

Conservation of Superior Phenotypes of Teak (*Tectona grandis*) in Central India

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Among Indian tree species, teak is the most valuable timber tree species with a lot of variations existing in nature.

Value of teak timber is attributed to nice grains which is due to differential growth conditions created in a year with extreme temperature range.

The fast grown teak of Nilambur in Kerela fetches a lower price than the slower grown teak of central India.

There is a lot of scope for improvement in this species, due to lots of variations and which is nearly untouched for manipulations.



In any species different kinds of genetic variation is govern by five major evolutionary process, in natural forest stands.

**i.e. mutation,
migration,
hybridization,
selection
and genetic drift.**



It may be:

- **geographical variation**
- **stand to stand variation**
- **individual tree variation.**

In teak, individual tree variation is an important source of practical breeding program.

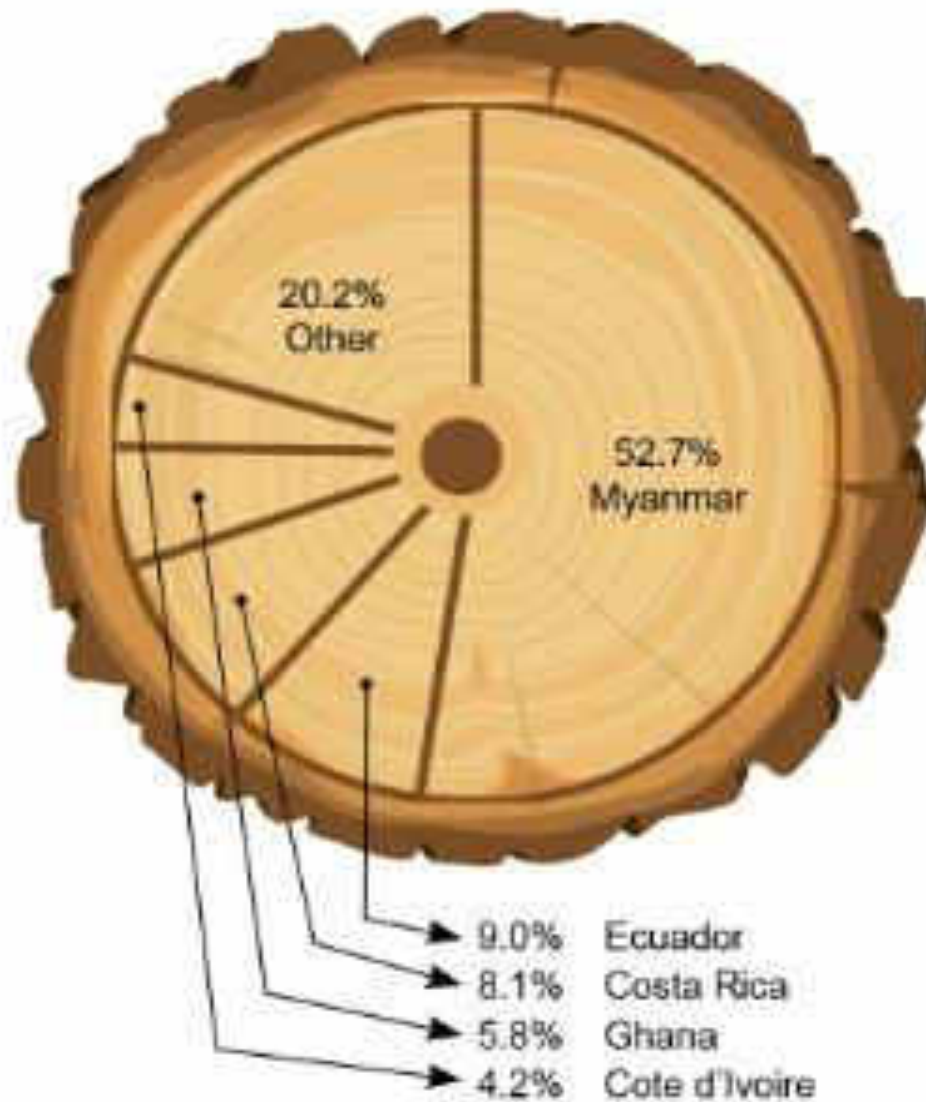


Teak is justly famous for its durability. In Karla Caves near Lonavla in Maharashtra state, there is a set of 'ribs' that line the ceiling of the main caves; such ribs are over 2000 years old and are still sound in every sense.

Teak timber is impregnated by a large quantity of resinous matter which fills up every pore of the wood; for this reason it resists the action of water, and at the same time is not attacked by termites or white ants.



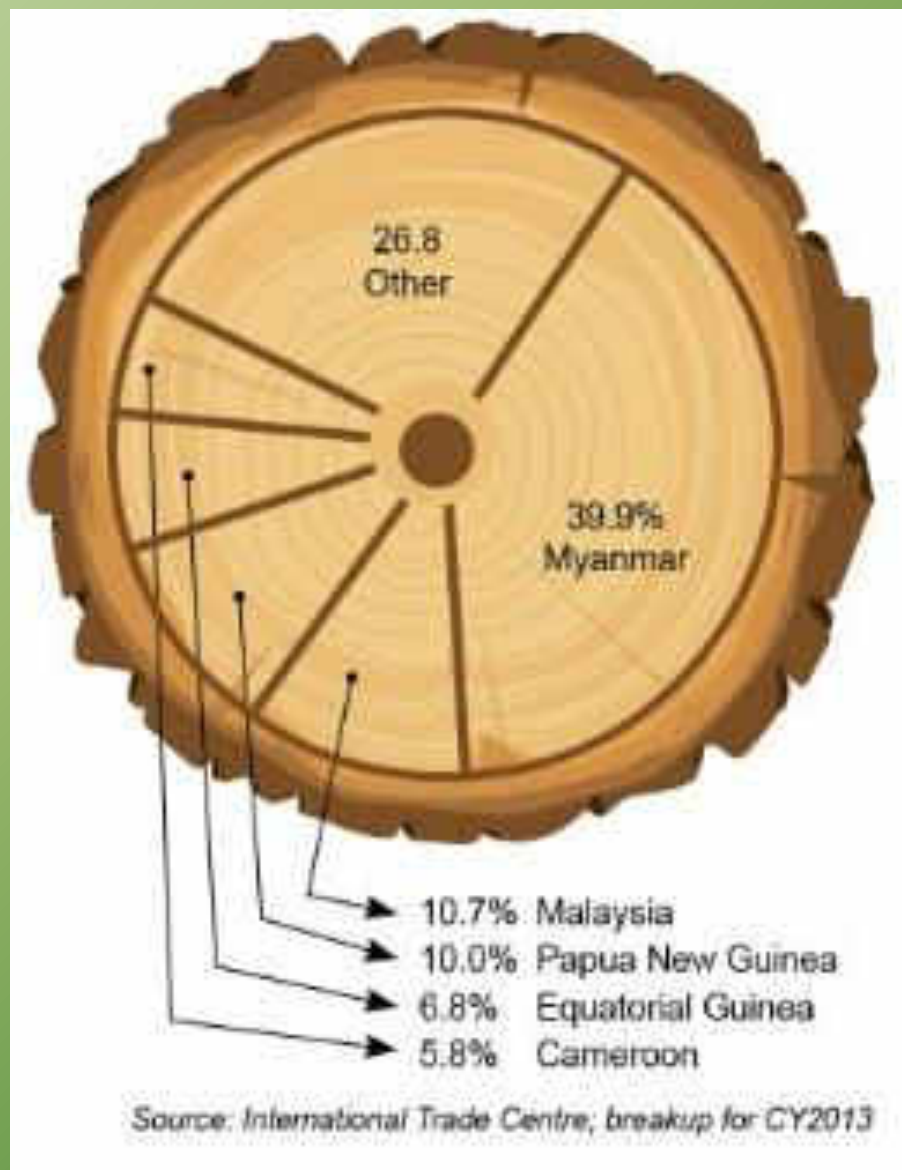
Source of Indian Teakwood Imports



Source: Ministry of Commerce, Govt, breakup for FY2014



Global Tropical Hardwood Exporters



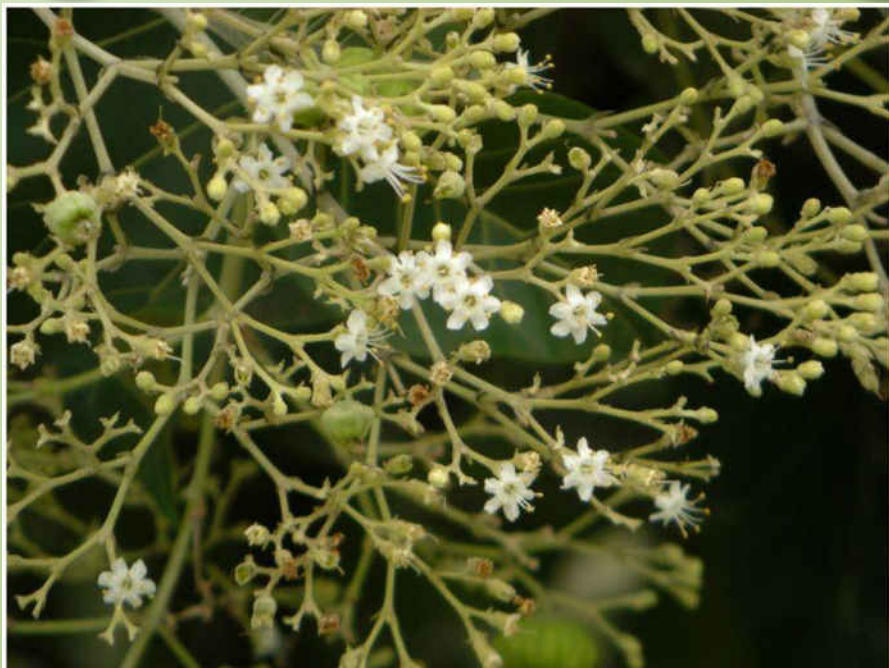
Teak (*Tectona grandis*): A very large sized deciduous tree





Young branches quadrangular, downy or hairy.
Leaves opposite, 30-60 cm. long and 15-30 cm. broad;
In young seedlings the leaves are much larger, the size
of a small umbrella. The leaves are rough but hairless
above, densely covered with reddish down beneath.





Flowers: in monsoon, flowers come in lax clusters at the ends of branches, white and small (about 6mm. across) and very fragile
leaves fall off in November to January, tree is leafless throughout the hot season.
New leaves appear with the flowers during the monsoon



**Fruit: 15mm
across, spongy,
enclosed in the
persistent
calyx, ripens in
winter;**





✚ In Madhya Pradesh, teak is found on variety of formations.

✚ In MP -Rich teak forest found in the district of Hoshangabad, Harda, Betul, Chhindwada, Seoni, Mandla, Balaghat, Dewas Khandwa etc.

✚ Although, it occurs naturally but being cultivated for its timber. Therefore this species has been taken for Tree Improvement Programme



Selection of plus tree is the basic need for any tree improvement programme, based on the phenotypic characteristics.

For timber species the characteristic i. e. fast growth rate, good pruning ability, straight stem, horizontal branches with small diameter, small crown, disease resistance and wood properties appropriate for end use.



Since the inception of tree improvement programme in India (1977), 306 Candidate Plus Trees were selected in Madhya Pradesh by State Forest Research Institute, Jabalpur

Establishment of clonal seed orchards has been done and presently teak CSO are in 154.38 ha

Present paper deals with the evaluation of those existing plus trees for their present status and wood characteristics



Candidate Plus Trees of Teak in different 14 Divisions

East Mandla	13	Chhindwara	29
West Mandla	14	Sehore	31
North Betul	46	Khandwa	20
Damoh	70	Dewas	10
Jhabua	07	Indore	01
South Seoni	18	South Balaghat	19
Hoshangabad	22	Harda	06

Total trees = 306



Methodology for evaluation





+ Individual tree location with their GPS Coordinates has been also recorded with its photograph

+ Information was recorded on prescribed format

+ Tree Evaluation of all the Candidate Plus Trees of Teak was done based on the following parameter:

+ Tree Vigour

+ Girth

+ Height



- ✚ Bole form
- ✚ Branching habit
- ✚ Crown Diameter
- ✚ Apical Dominance
- ✚ Self Pruning Ability
- ✚ Tree Health
- ✚ Wood Properties
 - ✚ Heart Wood Percentage
 - ✚ Specific gravity of wood



Points allotted for scoring- (followed by Mandal , 2001 with some modifications)

1. Vigour- 25

(a) Height – 15

(b) Girth - 10

2. Bole form – 20

3. Branching habit

(a) Branch angle -15

(b) Branch thickness- 10

4. Crown diameter – 5

5. Apical dominance - 10

6. Self pruning ability - 5

7. Tree health - 10

8. Wood properties – 30

(a) Specific Gravity - 20

(b) Heartwood percentage – 10

Total -

130



Vigour: Total points – 25	values	Values and allotting points	
Height: Points= 15	Ave 24.4 m	< 20.5	1
0-4 Less than average	Max 36.5 m	21.5	2
5-10 More than average	Min 12.0 m	22.5	3
11-12 More than average but shorter than tallest check trees		23.5	4
13-15 For taller than tallest check tree		24.5	5
		25.5	6
		26.5	7
		27.5	8
		28.5	9
		29.5	10
		30.5	11
		31.5	12
		32.5	13
		33.5	14
		34.4 & < 34.5	15
Girth at breast height: Points = 10	Ave. 126.5 cm	<80-	1
0-2 Smaller than average	Max. 270cm	80	2
3-5 equal to average	Min. 69cm	95	3
6-8 between average and largest check tree		110	4
9-10 more than the largest check trees		125	5
		140	6
		155	7
		170	8
		185	9
		200 & > 200	10



	values	Values and allotting points	
Bole form: Total points = 20			
(Deduct)			
1-3 for basal sweep	--	Ideal bole form	20
1-5 for trunk bends, spiral bole			
1-5 for trunk curves & knots			
1-3 for cross section not circular			
1-3 for detectable bole swelling			
Branching habit: Total points = 25			
Branch Angle from bole- 15		> 90°	10
	40 to 100°	80°- 90°	15
		70°- 80°	13
		60°- 70°	10
		50°- 60°	6
		40°- 50°	2
		<40°	0
Branch thickness- 10	--		
Less than 1/4 of main stem - 10			10
1/4 to 1/3 of main stem - 7-9			7-9
1/3 to 1/2 of main stem - 4-6			4-6
more than 1/2 of main stem - 0-3			0-3



	values	Values and allotting points	
Crown diameter: Total points = 5			
Balanced narrow and perfect- 5	Ave 7.6	2-5 m	5
Average- 3	Max- 17.5	6-10 m	3
Wide - 2	Min - 2.6	11- 15 m	2
Very wide - 1		>15	1
Apical dominance Total points = 10			
100-70 % 10	Avg 98.39	100-70%	10
69- 55 % 7-9	Max- 100	69 - 55 %	7-9
54 - 40 % 4-6	Min -70	54 - 40 %	4-6
39 - 25 % 1-3		39 - 25%	1-3
<25% 0		< 25 %	0
Self pruning Ability: Total points = 5	Ave 14.4		
Branching above 20 m	Max 27	above 20 m	5
Branching between 15 to 20 m	Min 3.5	15 to 20 m	4
Branching between 10 to 14 m		10 to 14 m	3
Branching between 5 to 9 m		5 to 9 m	2
Branching below 5 m		below 5 m	1



Tree Health: Total points = 10			
Disease tree - 10	-	-	10
Leaf infected - 5	-	-	5
Bole infected - 3	-	-	3
Wood Property: Total points 30			
		0.4	8
(a) Specific gravity - 20	0.7	0.5	10
15-20 above average	1.0	0.6	12
10-14 average	0.5	0.7	14
5-9 light		0.8	16
0-4 very light		0.9	18
		1.0	20
(b) Heartwood % - 10	89.3	82 & <82	1
5-10 above average	99.2	84	2
3-4 average	75.9	86	3
0-2 short		88	4
		90	5
		92	6
		94	7
		96	8
		98	9
		99 & > 99	10
Total Marks	130		





Information on following characteristic were also recorded:

- + Fruit bearing Capacity**
- + Wood Moisture content**
- + Wood Oil %**
- + Age (No. of rings)**
- + Growth rate**

Fruit bearing capacity vary clone to clone.





Nos. Of CPTs found exists on the site = 219

East Mandla	13	Chhindwara	11
West Mandla	08	Sehore	31
North Betul	29	Khandwa	19
Damoh	70	Dewas	04
Jhabua	04	Indore	0
South Seoni	08	South Balaghat	04
Hoshangabad	15	Harda	03

Total trees = 219



Trees excluded in plus tree list due to following deformities:

- ▶ Very old
- ▶ Top dying





Trees excluded in plus tree list due to following deformities:

- ➡ Top broken
- ➡ Hollowing





Trees excluded in plus tree list due to following deformities:

- ▶ Rotten wood sample
- ▶ Heavy termite attack





Nos. Of trees found up to the mark to be declared as plus trees = 136

East Mandla	09	Chhindwara	08
West Mandla	04	Sehore	19
North Betul	16	Khandwa	08
Damoh	38	Dewas	04
Jhabua	04	Indore	0
South Seoni	06	South Balaghat	03
Hoshangabad	10	Harda	01
Total trees = 136			



Tree code	Points allotted	Parameters recorded	Points Scored	%
DPC -1	1. Vigour- 25			
	(a) Height - 15	31.5 m	12	
	(b) Girth - 10	146 cm	6.5	
	2. Bole form - 20	Straight Cylindrical	18	
	3. Branching habit- 25			
	(a) Branch angle -15	90°	15	
	(b) Branch thickness- 10	15-20 cm	10	
	4. Crown diameter – 5	5.7 m	4	
	5. Apical dominance - 10	100%	10	
	6. Self pruning ability - 5	CBH -22 m	5	
	7. Tree health - 10	Bole healthy, leaves infected	5	
	8. Wood properties – 30			
	(a) Specific Gravity - 20	0.74	11	
	(b) Heartwood percentage – 10	94.87	7.5	
	Total -	130	104	80.00



Cumulative scores obtained by the tree and their grading

S.No.	Tree code	Points Scored out of 130	Percentage
1	HBPT - 9	113	86.92
2	KPC - 11	111	85.38
3	BLC - 09	111	85.38
4	KPC - 1	110.5	85.00
5	KPC - 9	110.5	85.00
6	BLC - 07	108	83.08
7	BLC - 10	107.5	82.69
8	CSC - 24	107	82.31
9	BBC - 56	107	82.31
10	KPC - 2	106	81.54



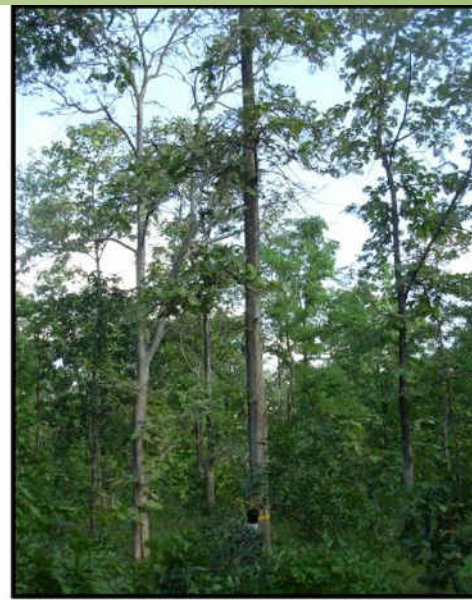
Trait-wise Grading of all the CPTs

Height

Name of Candidate Plus Tree	Height (m)
DPC-3	36.5
KPC-4	35.5
CSC-28	33
BLC-10	33
KPC-1	32.5
KPC-2	32
KPC-7	32
KPC-9	32
BLC-7	32
DPC-1	31.5



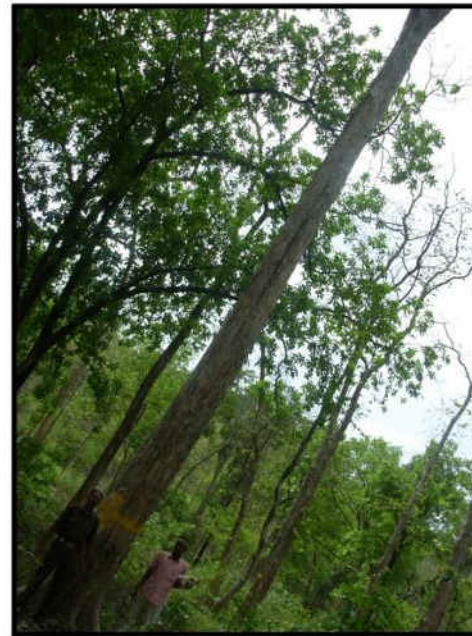
DPC-3 (36.5 m)



KPC-4 (35.5 m)



CSC-28 (33 m)



BLC-10 (33 m)



Girth at Breast Height

Name of Candidate Plus Tree	GBH (cm)
HBPT-9	270
HBC-6	226
HBPT-14	215
BBC-56	210
MJC-18	209
MJC-19	206
MJC-21	195
BSC-06	192
MJC-22	192
SRC-1	190



HBPT-9 (270 cm)



HBC-6 (226cm)



HBPT-14 (215 cm)



BBC-56 (210 cm)



Clear Bole Height

Clear bole height wise grading of candidate plus trees

S.No.	Name of Candidate Plus Tree	CBH. in Meter	Ht. in Meter
1	BLC-9	27	31.5
2	DHC-57	25	28
3	DPC-1	22	31.5
4	BBC-54	21.5	28
5	BLC-7	21.5	32
6	KPC-18	21	29
7	DHC-7	21	24
8	DHC-52	21	21
9	DHC-54	21	21
10	DHC-62	21	23



BLC-9 (27 m)



DHC-57 (25 m)



DPC-1 (22 m)



BBC-54 (21.5 m)



Crown Diameter

Code	Crown dia (m)
DHC-60	2.6
DPC-2	2.9
DHC-63	3.3
DHC-14	3.5
SRKC-14	3.5
SRKC-19	3.5
BLC-09	3.6
DHC-20	3.6
DHC-15	3.7
DHC-59	3.9



Estimated Volume

Code	Volume (cum)	Age (no. of annual rings)
HBPT-9	2.744	159
BBC-56	2.077	164
MJC-18	1.987	141
BLC-10	1.941	131
MJC-19	1.929	157
HBC-6	1.924	156
HBPT-14	1.742	133
BSC-6	1.735	164
MJC-21	1.727	163
MJC-22	1.674	156





Growth Rate in terms of Mean Annual Increment

Growth rate wise grading of candidate plus trees

S. No.	Name of Candidate Plus Tree	Mean Annual increment (cum)
1	HBPT-9	0.0173
2	BLC-10	0.0148
3	MJC-18	0.0141
4	BLC-7	0.0140
5	HBPT-14	0.0131
6	BBC-56	0.0127
7	HBC-6	0.0123
8	MJC-19	0.0123
9	BBC-60	0.0110
10	MJC-22	0.0107



Heart wood percentage

Heart-wood percentage wise grading of candidate plus trees

S.No.	Name of Candidate Plus Tree	Heart wood %	Age (no. of annual ring)
1	BLC-9	99.16	98
2	HBPT-9	98.37	159
3	BBC-43	98.20	156
4	KPC-3	98.09	106
5	BSC-17	97.87	102
6	KPC-7	97.32	90
7	BBC-57	97.20	120
8	CSC-30	97.19	121
9	MJC-22	97.07	156
10	KPC-11	97.02	100

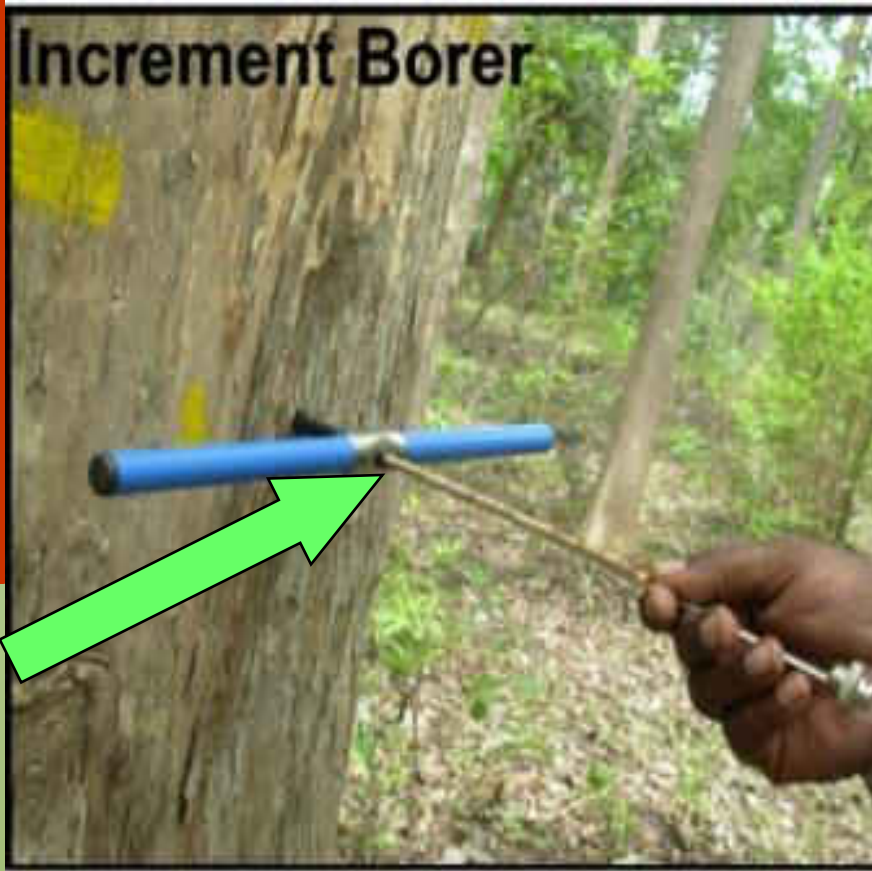
Variation in Heartwood/Sapwood





Specific Gravity

Name of Candidate Plus Tree	Specific Gravity
CSC-26	1.010
KPC-9	0.945
BShC-03	0.941
KPC-1	0.933
BLC-7	0.906
KPC-11	0.901
KPC-20	0.876
DHC-29	0.862
DHC-40	0.858
DHC-65	0.847





Degree of resistant/ susceptibility of candidate plus trees

S. No.	Name of Candidate Plus Tree	Infected leaves %	Scoring	Degree
1	DPC-1	15	1	Most Resistant
2	DPC-2	20	1	Most Resistant
3	DPC-3	50	2	Least Resistant
4	DPC-4	40	2	Least Resistant
5	CSC-05	0	0	Immune
6	CSC-11	0	0	Immune
7	CSC-20	0	0	Immune
8	CSC-22	0	0	Immune
9	CSC-24	0	0	Immune
10	CSC-26	0	0	Immune



Damage Rating for Tree Assessment

Score	Damage (% defoliation)
0	No damage
1	1-25
2	26-50
3	51-75
4	76-100

Degree of Resistance /Susceptibility

S. No.	Degree	Scoring average	Indices
1	Immune	0	I
2	Most resistant	1.00	MR-1
3	Highly resistant	1.25	HR
4	Resistant	1.50	R
5	Moderately resistant	1.75	MR2
6	Least resistant	2.00	LR
7	Moderately susceptible	2.25	MS1
8	Susceptible	2.50	S
9	Highly susceptible	2.75	HS
10	Most susceptible	3.00	MS2

Followed by Roychoudhary et.al. (2003) One side of tree was considered as one replicate and average value of the four sides was calculated to estimate the degree of resistance.



Trees found completely disease free amongst heavy infested surrounding area

S. No	Name of trees	Division	Range
1	MKC-25	West Mandla	Kalpi
2	MJC-21	East Mandla	Jagmandal
3	MJC-30	East Mandla	Jagmandal
4	DHC-20	Damoh	Hathani
5	DHC-29	Damoh	Hathani
6	DHC-44	Damoh	Hathani
7	JKC-1	Jhabua	Katthiwada
8	SRKC-16	Sehore	Rehti



CONCLUSION

- Only 136 trees were found up to the mark out of 306. There is need to select some more plus trees of teak form the natural population.
- Trees of excellent height, girth, clear bole height, ideal circular bole with less tapering, self pruning ability are exist in natural population of Madhya Pradesh, which may be used as reproductive source material for plantation purposes.



- **Wood characteristics like higher specific gravity, higher heartwood percentage which show high inheritance pattern, should be strongly considered along with all the phenotypic characteristics i.e. height, girth, bole form, crown habit, branching pattern etc.**
- **Wide range (0.5 to 1.01) of specific gravity concluding great variation in genetic make of the trees**



Specific trait-wise trees were identified during present study. They may be used in future tree breeding programmes.

A special protection should be provided to conserve those superior genetic resources.

It is also requisite to multiply them through original seeds or through micro-propagation technique to sustain the unique creations of the nature.

Thanks

