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Conservation of Selected Rare and Endemic Trees
from Northern Western Ghats

Biodiversity is a measure of health of ecosystem and climate. Due to various anthropogenic activities merely for economic and human made capital there is serious threat to natural capital. In order to sustain the natural resources and ultimately human survival. It is essential to adopt different approaches for management and conservation of biodiversity. In present investigation an attempt has been made for conservation of some rare and endemic tree taxa through development of nursery techniques. Twenty tree taxa were studied for their seed behavior, germination and conservation. It offers an important method for the conservation and sustainable utilization of bioresources from these forest trees.

Key words: Trees, Conservation, Biodiversity, Northern Western Ghats

The nursery techniques established here will be useful for the rapid regeneration of endemic trees which will be helpful for the forest department to conserve the unique species at large scale.

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Introduction

Globally we have experiencing major loss and degradation of biodiversity as a result of globalization. Biodiversity encompasses all levels *viz.* ecological, evolutionary, wild varieties, agroecosystems, domesticated species and hybrids. India is one of the 17 megadiverse countries and third largest country in Asia. Myers *et al.* (2000) demarcated 25 global biodiversity hotspots in the world for the first time, to which in 2009 were added another 9 hotspots based on the criteria of exceptional concentration of endemic plants and higher degree of anthropogenic pressure. India accommodates part of four global biodiversity hotspots - the Himalaya, the Western Ghats, Indo-Burma and Sundaland which are facing challenges due to anthropogenic disturbance and climate change (Chitale *et al.,* 2015). The Western Ghats extending along the west coast of India, covers an area of 180,000 Km^2. The area is extraordinarily rich in biodiversity. Like other hotspots, the Western Ghats has a high proportion of endemic species. The Western Ghats contains numerous medicinal plants and important genetic resources such as the wild relatives of grains, fruits, pulses and spices. Presently, biodiversity in the Western Ghats is threatened by a variety of human pressures due to which the existing forests are highly fragmented and facing the prospect of increasing degradation. The forests of the Western Ghats are some of the best representatives of non-equatorial tropical evergreen forests in the world. The Western Ghats have evolved into one of the richest centers of endemism owing to their isolation from other moist areas. The hills of the Western Ghats are embedded in a landscape that has much drier climatic conditions (Ramesh *et al*., 1997). Semi-evergreen forests occur primarily in the states of Maharashtra, Goa and Karnataka in the Western Ghats within an elevational range of about 300-900 m. (IIRS, 2002). This forest type includes secondary evergreen dipterocarp forests, lateritic semievergreen forests, bamboo brakes and riparian forests as described by Champion and Seth (1968). It is estimated that there are four thousand species of flowering plants known from the Western Ghats and 1,500 (nearly 38

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percent) of these are endemic (Nair and Daniel, 1986). Approximately 63 percent of India's woody evergreen taxa are endemic to the Western Ghats (Johnsingh, 2001). Of the nearly 650 tree species found in the Western Ghats 352 (54 per cent) are endemic (Daniels, 2001).

Biodiversity is not measured in any single unit but rather is distributed across a hierarchical continuum of ecological scales (Wilson, 1992). This continuum can be condensed into three levels: species, sites, and landscapes. These three levels interlock geographically through the occurrence of species at sites and of species and sites in landscapes but are nonetheless identifiable. The 2002 IUCN Red List of Threatened Species (IUCN, 2002) which represented the best available data source on the global conservation status of species at the time the outcome definition process took place. The Western Ghats species listed as Critically Endangered, Endangered, and Vulnerable in the IUCN Red List were considered as conservation targets. According to World Wide Fund for Nature (WWF, 2001) there are five major ecoregions in the Western Ghats: the North Western Ghats Montane Rain Forests, the Southern Western Ghats Montane Rain Forests, the Northern Western Ghats Moist Deciduous forests, the Southern Western Ghats Moist Deciduous Forests, and the South Deccan Plateau Dry Deciduous Forests. The most important aspect which needs to be considered in case of the Northern Western Ghats (NWG) is the 'fragility of ecosystem' shaped due to climate especially along the main crest line (Ghate, 2015).

Ex-situ conservation is an additional powerful tool in long term conservation and sustainable utilization of rare, endangered and threatened (RET) species. Among different strategies Botanical Gardens are the important way in ex-situ conservation of RET species of the country. Nursery is a fundamental part of any botanical garden. For development of well flourished garden it is necessary to establish nursery and nursery techniques of species selected for conservation. A nursery is a place where plants are reared. For the establishment of nursery knowledge of several things such as seed collection, seed processing, seed physiology, seed pre-treatment, seed sowing, nursery beds, growth regulators, fungicides, transplantation and plantation in field is necessary. Each of these tasks requires expertise and skill which can be achieved by practical experience.

Seeds are the principal means of regeneration for most of the woody plants. They serve as the delivery system for the transfer of genetic materials from one generation to the next. The part of tree's life cycle that involves seed formation, maturation, dissemination and germination is a complex and fascinating chain of events. The knowledge of these events is necessary for successful collection and utilization of seeds for artificial regeneration. Introduction of such RET species raised in nursery will open new avenue for academic as well as economic aspects of biodiversity in general and of the species in particular.

Material and Methods

The target species were selected from the literature and field survey with special emphasis on different threats posed by these species. The selected species were identified with available regional floras (Yadav and Sardesai, 2002; Gamble,1915). The recent

Table 1: Plant species, seed physiology, pre-treatment and germination.

Sr. No.	Name of species	Seed physiology	Pre-treatment	No. of days	Germination %
1.	*Artocarpus hirsutus* Lam	HR	Water soaking (2 hrs.)	up to 60	90%
2.	*Buchanania cochinchinensis* M. R. Almeida	I	Water soaking (30 hrs.)	from 20-40	70%
3.	*Calophyllum inophyllum* L.	I	Cracking of endocarp	30	70%
4.	*Dysoxylum binectariferum* (Roxb.) Hook. f. ex Bedd.	HR	Removal of seed coat	20-25	90%
5.	*Erinocarpus nimmonii* J. Graham	O	H_2SO_4 (4 min.)	7-13	66%
6.	*Garcinia gummi-gutta* Roxb.	MR	Germinator solution (20%)	35	70%
7.	*Garcinia indica* Choisy	MR	Water soaking (2 hrs.)	30-60	80%
8.	*Garcinia talbotii* (Talbot) Raizada ex Santapau	MR	Germinator solution (20%)	30	67-70%
9.	*Grewia umbellifera* Bedd.	MR	Soaking in GA (50 ppm-2 hrs)		50%
10.	*Hardwickia binata* Roxb.	O	Soaking in warm water (10-12 hrs)	10-30	75-80%
11.	*Holigarna arnottiana* Hook. f.	HR	Germinator solution (20%)	10 -15	60%
12.	*Holigarna grahamii* Kurz.	HR	Germinator solution (20%)	10 -15	60%
13.	*Mesua ferrea* L.	HR	Germinator solution (20%)	30-45	80 - 85%
14.	*Moullava spicata* (Dalzell) Nicolson	HR	Boiled water + overnight soaking	7-13	70%
15.	*Pterocarpus marsupium* Roxb.	O	Removal of wings (water soaking-2 hrs.)	15	60%
16.	*Sageraea laurifolia* Blatt.	I	Soaking in 12% Humic acid (15 min.)	after 24	80%
17.	*Saraca asoca* (Roxb.) De Wilde	HR	Boiled water	24-45	70%
18.	*Soymida febrifuga* (Roxb.) A. Juss.	MiR	Removal of wings	5	90 %
19.	*Strychnos nuxvomica* L.	I	Conc. H_2SO_4 for 5 min. then rinsed under tap water	50-60	50%
20.	*Syzygium laetum* (Buch.-Ham.) Gandhi	HR	Germinator solution (20%)	15	70%

Note: HR= Highly Recalcitrant MR= Moderately Recalcitrant MiR= Minimally Recalcitrant I= Intermediate O= Orthodox

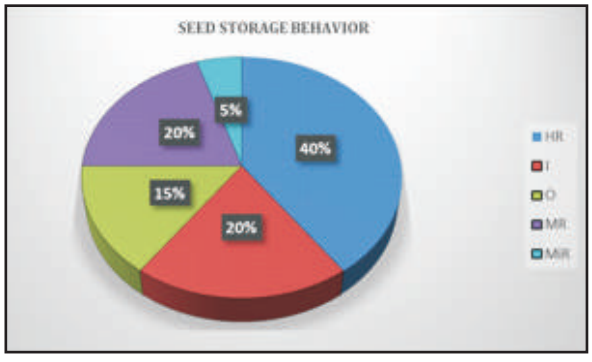


Fig. 1: Seed storage behavior of species

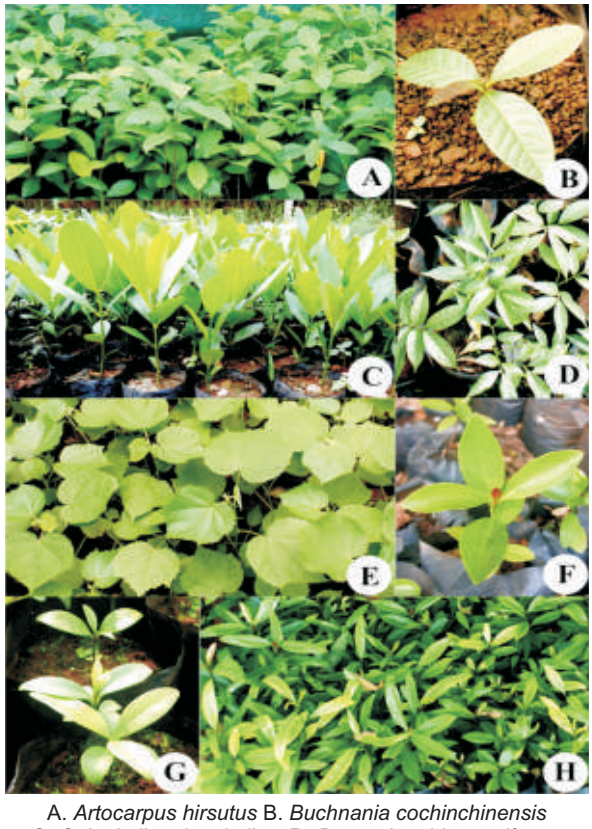
nomenclature of species is as per online database (TROPICOS; THE PLANT LIST; IPNI). The list of species undertake for present study with details on family, vernacular name, status and their respective fruit type is provided (Table 2). These twenty represents six different types of fruits in which drupe is dominant with 30% of species (Fig. 2). The fruits and seeds were collected according to phenology of particular species in appropriate season. The collection of genetically and physiologically good quality fruits and seeds is important. The optimal time for fruit and seed collection is when large amount of viable, mature seeds can be obtained. The collection of seeds requires knowledge about phenology and structural changes in fruits and seeds during maturation.

The mature fruits and seeds were collected by different methods depending upon the respective fruit type. The seeds were processed properly for germination. The seeds were extracted from fruits on the basis of nature of fruit.

The seedlings were raised either in polythene bags usually of 8" x 6" size or in nursery beds (2 x 2 m) (Plate 1 and Plate 2). When seedlings were raised on nursery bed the ground was levelled and cleaned. The soil was loosened and exposed to sunlight. The seeds were sown in rows keeping some distance (5 to 6 cm) between them. After certain period of germination (10-12 months) seedlings were transferred to polythene bags. When seeds were sown in polythene bags the bags were filled with soil and sand. The seeds were generally sown at the depth of 1.0 cm.

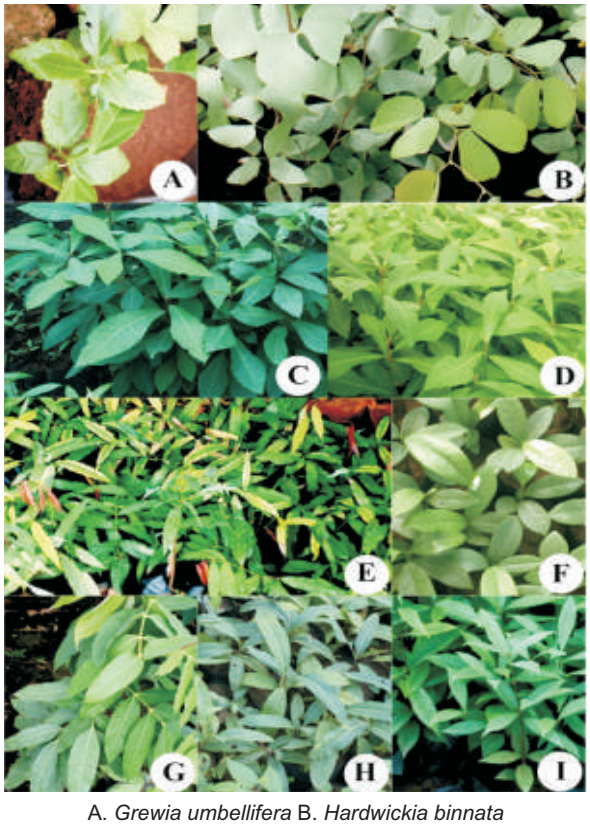
After sowing the watering was done at an interval of a

Plate 1



A. *Artocarpus hirsutus* B. *Buchnania cochinchinensis*
C. *Calophyllum inophyllum* D. *Dysoxylum binectariferum*
E. *Erinocarpus nimmonii* F. *Garcinia gummi-gutta*
G. *Garcinia indica* H. *Garcinia talbottii*

Plate II



A. *Grewia umbellifera* B. *Hardwickia binnata*
C. *Holigarna arnottiana* D. *H. grahamii*
E. *Mesua ferrea* F. *Sageraea laurifolia* G. *Saraca asoca*
H. *Soymida febrifuga arcinia* I. *Syzygium laetum*

day. It was done manually by water canes or pipes. Care should be taken that seeds should not got washed out or young seedlings should not get injured. The seedlings at initial stage were kept in polyhouse and then transferred outside. The disease or pests were not commonly observed except some species at their initial stages. Much care was not necessary as the forest tree species are quite resistant to pests and diseases therefore use of pesticides or fungicides was rare.

Results and Discussion

The presently studied 20 species shows recalcitrant (highly, moderately, minimally), intermediate and orthodox seed storage behavior in 13, Four and Three species respectively (Table 1). The species showing recalcitrant nature occur in evergreen and semi-evergreen forest patches of Western Ghats. The environmental conditions in these patches are favorable for germination of recalcitrant seeds. The studied taxa shows different seed physiology *viz*. Highly Recalcitrant, Intermediate, moderately recalcitrant, minimally recalcitrant and orthodox among which 40% species exhibit higly recalcitrant seed physiology (Fig. 1). They possess low temperature and more moisture content due to unavailability of direct sunlight and abundance of leaf litter. Majority of recalcitrant species possess fleshy fruits, thalamus, cotyledons and endosperm except *Grewia umbellifera* Bedd. and *Soymida febrifuga* (Roxb.) A. Juss. Because of these accessory parts the diaspore possesses high moisture content at the time of shedding. The species namely *Artocarpus hirsutus* Lam., *Dysoxylum binectariferum* (Roxb.) Hook. f. ex Bedd., *Holigarna arnottiana* Hook. f., *H. grahamii* (Wight) Kurz., *Mesuaferrea* L., *Moullava spicata* (Dalzell) Nicols., *Saraca asoca* (Roxb.) de Wilde and *Syzygium laetum* (Ham.) Gandhi

Table 2: Plant species family, vernacular name, status, fruit type.

S.No.	Name of species	Family	Vernacular name	Status	Fruit type
1.	*Artocarpus hirsutus* Lam	Moraceae	Lakucha	LC; E	Sorosus
2.	*Buchanania cochinchinensis* M. R. Almeida	Anacardiaceae	Charoli	LR	Drupe
3.	*Calophyllum inophyllum* L.	Clusiaceae	Undi	LC	Drupe
4.	*Dysoxylum binectariferum* (Roxb.) Hook. f. ex Bedd.	Meliaceae	Yerandi	DD	Capsule
5.	*Erinocarpus nimmonii* J. Graham	Tiliaceae	Chera	LR	Capsule
6.	*Garcinia gummi-gutta* Roxb.	Clusiaceae	Malabar Tamarind	E	Berry
7.	*Garcinia indica* Choisy	Clusiaceae	Kokum	VU	Berry
8.	*Garcinia talbotii* (Talbot) Raizada ex Santapau	Clusiaceae	Phansada	E	Berry
9.	*Grewia umbellifera* Bedd.	Tiliaceae	Phalsa	R	Drupe
10.	*Hardwickia binata* Roxb.	Fabaceae	Anjan	E	Pod
11.	*Holigarna arnottiana* Hook. f.	Anacardiaceae	Ran bibba	E	Drupe
12.	*Holigarna grahamii* Kurz.	Anacardiaceae	Jangali bibba	E	Drupe
13.	*Mesua ferrea* L.	Clusiaceae	Nagkesar	E	Drupe
14.	*Moullava spicata* (Dalzell) Nicolson	Caesalpiniaceae	Wakerich bhat	E	Pod
15.	*Pterocarpus marsupium* Roxb.	Fabaceae	Bivala	NT	Pod
16.	*Sageraea laurifolia* Blatt.	Anonaceae	Har-kinjal	NT	Etaerio of berries
17.	*Saraca asoca* (Roxb.) De Wilde	Caesalpiniaceae	Sita asok	VU	Pod
18.	*Soymida febrifuga* (Roxb.) A. Juss.	Meliaceae	Ruhin	E	Capsule
19.	*Strychnos nuxvomica* L.	Loganiaceae	Kuchala	R	Berry
20.	*Syzygium laetum* (Buch.-Ham.) Gandhi	Myrtaceae	Dev jambhul	E	Berry

Note: E= Endemic; LR= Low Risk; DD= Data Deficient; R= Rare; VU= Vulnerable NT= Near Threatened

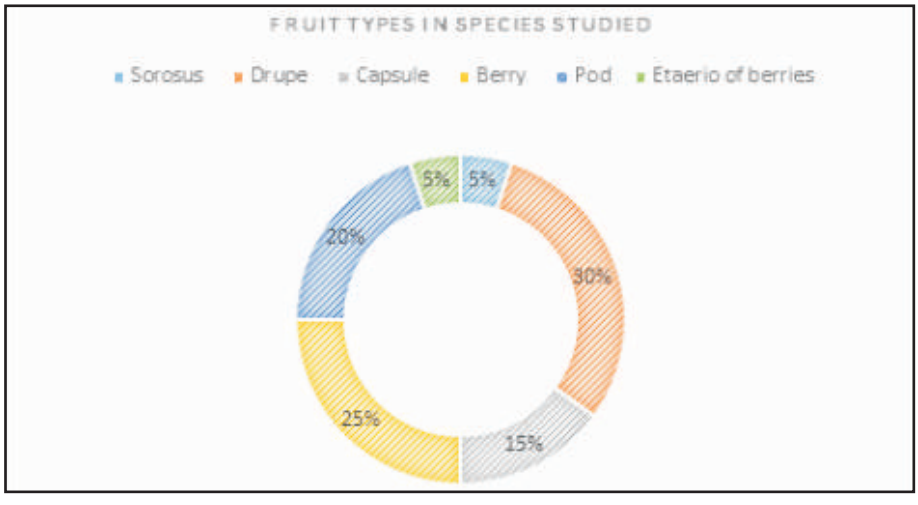


Fig. 2: Fruit type variation in species

possesses highly recalcitrant seeds which show decrease in germination percentage with loss of moisture and increase in temperature in storage conditions within a week. The seeds of Garcinia gummi-gutta Roxb., Garcinia indica Choisy, Garcinia talbottii (Talbot) Raizada ex Santapau and *Garcinia umbellifera* show moderately recalcitrant seeds which can be stored under specific conditions. The seeds of Garcinia are stored in cotton bags mixed with ash for few weeks. The seeds of *S. febrifuga* show minimally recalcitrant seeds as germination reduce after Four to Five months of seed storage. The species showing intermediate nature occur in moist deciduous and dry deciduous forest. The seeds of these species possess hard testa except *Calophyllum inophyllum* L. where seeds are enclosed in hard bony endocarp. The seed survive under unfavorable environmental conditions in their natural habitat. The orthodox seeds possess hard testa which is impermeable to water. They can be stored in open situations without maintaining temperature and moisture. The seeds of *Erinocarpus nimmonii* J. Graham, *Hardwickia binata* Roxb. and *Pterocarpus marsupium* Roxb. remain viable when they are not excised from the fruits.

Among studied taxa six shows high germination rate in germinator solution (Trade name), mechanical and water treatment shows high germination percentage in five species each. The use of chemicals and growth regulators shows better germination in two species respectively.

The information on seed longevity, desiccation and freezing sensitivity is prerequisite for conserving plant species that generally produce non-orthodox seeds. The longevity of seed varies from species to species. The seeds were divided into different categories based on their storage behaviour. The first study on storage life of seed was done in 535 AD by Ssu-Hsieh in China. Seeds were divided into three biological classes according to their life span under ordinary storage conditions *viz*. microbiotic, mesobiotic and macrobiotic. Seed types were suggested depending upon the natural habitat to which they are adapted[2]. Seeds were classified into four groups of seeds orthodox, minimally recalcitrant, moderately recalcitrant and highly recalcitrant.

Fragmentation of populations, habitat degradation, narrow distribution and overexploitation of natural resources are the most apparent causal factors for population reduction of many endemic species. Due to habitat fragmentation, habitat destruction and anthropogenic activities large continuous forest patches were environmentally deteriorated and broken into small isolated and degraded patches. The information about population diversity and ecology is a prerequisite in understanding the species survival possibility in the short term so that an effective conservation strategy for long term survival can be formulated and implemented. In certain cases, the failure of seed germination due to environmental physiological and physical factors is the fundamental reason for species loss.

Conclusion

The present work is an attempt to develop nursery techniques of selected tree species for rapid regeneration. These nursery techniques of endemic species will be helpful for rapid multiplication and conservation. It will be also helpful for forest officials for propagation of forest trees. It will help in long term survival and sustainable utilization of these tree taxa.

उत्तरी पश्चिमी घाटों से चयनित दुर्लभ एवं देशज एवं देशज वृक्षों का संरक्षण

स्वप्नजा एम. देशपाण्डे और श्रीरंग आर. यादव

सारांश

जैवविविधता पारितंत्र और जलवायु के स्वास्थ्य का एक पैमाना है। केवल आर्थिक और मानव निर्मित पूंजी के लिए विभिन्न मावोद्भवी कार्यकलापों के कारण प्राकृतिक पूंजी के लिए गंभीर संकट हो गया है। प्राकृतिक संसाधनों तथा अन्ततोगत्वा मानवीय उत्तरजीविता को बनाए रखने के लिए जैवविविधता के प्रबंधन एवं संरक्षण के लिए विभिन्न एप्रोचों को अपनाना आवश्यक है। वर्तमान शोध में पौधशाला तकनीकों के विकास के जरिए कुछ दुर्लभ और देशज वृक्ष टैक्सा के संरक्षण का प्रयास किया गया है। बीस वृक्ष टैक्सा का उनके बीज व्यवहार, अंकुरण और संरक्षण के लिए अध्ययन किया गया। यह इन वन वृक्षों से जैवसंसाधनों के पोषणीय उपयोग और संरक्षण के लिए एक महत्वपूर्ण विधि उपलब्ध कराता है।

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