of the Andaman and Nicobar Island is 11°42' 59" N – 92° 44' 02" E (**Table 1.)**. The highest peak is located in North Andaman Island Saddle Peak at 732m (2,402 ft). It has 572 islands of which 38 are permanently inhabited spreads in an area of 8,249 km^2. The average annual rainfall as recorded during the year 2007 is 2779.5 mm in Andaman Islands and 2437 mm in Nicobar

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Islands. The vegetation is mostly wet evergreen (North Andaman, South Andaman) and deciduous (Middle Andaman) [11]. The district of South Andamans comprises three different administrative subunits called Tehsils, viz. Port Blair Tehsil (PBT), Ferrargunj Tehsil (FGT) and Little Andaman Tehsil (LAT)The study was undertaken in Chidiyatapu Port Blair Tehsil (PBT) and Chauldari, Jirkhatang, Sholbay, Mt.Harriet Ferrargunj Tehsil (FGT) **(Figure 1).**

Species	Latitude	Longitude
M. andamanica	11° 40" N	92° 43" E
M. andamanica	11° 37" N	92° 33" E
M. camptosperma	11° 40" N	92° 43" E
M. griffithii	11° 43" N	92° 45" E
M. griffithii	11° 67" N	92° 76" E
M. griffithii	11° 40" N	92° 43" E

Table 1. The geographical co-ordinates of *Mangifera* species collected from South Andaman Island

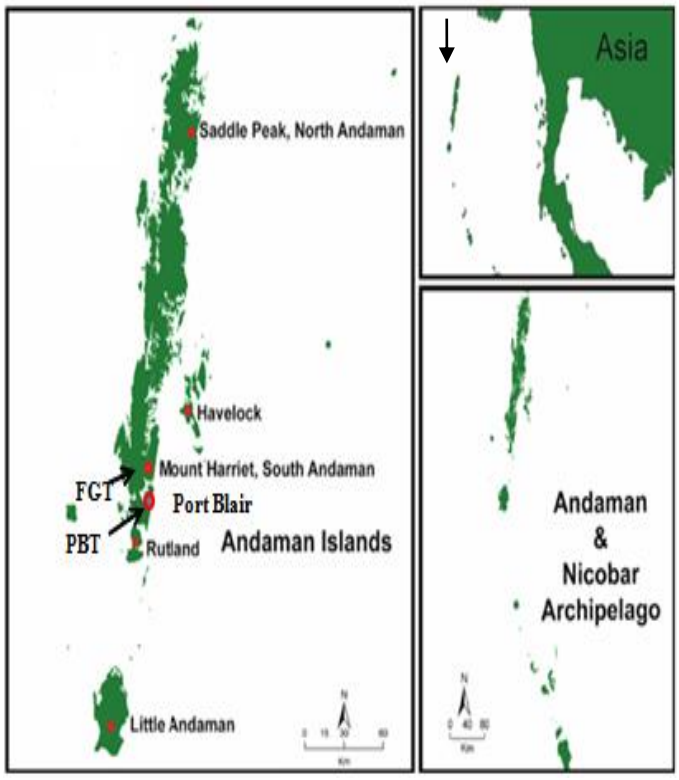

Figure1. Map showing the sampling locations for *Mangifera* species surveys covering Port Blair and Ferrargunj Tehsil of South Andaman Island

B. Collection and propagation of *Mangifera* species

Methods of *ex-situ* conservation are now accessible and can easily be grouped accordant to the part of the plant that is to be conserved—the whole organism, seed, tissues, or genetic material in culture. The scions, leaf and fruit of *Mangifera* species namely *M. andamanica*, *M. camptosperma*, *M. griffithii* were collected from South Andamans Island (PBT and FGT) during 2014 **(Table 2.)** and transferred to ICAR-IIHR, Bengaluru. The scions were grafted [12-15], leaves and fruit was utilized for further analysis [16-19].

Species	Tehsil	Place	Location
M. andamanica	FGT	Chauldari	Andaman, India
M. andamanica	FGT	Jirkhatang	Andaman, India
M. camptosperma	FGT	Jirkhatang	Andaman, India
M. griffithii	FGT	Mt. Harriet	Andaman, India
M. griffithii	FGT	Sholbay	Andaman, India
M. griffithii	PBT	Chidiyatapu	Andaman, India

*FGT - Ferrargunj Tehsil; PBT –Port Blair Tehsil

Table 2. The geographical locations of *Mangifera* species collected from South Andaman Island

III. RESULTS AND DISCUSSION

In tropical rainforests wild fruit tree species forms an excellent genetic diversity, as they are concerned to wide array of families, genre and subspecies being engaged along with their scope of intraspecies variance [20].The wild fruit crop of tropical forests considerably imparts to the diversity of species towards nutrition in most of the developing countries [21], but the consumption of the these native fruit are at a major threat due to over exploitation, deforestation and population growth resulting in adverse affect in accessibility of these fruits. There is a wide genetic base in the *Mangifera* species collected from Andaman Island. Currently the grafting an *ex-situ* technique is utilized in tree fruit species viz., almond, apple, apricot, cherry, citrus, grape, mango, peach and plum [22]. In fruit plants the usage of rootstocks has an impact on various parameters like fruit characters, stress factors (biotic & abiotic), yield and ecological conditions by stimulating the scions in improving uptake of nutrients, transporting and utilizing efficiently [23]. The zygotic (monoembryonic) and nuclear (polyembryonic) seedlings are both used as rootstock for grafting [24], monoembryonic seedling shows more inhibition of growth as compared to polyembryonic seedling [25] but use of polyembryonic seedling as rootstock would assure uniformness in fruit orchard unlike zygotic seedlings. Nucellar seedlings are identical to the parent plant [26-28]. However, differences might occur because of somatic variations [29]. Polyembryonic varieties viz., 'Olour' have been observed to be moderately tolerant to salt stress [30].The scions of these wild *Mangifera* species collected were grafted [31] to *M.indica* variety 'Olour' under controlled conditions of green house at ICAR-IIHR, Bengaluru, India **(Figure 2)**. Successful grafts from three species *M. andamanica* **(Figure 3a and Figure 3b),** *M. camptosperma* **(Figure 3c and Figure 3d),** and *M. griffithii* (**Figure 3e and Figure 3f)** obtained was recorded **(Table 3.)**. Seedlings of *M. camptosperma* showed more vigour, success and survival after grafting on *M. indica* rootstock. *Ex-situ* conservation of these wild species and *M. andamanica* (**Figure 3b)** in particular was carried out by collecting of stones and rising of seedlings for further improvement and exploitation. The identification, morphological and molecular characterization of these species was analysed previously [6]. Currently evaluation

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of desirable interstocks is implemented to develop these species and genetically characterized as a part of divergence studies within genic collection at ICAR-IIHR, Bengaluru.

Figure 2. ICAR-IIHR Green house in Field Gene Bank

Species	Total Scions	Scions Grafted	Successful Grafts
M. andamanica	15	10	1
M. andamanica	12	10	1
M. camptosperma	10	10	2
M. griffithii	11	06	0
M. griffithii	17	05	0
M. griffithii	12	05	1

Table 3. List of the graft success in *Mangifera* species

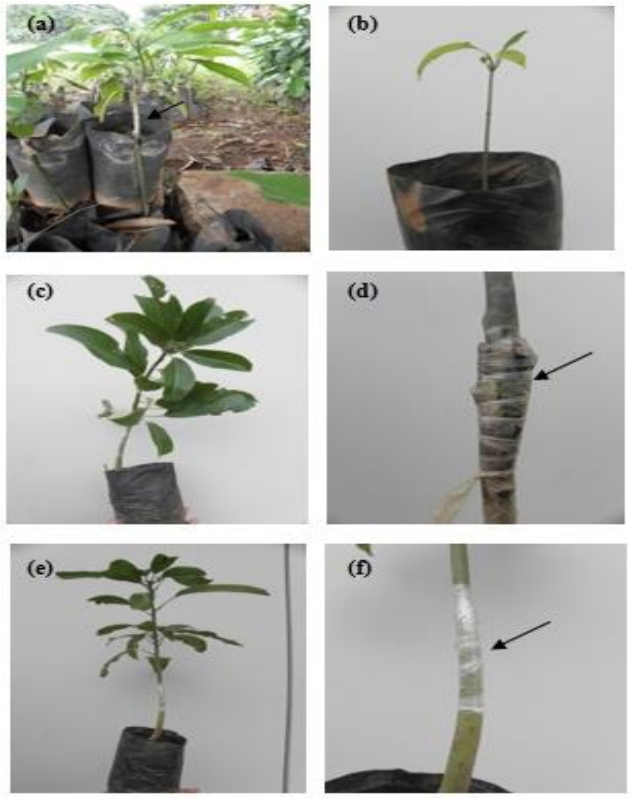

Figure 3.The grafted *Mangifera* species from South Andaman Island

IV. FUTURE PROPOSED GUIDELINES

Plants play a major role of Medicare and Agriculture in India representing a natural resource. The above emphasized wild *Mangifera* species are used by tribals and local people to heal several diseases. Therefore, there is huge demand for conservation of these diverse species for the existing and forthcoming generations, by implementing latest technological methods of conservation. *Ex-situ* and *In-situ* conservation of such IUCN red listed species would be excellent step stone towards conservation by discovery of hotspots and collection of wild species more importantly to propagate and conserve redundantly integrating into the breeding projects resulting in the development of the novel crop on the basis of national and international scope. Thus conservation of the species naturally and regenerating artificially is going to be finest choice to retrieve the species from near extinction.

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Conflict of interest
The authors wish to declare that they have no conflicts of interest.

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