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Evaluation of *Gmelina arborea* (Roxb.) Germplasm for Qualitative Traits and Insect Pest Resistance in Natural and Planted Populations of Madhya Pradesh,India

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Abstract

Gmelina arborea Roxb., a fast-growing tree species native to tropical and subtropical regions of Asia, has garnered attention for its potential in wood-based industries. However, its large-scale plantation in Madhya Pradesh, India, faces significant challenges. This study investigates the prevalent diseases and pests, bole form and branching habit of *Gmelina arborea* among different populations in Madhya Pradesh. Extensive field surveys were carried out to identify the natural and planted populations of *Gmelina arborea.* Based on these surveys three natural populations viz Betul, Mandla and Jabalpur Population and five planted populations Sonaghati, Badhaura, Saraswahi, Neemkheda and Barha were selected for the present investigation. Observations of the bole form of trees was recorded visually as Crooked, less crooked, nearly straight, straight. Branch angle was visually observed and observation was recorded 30^0, 45^0, 60^0 and 90^0. Disease and pest incidence was visually assessed and intensity of the observations are recorded as Heavy infection, Moderate infection, Low infestation, A healthy tree with no attack. Considerable variation among the qualitative traits was observed among population under study. most straight and nearly straight trees found in planted population than natural populations. 90^0 and 60^0 branch angles were observed more in plantation than natural populations. More number of healthytree and tree with low infestation was observed in plantations. Agroclimatic zones of Satpura plateau performs better for bole form. Kymore plateau and Satpura hills agroclimatic zones performs well in case of branching angle and health status. Northen hill zones of Chhattisgarh underperforms as far as qualitative traits are concerned.

Keywords: Bole form, Angle of branching, Health status, Populations, Agroclimatic zones

Introduction

Gmelina arborea (Roxb.) is a rapidly spreading, deciduous tree that grows from a moderate to a large size. This tree having numerous branches and produce a broad and shady crown. It grows to maximum

height of 30 meters and occasionally much more. Gmelina can have straight and cylindrical bole, DBH ranging from 50cm to 140 cm.

Natural occurrences of *Gmelina arborea* Roxb., can be found in Asia's tropical and subtropical areas. It is naturally distributed to East Asia, southern China, Indian subcontinent, Myanmar, Thailand, Laos, Vietnam, Malaysia, Indonesia and Philippine. It occurs in a variety of forest habitats, including tropical semi-evergreen, sub-montane, very moist teak forests, deciduous, sal and dry teak forests. It is found throughout plantations, small woodlots, and agroforestry settings.

Gmelina arborea wood is utilized in carpentry, packing, matches, pulp, and particle board. Recent study shows that Gmelina fruits can be used for extraction of biodiesel. Farmers, forest departments, and the Ayurveda industry favours this plant because of its utility, quick growth, and high economic yield. It is utilized in musical instruments, carvings, and building boards. In addition to being used as fodder, the leaves and fruits of Gmelina are also utilized to raise silkworms. The species is also planted as a shade tree for cocoa and coffee. The species has drawn attention due to its rapid growth and high rate of returns on investment. Variety of goods furniture, pulp etc. can be made from its wood. Gmelina is quite useful in agroforestry systems as well Dvorak (2004).

Despite these positives, it has not been determined that large-scale plantation establishment with this species is feasible in India due to poor early results, such as poor growth, poor form, and outright abandonment of plots due to disease or pests. The planting of this tree has been harmed by pests, diseases, and animals.

The plantation of Gmelina in Madhya Pradesh is being damaged by some noteworthy diseases reported by Jamaluddin *et al*. (1988). Top Dyeing and mortality problem is prevailing due to insect disease complex. Because of attacks from the insect *Tingis beesoni*, the fungus *Hedersonula toruloidea*, the needle grub *Parasa lepida*, and significant foliar damage, this species is unpopular with foresters who desire to plant it widely (Harsh *et al.* 1992; Meshram and Garg, 2000). Harsh *et al.* (1992) studied damage caused by a combined attack of pests and fungi resulting in defoliation of leaves, desiccation of young shoots, formation of branches and stems, and ultimately mortality in two provenance trial inIndia. Jamaluddin *et al.* (1988) observed significant differences in infection intensity between sources and found that provenance of local origin (Madhya Pradesh) was largely free of the diseases. Certain provenances from Central North India, Southwest India, and North India were distinctly different from other sources in that they were severely affected by both fungi and insects.

clones and the wood density of Gmelina is roughly 410 kg/m3 at 8 years of age, which is lower than most commercial species Dvorak (2004). These and other factors could limit the degree of improvement and use of Gmelina. Low density has an impact on product strength and pulp yields. Gmelina trees tend to fork or branch frequently. one or more side branches may compete with the top shoot primary axis. This competition reaches the extent where the top shoot loses its dominance and even dies hence Zobel (1977) argues that the major cause of variability in wood is differences in tree bole form and limb characteristics. the chief cause of wood degradation is reaction wood which is normally related to differences in tree form hence the branching habit that is branch angle, stem straightness, and stem height for axis persistence should be studied.

The species is vulnerable to insect attacks and disease, which is constraint in popularising plantation of Gmelina among farmers. Artificial pollinations are labour-intensive and occasionally challenging to complete successfully, delaying breeding cycles and the deployment of elite populations and making this species unpopular among foresters to plan large-scale plantations, therefore careful screening of genotype for disease and pest resistance is required for tree improvement of the species

Development of clones resistant to insect and disease assaults is a cost-effective way to sustain plantation stocking and quality timber production. Exploitation of tree-to-tree variation in the qualitative traits of Gmelina, and evaluation of its germplasm for insect pest resistance can create new races of Healthy trees with both ideal growth rates and thick wood.

Materials and methods

Survey of locations and recording of growth data

Based on available information about the forest flora and vegetation composition of Madhya Pradesh, extensive field surveys were carried out to identify the natural and planted populations of *Gmelina arborea.* Based on these surveys three natural populations viz Betul, Mandla, and Jabalpur location were and five planted populations Sonaghati, Badhaura, Saraswahi, Nohta, Neemkheda, Barha and Moiyanala were selected based on earlier studies. The location details of natural and planted populations are given in Figure-1 and Table-1. In the identified populations, based on ocular judgment, 27 trees per population were selected and marked. A distance of 100m was maintained between trees while selecting natural populations. The marked trees were evaluated for qualitative traits and form characters. Observations for qualitative traits like bole form, branching angle, and disease and pest resistance, and heartwood colour were recorded to study the variation presents among the populations of *Gmelina arborea*. Observations of the bole form of trees was recorded visually as Crooked, less crooked, nearly straight, straight (Figure 3, F). Branch angle was visually observed and observation is recorded 30^0, 45^0, 60^0 and 90^0 (Figure 2). Disease and pest incidence was visually assessed and intensity of the infestation were recorded as Heavy infection, Moderate infection, Low infestation, A healthy tree with no attack (Figure 3A, B, E). The heartwood colour was estimated using Munsell colour chart. The heartwood of each sample is separated and powdered and used for estimation. Observations was obtained with the help of Munsell colour chart by holding the Powdered samples against the chart. (Thulasidas *et al.* 2006)

Results and Discussions

Variability in qualitative traits and of *Gmelina arborea* in Madhya Pradesh

Qualitative traits of *Gmelina arborea* suggested that the population of Jabalpur and Sonaghati have highest number (13) of genotypes which have straight form of stem while lowest number tree which are having straight stem have been reported from Barha (7) (Table 2). Betul, Neemkheda, Barha and Saraswahi (8) reported genotypes which are having nearly straight bole where very less genotypes having nearly straight stem located in Jabalpur (3) (Table 2). Somewhat more amount (9) less crooked stem are reported from Betul and least less crooked stem are reported from Mandla (3) (Table 2). Most crooked bole form observed at Mandla (7) and least crooked bole which are recorded nil are from Sonaghati (Table 2).

Maximum number of trees showing average branch angle of 90^0 were observed in the population of Jabalpur (6) and minimum genotype having branch angle 90^0 are observed at TFRI and Sonaghati (1) (Table 2, Figure 4). 60^0 angle of genotypes was maximum (10) at Barha location while minimum (7) at

Mandla, Sonaghati and Saraswahi. The highest no of genotype having branch angle 45^0 was found at Saraswahi (15) and lowest from Mandla (4) (Table 2). 30^0 of angle of branching was reported from Neemkheda (8) no tree with 30^0 was reported from Saraswahi (Table 2).

Maximum number of healthy trees were reported from Neemkheda and Barha (19) while lowest no was reported from Mandla (4) (Table 2). Low infestation reported maximum (7) at Badhaura while nil from Mandla. Maximum no of trees was moderately infected at Mandla (14) and least no of moderately infected trees were found at Saraswahi (2) (Table 2, Figure 4). Heavily infected trees found in more noat Mandla while no tree was infected heavily at Neemkheda location (Table 2).

Heartwood color of Gmelina was observed with the help of Munsell color chart by holding wood powdered heartwood against color chip in the chart. Heartwood color is distinctly observed as pale- yellow color (2.5Y 8/4) and pink color (7.5YR7/4). highest no of trees having heartwood color were reported from Barha (18) followed by Jabalpur (16) while lowest number of trees were reported from Saraswahi (Table 2). Most trees having pink colored heartwood observed at Saraswahi (16) and least trees were reported from Barha (Table 2, Figure 4).

Variation in Natural population versus plantation

Analysis of qualitative data showed that most straight and nearly straight trees found in planted population than natural populations (Table 2). 90^0 and 60^0 branch angles of *Gmelina arborea* observed more in plantations than natural populations (Table 2). More no of healthy tree and tree with low infestation was observed in plantations (Table 2). On the basis of means of observations recorded for qualitative parameters in natural and planted populations it is observed that the performance of *Gmelina arborea* is more consistent in plantations than natural populations as far as qualitative traits are concerned. Similar findings were observed by Lauridsen and Khjar (2002) in the provenance trial research on Gmelina for three decades. This study reiterate that Gmelina responds strongly to domestication through plantation silviculture. Although the natural population is the best source for genetic variability assessment, Gmelina from the natural populations appear genetically inferior to “landraces” i.e., plantations.

Effect of agroclimatic zones on qualitative parameters

Betul, Sonaghati, Saraswahi and Neemkheda populations showed overall good performance with respect to all the qualitative parameters under study. (Table 2) Betul and Sonaghati represents Satpura Plateau agroclimatic zone while Neemkheda and Saraswahi represents Kymore plateau and Satpura hills agroclimatic zones (Table 1). On the basis mean value of the recorded observations of bole form of different agroclimatic zones it has been observed that agroclimatic zones of Satpura plateau performs better for bole form. Kymore plateau and Satpura hills agroclimatic zones performs well in case of branching angle and health status, Northen hill zones of Chhattisgarh underperforms asfar as qualitative traits are concerned.

Conclusion:

This study sheds light on the complex challenges facing the cultivation of *Gmelina arborea* in Madhya Pradesh, India. The prevalence of diseases and pests, such as Tingis beesoni, Hedersonula toruloidea, and Parasa lepida, poses significant threats to Gmelina plantation. The research emphasizes the need for meticulous genotype screening to identify disease and pest-resistant variants, thus ensuring the success

of large-scale plantations.

Furthermore, the study reveals substantial variability in tree form, branching angles, and overall health status among different populations. This variability provides valuable insights for tree improvement programs, offering opportunities to develop *Gmelina arborea* variants better suited to local conditions. Addressing issues related to tree form, such as stem straightness and branching habits, is crucial for ensuring the quality and yield of wood products.

To overcome these challenges, it is imperative to invest in research and development initiatives focused on disease-resistant genotypes and innovative breeding techniques. Collaborative efforts between researchers, foresters, and policymakers are essential to create sustainable strategies for *Gmelina arborea* cultivation.

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Table 1 GPS Range, Elevation, Rainfall and Agroclimatic zones of the selected populations of Mahya Pradesh

Sr no	Location	Latitude	Longitude	Elevation (Ft)	Agro-climatic Zone	Soil Type	Rainfall (Range in m.m.)
1	Jabalpur	N23°05'55"	E79°59'26"	1322	Kymore Plateau and Satpura Hills	Mixed red and black soils (Medium)	1000 to 1400
2	Barha	N23°01'30"	E79°59'40"	1374			
3	Saraswahi	N23°48'59"	E80°27'43"	1269			
4	TFRI	N23°00'61''	E79°57'45''	1315			
5	Badhaura	N24°24'47"	E81°44'30"	1456			
6	Mandla	N23°01'20"	E80°41'46"	1476	Northern Hills zone of Chhattisgarh	Red &Yellow	1200 to 1600
7	Betul	N21°54'13"	E77°54‘12"	2092	Satpura Plateau	Shallow black (Medium)	1000 to 1200
8	Sonaghati	N22°05'45''	E78°52'29''	2227			

Table 2: Observed number of frequencies of the character under study in the different population

Character	Order	JAB	MAN	BET	NEE	BAR	SON	SAR	BAD	Total
Bole form	Straight	13	10	11	12	7	13	12	11	89
	Nearly Straight	3	7	9	8	8	7	8	6	56
	Less bent	7	3	6	6	7	7	5	4	45
	Bent	4	7	1	1	5	0	2	6	26
Branching angle	90^0	6	2	4	1	3	1	5	5	27
	60^0	8	7	8	8	10	7	7	8	63
	45^0	10	14	9	10	10	13	15	8	89
	30^0	3	4	6	8	4	6	0	6	37
Health status	Healthy	14	4	18	19	19	10	18	14	116
	Low Infection	3	0	3	3	1	2	4	7	23
	Moderate infection	4	14	4	5	5	11	2	5	50
	Heavy infection	6	9	2	0	2	4	3	1	27
Heartwood colour	Pale yellow color	16	13	14	14	18	13	11	15	114
	Pink color	11	14	13	13	9	14	16	12	102

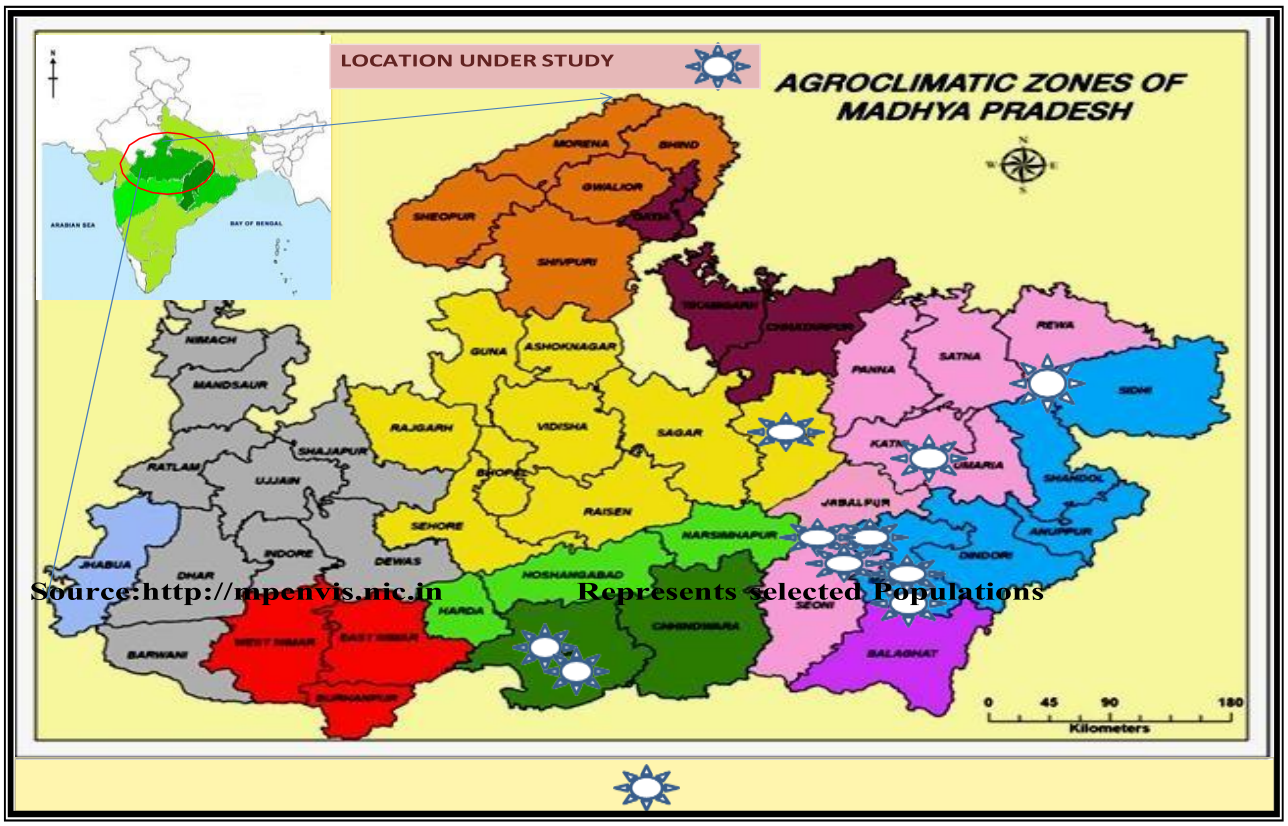

Figure1: Location of the populations projected on maps of Agroclimatic zones of Madhya Pradesh

Figure 2: Branching habit of Gmelina in plantation

Figure 3. Observation recorded of *Gmelina arborea* for health status

(A) Low infection in Gmelina

(B) Heavy infection in Natural tree

(C) Gmelina in natural location

(D) Gmelina in plantation

(E) Healthy tree of Gmelina in plantation

(F) Straight trees of Gmelina